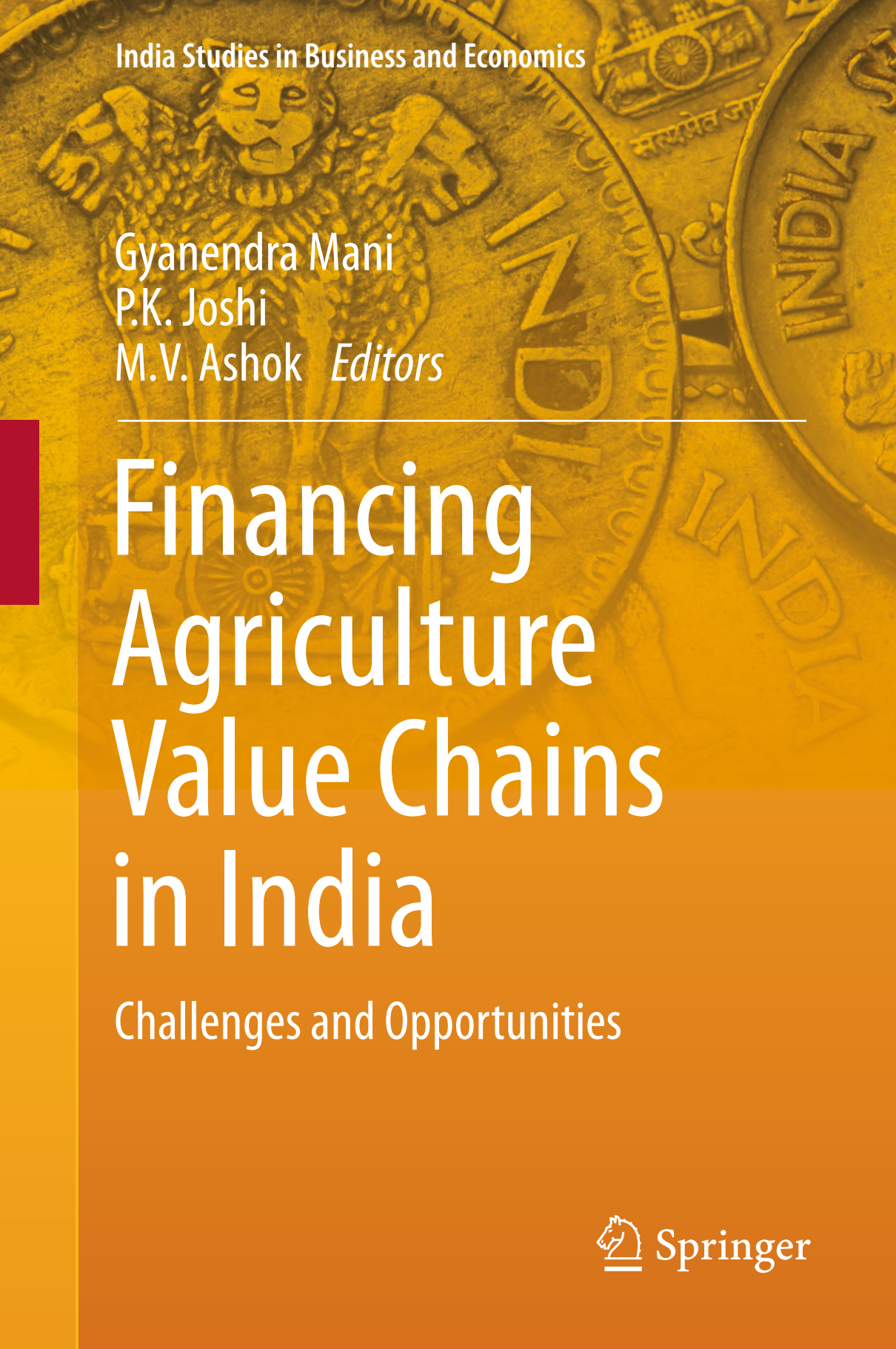
India Studies in Business and Economics
Gyanendra Mani
P.K. Joshi
M.V. Ashok Editors
Financing Agriculture Value Chains in India
Challenges and Opportunities
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Editors

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Editors
Gyanendra Mani
National Bank for Agriculture and Rural Development (NABARD)
Itanagar
India

P.K. Joshi
South Asia Office
International Food Policy Research Institute (IFPRI)
New Delhi
India

M.V. Ashok
Department of Economic Analysis and Research
National Bank for Agriculture and Rural Development (NABARD)
Mumbai
India

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Foreword

Despite a progressive decline in the share of agriculture in the gross value added, fostering rapid growth in agriculture and rural development remains a major policy concern in India. The importance of agriculture goes beyond its economic contribution. It is way of life for about half of India's population, and an important source of income for small-scale entrepreneurs, traders, processors and retailers of the supply or value chains for various agricultural commodities. Indian agriculture is dominated by smallholders, and there is enough evidence to show 'small farms are more efficient in production', but these have now come under a confluence of biotic and abiotic pressures threatening the livelihood of millions of farmers. Nevertheless, the expanding demand for food commodities such as fruits, vegetables, milk, meat, egg and fish that generate higher returns to land, labour and capital, is creating opportunities for faster and sustainable growth of smallholder production systems and livelihood of smallholder farmers and other marginalized sections of the rural populace.

Can smallholder farmers expropriate benefits of growing markets for high-value food commodities and value addition? There is an apprehension. Smallholder farmers are often poor, and their lack of access to institutional credit hinders them from adopting improved technologies and use of quality inputs. They also face barriers in the market. Their marketable surplus is too small to be remuneratively traded in the distant urban demand centres. The traditional supply chains for most agricultural commodities are long and dominated by intermediaries or commission agents; many of them also act as lenders and by tying the credit transactions with product transactions exploit the smallholders by paying them less than the market price of their produce.

Nevertheless, several innovations have taken place in both product and financial markets that can be downscaled to the needs of smallholders. It is being increasingly realized that some of the constraints that farming communities face can be alleviated using these in a value chain framework. The Government of India has been offering several financial incentives to processors, financial institutions and farmers to develop integrated value chains for agricultural commodities. The amendment of APMC Act to allow private investment in agricultural markets and

contract farming, removal of restrictions on inter-state trade of agricultural commodities, promotion of Farmers' Producer Organizations and integration of regulated markets across through e-NAM (electronic national agricultural market) are some of the laudable efforts.

The financial institutions have been supportive of these initiatives by integrating their products and services along the value chains. National Bank for Agriculture and Rural Development (NABARD) too has been engaged in developing innovative products to ensure development of a sustainable value chain for various agri-commodities. Some major initiatives like setting up funds, viz. Producers Organization Development Fund (PODF), Farm Sector Promotion Fund (FSPF) and Food Processing Fund (FPF), for supporting promotion and nurturing of producer organizations and other farm sector-related activities, developing Primary Agricultural Cooperative Societies (PACS) as Multi-Service Centres (MSCs), extending Credit facility to marketing federations, corporations and cooperatives; accreditation of warehouses owned by PACS and extending Warehouse Receipt System in PACS; and implementation of Gramin Bhandharan Yojana (GBY) and Agricultural Marketing Infrastructure (AMI) schemes have directly contributed to the well-being and income of farmers.

This volume is a compilation of papers presented in the National Seminar on 'Financing of Agriculture Value Chains: Challenges and Opportunities' organized by NABARD jointly with International Food Policy Research Institute (IFPRI), New Delhi and comprises contributions of experts on theoretical and empirical perspectives on agricultural value chain and their financing mechanisms, and provides a way forward to improve efficiency, inclusiveness, competitiveness and sustainability of agricultural value chains. It also deliberates upon the possibilities of developing innovative financial products for integration into the value chains. Taking clue from the recommendations, NABARD has started working to evolve financial cum developmental products to effectively integrate smallholders into the value chains. I am quite hopeful that this volume will be useful to various stakeholders including policymakers, agribusiness firms and financial institutions in their efforts towards developing efficient, inclusive and sustainable agricultural value chains for the benefit of millions of small-scale producers and entrepreneurs.

Mumbai, India

Harsh Kumar Bhanwala
Chairman, NABARD

Acknowledgements

From time to time the National Bank for Agriculture and Rural Development (NABARD) organizes dialog, brainstorming sessions, seminars and workshops to seek inputs from experts to improve upon efficiency and effectiveness of its delivery of developmental as well as financial products and services to its clients, especially the farmers. This volume is an outcome of the papers presented and discussed in a national seminar 'Financing of Agriculture Value Chains: Challenges and Opportunities' organized by NABARD jointly with the South Asia office of the International Food Policy Research Institute (IFPRI), New Delhi at Bankers Institute of Rural Development (BIRD), Lucknow. The editors gratefully acknowledge the contributions of the authors, who submitted their paper to the national seminar, although only a few selected papers could find a place in this edited volume. The editors also wish to extend heartfelt thanks to all those who participated in the seminar as panelists, keynote speakers, discussants, rapporteurs and audience, and provided valuable insights during the course of deliberations.

In our efforts from conceptualization of the seminar on this vital topic to its final outcome in its present form as an edited volume, we have been motivated, guided and supported by the top management of NABARD, including Dr. Harsh Kumar Bhanwala, Mr. H.R. Dave and Mr. R. Amalorpavanathan. We express our sincere gratitude to them. Our sincere thanks to Dr. D.V. Deshpande, Mr. Sunil Chawla and their team comprising all faculty members and staff at BIRD/National Bank Staff College (NBSC), Lucknow for their excellent logistic arrangements. We also thank Mr. D.K. Panwar and others in the Department of Economic Analysis & Research for their excellent support in one way or the other in organizing this event.

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Gyanendra Mani
P.K. Joshi
M.V. Ashok

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Editors and Contributors

About the Editors

Gyanendra Mani is currently General Manager and Officer Incharge, National Bank for Agriculture & Rural Development (NABARD), Arunachal Pradesh RO. He obtained Ph.D. in Agricultural Economics from G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. He has conducted about 40 studies on behalf of NABARD and published about 40 articles/research papers in Indian and International journals. He has handled several consultancy projects on behalf of NABARD, including 'Evaluation of SGSY Scheme' for Ministry of Rural Development, Government of India which was instrumental in replacing the SGSY by National Rural Livelihood Mission, presently in place. He also conceived the idea of and launched the 'THE MICROFINANCE REVIEW' Journal on behalf of Bankers Institute of Rural Development (BIRD), Lucknow and managed it from 2009 to 2015 in the capacity of 'Managing Editor' of the Journal. He also coordinated several national-level seminars on Microfinance, Agricultural Value Chains, etc. on behalf of NABARD. As a faculty of BIRD, he conducted two exposure visits of senior bankers to Israel and the Netherlands. He is also a National Resource Person for 'Design of Training' programme being conducted by DoPT, Government of India.

P.K. Joshi is Director for International Food Policy Research Institute (IFPRI) South Asia. Previous to this, he held the positions of the Director of the National Academy of Agricultural Research Management, Hyderabad, India, and the Director of the National Centre for Agricultural Economics and Policy Research, New Delhi. He has received several awards, viz. Dr. M.S. Randhawa Memorial Award of the National Academy of Agricultural Sciences (2009–11), Prof. R.C. Agarwal Lifetime Achievement Award and DK Desai Award of the Indian Society of Agricultural Economics and RT Doshi Foundation Award of the Agricultural Economics Research Association. He has also served as the chairman of the SAARC Agricultural Centre's governing board in Dhaka, Bangladesh (2006–08); chairman of the UN-CAPSA governing board in Bogor (2007); and member of the intergovernmental panel on the World Bank's International Assessment of Agricultural Science and Technology for Development (2007–08). He served as a member of the International Steering Committee for the Climate Change, Agriculture, and Food Security Challenge Programme, led by the ESSP Science Community and the CGIAR (2009–11).

M.V. Ashok is currently the Chief General Manager heading the Department of Economic Analysis & Research at NABARD Head Office, Mumbai. He is a postgraduate in agriculture from the Indian Agricultural Research Institute (IARI), New Delhi, with additional qualifications in Financing Micro Enterprises from UK, besides Financing of Agri Business Management from USA. He has experience in development banking spanning 34 years with different banks like

Canara Bank, RBI and finally with NABARD since 1983. During his tenure in NABARD, he has served as Officer In charge. He has headed two state NABARD Regional Offices at Jharkhand and Maharashtra and has been a faculty member of BIRD, Lucknow. He has extensive exposure to rural finance sector in several countries including Thailand, Kenya, China, Germany, UK and USA.

Contributors

N. Ajjan Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Mohd. Arshad Khan National Institute of Agricultural Economics and Policy Research, New Delhi, India

M.V. Ashok Department of Economic Analysis and Research, National Bank for Agriculture and Rural Development (NABARD), Mumbai, India

Pratap S. Birthal National Institute of Agricultural Economics and Policy Research, New Delhi, India

Ramesh Chand NITI Aayog, Government of India, New Delhi, India

B.S. Chandel National Dairy Research Institute (NDRI), Karnal, Haryana, India

Raj Chandra Iowa State University, Ames, Iowa, USA

Khyali R. Chaudhary National Institute of Agricultural Economics and Policy Research, New Delhi, India

S. Chowdhury National Dairy Research Institute (NDRI), Karnal, Haryana, India

Bahni Dhar College of Fisheries, Central Agricultural University, Agartala, Tripura, India

Madhusudan Ghosh Department of Economics and Politics, Visva-Bharati, Santiniketan, West Bengal, India

K.V. Gouri Basix Consulting and Technology Services Limited, Hyderabad, Telangana, India

P.K. Joshi International Food Policy Research Institute (IFPRI), South Asia Office, New Delhi, India

Sammu Kumar National Dairy Research Institute (NDRI), Karnal, Haryana, India

Vijay Mahajan Basix Social Enterprise Group, Hyderabad, Telangana, India

D.K. Mahawar National Dairy Research Institute (NDRI), Karnal, Haryana, India

Gyanendra Mani National Bank for Agriculture and Rural Development (NABARD), Itanagar, India

A.V. Manjunatha Agriculture Development and Rural Transformation Centre, Institute for Social and Economic Change, Bengaluru, Karnataka, India

Bitan Mondal Institute of Agriculture, Vishwa Bharti, Sriniketan, West Bengal, India

Amar K.J.R. Nayak XIMB, Xavier University, Bhubaneswar, Odisha, India

D.K. Pandey College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh, India

Pallavi Rajkhowa International Food Policy Research Institute (IFPRI), South Asia Office, New Delhi, India

K.B. Ramappa Agriculture Development and Rural Transformation Centre, Institute for Social and Economic Change, Bengaluru, Karnataka, India

Devesh Roy International Food Policy Research Institute (IFPRI), New Delhi, India

Raka Saxena National Institute of Agricultural Economics and Policy Research, New Delhi, India

H.P. Singh Banaras Hindu University, Varanasi, Uttar Pradesh, India

S.P. Singh Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India

Naresh Singla Centre for Economic Studies, Central University of Punjab, Bathinda, Punjab, India

Smita Sirohi National Dairy Research Institute (NDRI), Karnal, Haryana, India

S.D. Sivakumar Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Vinay Sonkar International Food Policy Research Institute (IFPRI), New Delhi, India

Rajib Sutradhar Omeo Kumar Das Institute of Social Change and Development (OKDISCD), Guwahati, India

Md. Tajuddin Khan International Food Policy Research Institute (IFPRI), South Asia Office, New Delhi, India

A.D. Upadhyay College of Fisheries, Central Agricultural University, Agartala, Tripura, India

R. Venkatram Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Part I
Agriculture Value Chain Financing: Theoretical Framework

Financing Agricultural Value Chains: An Overview of Issues, Lessons Learnt, and Policy Implications

Gyanendra Mani and P.K. Joshi

1 Introduction

Fostering rapid growth in farm sector remains an important policy concern in India in spite of a significant decline in its share in the gross domestic product (GDP), from 47% in 1970–1971 to 15% in 2014–2015. The importance of farm sector goes beyond its income contribution, as it still engages about half of the country's workforce and is dominated by small landholders (≤ 2 ha), the majority of whom practice subsistence agriculture. The smallholder farmers face numerous challenges, more prominently the poor access to markets and finances in transiting toward market-oriented agriculture.

Agricultural markets are fragmented, characterized by a long chain of intermediaries, high marketing costs and margins, low value addition, and low share of farmers in the final price that consumers pay. Smallholders have little marketable surplus and face higher marketing and transaction costs in selling it in distant urban markets (Birthal et al. 2005). Their limited access to institutional finance hampers them to adopt productivity-enhancing technologies and inputs, and to invest in land improvements, irrigation, mechanization, and farm storage. Their financial requirements are not large, yet commercial banks and such financial institutions are reluctant to provide them credit because of the high cost of lending relative to size of the loan, and higher lending risks (Chen et al. 2015). Further, smallholders have limited and often less-documented assets to use as collateral to secure institutional finance.

Gyanendra Mani (✉)
National Bank for Agriculture and Rural Development (NABARD),
Itanagar 791111, India
e-mail: gyanendra.mani@nabard.org

P.K. Joshi
International Food Policy Research Institute (IFPRI), New Delhi 110012, India
e-mail: p.joshi@cgiar.org

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Now, it is increasingly realized that some of the constraints related to product and financial markets that smallholders face can be mitigated using value chain approach that brings chain actors including farmers, aggregators, traders, processors, and financial institutions together to gain control over the processes of production, marketing, processing, and distribution so as to reduce transaction costs and enhance competitiveness of the entire chain (Meyer 2007; Trienekens 2011). In India, rapidly growing market for high-value food products (Joshi and Kumar 2016) is creating an opportunity for downstream chain actors to expand their business integrating "front-end" activities of wholesaling, processing, logistics, and retailing to "back-end" activities of production through institutional arrangements such as contract farming and informal producers' associations.

For financial institutions, value chains can serve an important entry point to enhance their outreach to chain actors, mainly small-scale producers and entrepreneurs, and to reduce transaction costs and risks associated with small-sized loans. Chain actors are better informed about the chain activities and business relationships of one another. Through value chain, a financial institution can obtain information on potential borrowers at a little or no cost (Meyer 2007; Casuga et al. 2008; Miller and Jones 2010). Further, value chain approach with its product market orientation can serve as a guarantee or collateral for funding. According to Miller and Jones (2010), "if the financial institutions can tailor their products and services along the value chain, these can reduce transaction costs, enhance their outreach to small-scale producers and entrepreneurs and improve their repayments."

This book is a compilation of the papers presented at the "National Seminar on Financing of Agriculture Value Chains: Challenges and Opportunities" organized jointly by the National Bank for Agriculture and Rural Development (NABARD) and the International Food Policy Research Institute (IFPRI) at the Bankers Institute of Rural Development, Lucknow, during November 29–30, 2015. This chapter provides a brief overview of the key findings, lessons learnt, and policy implications from the presentations and discussions during the seminar.

2 Conceptual Framework[1]

A value chain can be described as the "organized links across groups of producers, traders, processors, and service providers, including nongovernmental organizations (NGOs), that join together to improve productivity and the value added from their activities" (ADB 2013). Thus, a modern value chain differs from the traditional supply chain in its integration of back-end and front-end activities, and governance structure. Table 1 compares the key characteristics of the modern value chains with traditional supply chains.

[1]This section is adapted from Chen et al. (2015).

Table 1 Traditional supply versus modern value chains

Characteristics	Traditional supply chain	Modern value chain
Production	Supply-led bulk production	Market-driven or demand-driven differentiated production
Structure	Fragmented supply chain	Integrated supply chain
Marketing	Large number of market intermediaries	Less number of market intermediaries or direct procurement by the lead firm or processor or marketing firm
Extension services	Local input suppliers or local extension service providing agencies	Provision of extension services and inputs in the chain
Financing	Moneylenders, traders, relatives, and friends mostly for production	Financing within and outside chain through contract

Source Adapted from Casuga et al. (2008)

A traditional supply chain is fragmented and long with high marketing costs and margins at each stage. According to Chand (2012), the Indian agricultural marketing chain involves at least four intermediates between producers and consumers with a large price spread and with no or little value addition to the primary produce. A modern value chain, on the other hand, is organized linking farmers, aggregators, traders, and processors to reduce transaction costs, to minimize uncertainties in supplies and prices, and to add value to produce. A modern value chain, thus, provides a commercial context to production.

Value chains differ with one another in their organization (Miller 2012), and accordingly can be classified as those driven by (i) producers, (ii) buyers, and (iii) facilitators. Table 2 presents the key differences in these value chains. A producer-driven value chain refers to the way the chain actors at its upstream (i.e., producers) are organized to gain access to remunerative markets, to reduce marketing and transaction costs, and to counteract monopsonistic or oligopsonistic tendencies of buyers. It may take the form of a cooperative society, a producer association, or a self-help group (SHG).

Traders, processors, exporters, and retailers build up value chains to have a quantitative and qualitative control over the production process; to reduce transaction costs of aggregation of scattered small marketable surpluses; to optimally utilize their infrastructure, processing capacity, and manpower; and to meet consumer preferences of safe and quality food. These chains are termed as buyer-driven chains. Contract farming is a common form of buyer-driven chains.

Buyer-driven chains are often criticized because of the tendency of the buyers to exclude small-scale producers and to extract monopsonistic rent. Therefore, to make the market work for small-scale producers, developmental organizations including NGOs and government agencies facilitate collective action in the form of cooperatives, producer associations, and self-help groups. Buyers may also promote

Table 2 Business models for agricultural value chains

Type of business model	Drivers	Rationale
Producer-driven	• Small-scale producers, especially when formed into groups such as associations or cooperatives • Large farmers	• Access to new markets • Obtain higher market prices • Stabilize and secure market positions
Buyer-driven	• Processors • Exporters • Traders • Retailers	• Assure supply • Increase supply volumes • Serve niche markets and consumer preferences
Facilitator-driven	• Nongovernmental organizations • National and local governments	• Make markets work for the poor • Facilitate regional and local development

Source Miller (2012)

collective action through intermediaries. Such chains are termed as facilitator-driven value chains.

The papers by Joshi et al. (Chapter "Elements of Agriculture Value Chain Financing: A Review") and Gouri Krishna and Vijay Mahajan (Chapter "Different Models of Financing Small Farmers' Agricultural Value Chains") in this volume are typical of the conceptual framework discussed above in the context of Indian agricultural marketing system.

3 Agricultural Value Chains in India: Efficiency, Inclusiveness, and Sustainability

In an agrarian setup dominated by smallholders, evolving efficient inclusive, and sustainable value chains is a major challenge. Chain actors perform differentiated activities of production, procurement, transportation, storage, and distribution that otherwise are interconnected. Therefore, from the perspective of financing a value chain, it is important for a financial institution to understand the organization of a value chain and its performance. This section summarizes the key empirical findings culled from the papers presented and discussed, and the keynote addresses delivered in the seminar, and wherever required these observations have been complemented by the evidence available in the literature.

3.1 Types of Value Chain

In India, the value chains for most agricultural commodities are in rudimentary stage and yet to develop. Evidence from a large-scale survey of farmers indicates that more than 46% farm households sell approximately 58% of what they produce (GoI 2014), but bulk of it to the wholesalers and retailers (80%) and to the public agencies including Food Corporation of India (10%). Processors share hardly 5% of the total farm sales, and it is assumed that most of them source their requirements through institutional arrangements such as contract farming, cooperatives, and producers' associations.

Value chains are relatively better developed for perishables such as milk, broilers, eggs, fruits, and vegetables. In the case of milk, dairy cooperatives and private processors each procure about 10% of the milk produced. Most private dairy processors (multinational as well as domestic) procure their requirements through contract or contract farming. The study by Birthal et al. (Chapter "Formal Versus Informal: Efficiency, Inclusiveness and Financing of Dairy Value Chains in Indian Punjab") on value chains shows that in Punjab, a considerable proportion of farmers sell milk to dairy cooperatives, and processors, both multinational and domestic.

For broiler production, contract farming has emerged as a dominant mode and presently, three-fourths of the total broiler production takes place through contracts. Facilitator-driven value chains have also come up in some states (for example, Jharkhand), where poor producers have been organized into self-help groups or cooperatives to capture benefits of the expanding market opportunities (Ashok, Chapter "Strengthening Value Chain of Compound Cattle Feed" in this volume).

For marketing of fruits and vegetable, there are a variety of localized value chains, driven by buyers, producers, and facilitators. HOPCOMS in Karnataka and SAFAL (now MDFVL) in Delhi are examples of such facilitator-driven value chains (Birthal et al. 2007). HOPCOMS, the cooperative retail chain, sources its requirements from farmers' cooperatives. SAFAL, a retail chain promoted by the National Dairy Development Board, procures its requirements through informal producers' associations promoted by it. Many export-oriented agribusiness firms have promoted producers' associations to control over the production process to enable the farmers to comply with safety standards of the importing countries. For example, the Agrocel Industries secure their requirement of organic cotton and Basmati rice through producers' associations (Chen et al. 2015), and Mahagrapes (an apex organization of grape growers) sources grapes through cooperatives (Roy and Thorat 2008).

A number of agribusiness firms secure their requirements through contract farming (Singh and Singla 2011). Prominent among these are Nestle, Heritage Foods, PepsiCo, McDonalds' Global Greens, Namdharis, and Reliance Fresh. In this volume, Ramappa et al., Singla, and Sutradhar describe contract farming of vegetables.

3.2 *Efficiency*

Though not all, some studies in this volume do provide credence to the available empirical evidence that the farmers associated with value chains realize higher profits compared to those who are not. Singla (Chapter "Innovations in Agricultural Marketing in India: A Case Study of Supermarket in Punjab"), Sutradhar (Chapter "Smallholder Participation in Supermarket Driven Agri-Food Supply Chain: A Case Study of Reliance Fresh"), Venkatram (Chapter "Value Chain Analysis of Dry Fish in North-East Region of India"), and Birthal et al. (Chapter "Formal Versus Informal: Efficiency, Inclusiveness and Financing of Dairy Value Chains in Indian Punjab") find that participants in the value chains are more efficient technically, reap better harvest, and realize higher and stable prices. The main benefits accrue from reduction in marketing and transaction costs. Singla finds that despite higher cost, the contract farmers realize 10% more net returns. Venkatram (Chapter Value Chain Analysis of Dry Fish in North-East Region of India) finds potato production more efficient technically as well as economically when the producers align with a value chain. In the case of tomato, Ramappa et al. (Chapter "Tomato Value Chain in Karnataka") report a significant reduction in the marketing costs due to contracts.

In the case of dairying, Birthal et al. (Chapter "Formal Versus Informal: Efficiency, Inclusiveness and Financing of Dairy Value Chains in Indian Punjab") have shown that the farmers in a cooperative value chain realize more profit compared to those associated with other formal and informal value chains. They also find that large dairy farmers receive a relatively higher price probably because of their better bargaining power and compliance with firm-imposed food standards. Evidence from broiler (Ashok, Chapter "Strengthening Value Chain of Compound Cattle Feed") and fish (Upadhyay et al., Chapter "Broiler Value Chain Model for Empowerment of Poor Tribal Women: A Case Study in Jharkhand") value chains also points toward higher profits for value chain participants.

3.3 *Inclusiveness*

One of the criticisms against modern value chains, especially those driven by buyers, is that these are reluctant to work with smallholders because of the higher cost of contracting with a large number of them. A common observation from the papers presented in this volume is that modern buyer-driven value chains do not ignore smallholders completely because contracting with a large number of them, though may be costly, provides some advantages also, such as spreading supply risk. Birthal et al. find that firms often prefer contracting with resource-rich farmers capable of producing large volumes and complying with safety standards imposed by them.

To reduce the cost of contracting with smallholders, many agribusiness firms integrate smallholders indirectly through aggregators or commission agents or

producer associations (Chen et al. 2015). For example, Nestle sources its milk supplies from small producers through its local commission agents, and SAFAL integrates small producers through producers' associations promoted by it (Birthal et al. 2005).

3.4 Competitiveness

The entry of new buyers enhances market efficiency or competitiveness. This is evident from the statistically insignificant difference in the prices of milk across different value chains (Birthal et al., Chapter "Formal Versus Informal: Efficiency, Inclusiveness and Financing of Dairy Value Chains in Indian Punjab"). Likewise, studies by Singla (Chapter "Innovations in Agricultural Marketing in India: A Case Study of Supermarket in Punjab"), Sutradhar (Chapter "Smallholder Participation in Supermarket Driven Agri-Food Supply Chain: A Case Study of Reliance Fresh"), and Ramappa et al. (Chapter "Tomato Value Chain in Karnataka") indicate no significant difference in the prices offered by value chain organizers and the market prices. These observations are location-specific, and for markets to be competitive across space, these need to be integrated. Ghosh (Chapter "Optimal Institutional Architecture of Farmer Producer Organizations for Sustainable Value Creation for Small and Marginal Farmers") has shown that food grain markets in India are integrated. But, Roy et al. (Chapter "Impact of Market Reforms on Integration of Food Markets in India") find a lack of integration among markets for a number of commodities, and argue that back-end infrastructure is essential for integration of markets and to effectively implement the government's initiative of electronic National Agricultural Markets (e-NAM).

3.5 Financing

From genetic to end use, chain actors need finances for production, procurement, processing, storage, and distribution. Input suppliers need credit for manufacturing, bulk buying, stocking, and distribution of seeds, agrochemicals, farm equipment, and machines. Farmers need credit for purchase of inputs and for investments in land improvements, irrigation, storage infrastructure, machines, and equipment. Traders need finances for purchasing, bulking, and stocking of the produce before it is sold, and also for purchase of vehicles, to construct a warehouse, or pay for equipment to weigh or grade products. Small-scale processors require financial support for investment in processing infrastructure. Wholesalers and exporters need credit not only for buying, bulking, and stocking of product but also for their retail chains.

As opposed to conventional financing of a particular segment of the marketing system, value chain financing represents "a flow of funds to different links of the value chain, or among these links, in order to improve efficiency and

competitiveness, to reduce risk within the chain, and also to promote and develop the chain" (Shwedel 2010). The approach allows the chain actors an increased access to finances without much emphasis on collateral. Transactions are intertwined to allow automatic repayments of loans via transaction proceeds in the product market. And, the scale economies in product and financial markets reduce the lending costs and risks (Miller and Jones 2010).

Value chain activities can be financed using funds from either the participants of a chain or the sources outside the chain. In the case of internal financing, the lender may be a trader, a processor, or an institution that assumes a dual role of a buyer of produce and a provider of funds for production and processing. Financial support may be in the form of cash or kind and without collateral, but generally against hypothecation of crop/commodity or a commitment of sale of the produce. Internal financing has a greater role in the initial phases of the development of value chains. But, as a value chain consolidates to improve its efficiency and market position, the commercial banks and other financial institutions face lower transaction costs and lending risks; external financing overtakes internal financing (Casuga et al. 2008).

Though not explicit in most papers in this volume, there is an indication of value chains being financed internally by the lead firms in terms of provision of inputs and services, which is essential for sustainability of the chain. Birthal et al. find financing of value chains from external sources such as commercial banks and informal lenders. External financing from financial institutions is limited largely to resource-rich farmers.

3.6 Infrastructural Support

It is argued that despite increase in production, the prices of fruits and vegetables are going up due to storage constraints, where system could not handle more than 60% of annual production, as such, the 40% goes as a waste. This is basically on account of the fact that there are wide gaps in pack houses, reefer vans, and ripening chambers for handling perishables, and it suggests that almost all cold storage units are performing with average capacity utilization of 75%, and therefore, for the supply chain management, the banks have to develop credit products focusing mainly on cold chains, other than cold storages (Kohli 2015).

3.7 Warehouse Receipt Financing

It has been indicated by certain studies that the quantum of percent of net incremental earnings has been generally more in NWR issued by Agriculture Produce Market Committee (APMC) as compared to commercial banks which is mainly due to the fact that the cost of loan and storage cost per quintal are higher in the case of NWR financed by commercial banks as compared to APMC. This suggests that the

warehouse-based marketing should be promoted by strengthening APMC and delinking crop loan and warehouse receipts against pledge loan in commercial banks.

4 Key Lessons

Both value chains and value chain financing are gaining ground in India. The evidence presented in this volume indicates that value chain approach has considerable potential to (i) improve small farmers' access to markets and financial resources, (ii) reduce transaction costs, (iii) mitigate supply and market risks, and (iv) build human and social capital. We have also found that value chains have mostly been developed for commodities that have higher income potential and strong market demand, but these have remained localized.

Developing value chains and their financing is a big challenge but not insurmountable if value chain organizers, financial institutions, and policy makers follow innovative and directed approaches. A few lessons that we could synthesize from the papers included in this volume and also from the keynote addresses and presentations are as follows:

- Collective action in the form of self-help groups, cooperatives, producer associations at upstream of the value chain is essential to overcome scale limitations in aggregation of dispersed production and distribution of inputs and services, but it may not happen on its own; it requires intermediation or facilitation by the nongovernmental organizations, governments, or lead firms.
- Integration of financial products and services along the value chains will be easier through collective architecture connected with institutions engaged in delivery of technologies, inputs, and extension services.
- Agribusiness firms should have an appropriate pricing strategy based on open market prices allowing some premium as incentive to overcome the problem of extra-contractual sales and to comply with food safety standards. In the case of inputs, lead firms that buy in bulk should transfer a part of their price margin to farmers. These are important for the sustainability of value chains.
- Given the commercial orientation of value chains, the financial institutions must recognize the product market orientation of a value chain as substitute for physical collateral, i.e., these institutions should use contract agreements as collateral and guarantees by buyers or intermediaries or governments for lending to chain participants. However, the financial institutions should identify the short-term and long-term challenges in financing value chains in consultation with the chain actors so as to develop a road map to effectively integrate financial products along the value chains.
- In absence of external financing, chain participants may mobilize surplus funds from within the chain for their lending or leasing to those who need financial assistance.

- Management of value chain risks serves as reassurance to financial institutions to integrate their products in the value chain. This can be done through provision of inputs and technical services by the lead firms or facilitators. The price risks are rarely targeted except in broiler value chains where contracts provide fixed growing charges to farmers (Ramaswami et al. 2005). The producer organizations (e.g., cooperatives) can use surpluses and savings to protect farmers from production and price risks.

To sum up, a winning value chain model should be competitive, inclusive, and sustainable.

5 Policy Implications

Most value chains are context-, location-, and commodity-specific, and these have not been evaluated systematically for their potential for replication elsewhere, nor have the policies for their promotion been comprehensively reviewed. Macroeconomic conditions and external environment in the form of policies, laws, standards, regulations, and institutional support services can have significant impact on the performance of value chains. Some important areas for policy intervention are:

Investment in public infrastructure: Investment in public infrastructure such as roads, irrigation, electricity, and communication is essential not only to improve agricultural productivity but also to attract private investment in infrastructure (cold storages, refrigerated transport, food processing) that supports markets and market linkages and value addition, enabling the farmers to capture benefits of value chains. In the context of e-NAM, it is essential for the government to provide several public goods in the back end such as warehousing, grading facilities, laboratories, and banking and communication facilities for effective functioning of electronic markets.

Improvement in regulatory environment: The government should facilitate chain actors' access to finances from commercial banks and other financial institutions by building alliances among financial institutions, lead firms, and farmers in order to strengthen value chain financing. For this, it is essential to identify regulatory bottlenecks and improvise upon them to strengthen interface between products and financial markets. For example, e-NAM would require harmonization of regulations or amending thereof consistent with the spirit of market integration. These include reforms in Essential Commodities Act that differentially imposes stock limits on different stakeholders in the value chain, and effective implementation of the Modal Marketing Act.

Development of support services: To enable the farmers to capture benefits of value addition, the agribusiness firms need technological and extension support which at present is weak for the participants in the value chains. The government may promote alliances among research institutions, extension systems, and

agribusiness firms for effective dissemination of technological products and extension services to various chain actors. A competitive value chain is more amenable to financing by the commercial banks and other financial institutions.

Setting up of agri-export zones: Nationwide, 60 product-specific agri-export zones for value chain development have been identified. It would be important to follow a holistic approach to develop commodity-specific value chain bringing together different chain actors, regulatory bodies, and financial institutions.

Awareness generation about warehouse receipt financing

There is a need for generating awareness among the farming community about the significance of warehouse receipts which can act as a security against institutional and price risks, and also as a collateral to obtain institutional finance. This may require organizing trainings/capacity building programs for bank officials about WDRA Scheme and NWR financing.

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Elements of Agriculture Value Chain Financing: A Review

P.K. Joshi, Devesh Roy and Vinay Sonkar

1 Introduction

There is a robust evidence that credit matters in development. Experimental evidence documented by De Mel et al. (2008) in Sri Lanka and McKenzie and Woodruff (2008) in Mexico indicated that micro-entrepreneurs who randomly received grants to procure inputs experienced a higher return of 5–20% compared to the control group. Upon evaluating the 'Million Baht Village Fund' in Thailand, one of the largest government-backed microfinance programmes worldwide, Kaboski and Townsend (2012) find that the programme of increasing credit flow among the villagers increased investment in agriculture, pushed up wages and augmented income growth in agrarian centres. Working on a data set of 547 farm households in northern Peru, Guirkinger and Boucher (2008) find that limited access to credit reduced the value of agricultural output to the extent of 26%. As per results based on primary surveys, a similar trend has been documented by Kumar et al. (2013), who find that 74% Chinese households and 78% Indian households employed a lower level of agricultural input in crop production due to inadequate access to credit.

'Agriculture continues to be a fundamental instrument for sustainable development and poverty reduction' (World Bank 2008). Yet, lack of financial instruments in agriculture remains prevalent, and they are very costly and one-sided distributed, severely limiting smallholders' ability to compete (World Bank 2008). Value chain finance relates to use of value chain in providing customized service to participants along the chain mitigating risk and enhance the efficiency of the value chain.

P.K. Joshi (✉)
South Asia, International Food Policy Research Institute (IFPRI),
New Delhi 110012, India
e-mail: p.joshi@cgiar.org

D. Roy · V. Sonkar
International Food Policy Research Institute (IFPRI), NASC Complex,
New Delhi 110012, India

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The internal value chain finance is financing within the value chain, while external value chain finance is financing from outside the value chain. The example of internal value chain finance is that when a supplier gives credit to a farmer or when a big firm provides funds to a market arbitrator. The external value chain finance is when a bank gives a loan to a farmer based on a contract with a trusted buyer or a warehouse receipt from a recognized storage facility (IFAD 2012).

There are many options for organizing financing also from outside the value chain, ranging from the regular finance term loans, overdrafts, and lines of credit to less common finance options such as factoring, equity, joint ventures, and commodity exchanges. There are also various mechanisms and methods for attenuating the risks (market or price risk, crop or weather risks, production-related risks, collateral risks, or human factors) that influx agribusiness finance (African Development Bank (AfDB) 2009). An example of external value chain finance is the case of smallholders in Kenya where high-value crops producers can access microfinance for fertilizers. The exporter used to pay the farmers through the microfinance, and it is supposed to deduct the scheduled loan payments before releasing the net proceeds to the farmer group (Marangu 2007).

VCF offers a platform where participants connect to other participants in the value chain and gives opportunity to expand financing for agriculture, enhance efficiency and repayments in financing, and strengthen linkages among participants in value chains (FAO 2010). It can boost quality and cost-effectiveness in financing agricultural value chains by the following:

- Associating the financing needed to operate the chain;
- Customizing financial products to meet the needs of the participants in the chain;
- Making cost-effectiveness through the direct disbursements of loan payments at the time of product sale; and
- Using value chain finance knowledge and linkages of the chain to attenuate risks to the chain participants.

Agricultural Value Chain Finance (AVCF) is not an enlargement goal but rather attains other social and economic goals (IFAD 2012). AVCF is a set of different types of financial tools that can be utilized for agricultural and agribusiness financing. AVCF can facilitate increased financial access and reduce agricultural costs and financing risks.

After many years of deteriorating investment, there is, in fact, a reinvigorated interest in agricultural financing in India (FAO 2010). During the global food price crisis, higher prices provided opportunities for private sector for greater profits. This has indication for microfinance as investment decisions are usually based on evaluating the future trends and market potential.

In this paper, we review agricultural value chain financing in terms of its different forms. Drawing from the literature, we study how the choice of financing varies with the context of the value chains. We also link the innovations in the value chains and their bearing on financing. We then look at some real-world examples

and how they associate with the conceptual elements of value chain financing in agriculture.

With the above background, the paper is organized as follows. Section 2 presents review on the evolution of value chain finance, highlighting the continued high rates of growth in organized value chain financing. Section 3 provides the types and designs of value chain finance. Section 4 presents value chain modes and financial instruments while Sect. 5 presents risk mitigation products. Section 6 presents some innovations in value chain finance and finally Sect. 7 presents conclusions of this paper.

2 Value Chain Financing: A Review

The agro-food sector has experienced changes and now focuses more on demand rather than producer-defined agricultural goods. 'A global, liberalized and fragmented marketplace with little seasonality and product diversity; food safety and traceability requirements; and higher quality standards in conjunction with the enforcement of basic environmental regulations (FAO 2010)'. This development requires a better recognition of transactions within each value chain. Agricultural finance has always been difficult for several reasons including very high transaction costs, very high risk and less information which often lead to adverse economic policies and lack of guarantees, wide client distribution and lack of some basic infrastructure, particularly in rural areas.

VCF is very closely linked with value chain enhancement, and it has various constraints and weaknesses that must be overcome to allow a development and have a better flow of finance. Poor implementation of contract, few quality laboratories, lack of microcredit finance, opacity in pricing of credit and technical assistance packages are the main constraints in VCF (Fries 2007). With specific regard to financing, the foundation firms in the chain, who have the ability to get credit from formal chain, can offer finance to others in the chain (Fries 2007).

The primary focus of the literature on financial enhancement has been on two strands. The first strand of empirical inquiry revolves around identifying the determinants of access to financial services from formal institutions. The second strand evaluates the impact of access to the formal financial sector. Formal financial institutions include both public and private commercial banks, regional rural banks, village cooperatives and their higher tier bodies.

Stiglitz and Weiss (1981) point out that formal lending is affected by problems of adverse selection and moral hazard which can limit access to credit to a selected few. To overcome the problems, there are screening and signalling mechanisms. For example, a prospective borrower can build up credit history with small test loans to win the confidence of the formal lenders, or provide marketable collateral of lender's interest and arrange for third-party guarantee to safeguard lenders' interest in case of default (Besley 1994). The poor are often unable to arrange these collaterals and are thus often unsuccessful in accessing financial services from the

formal sector, even if the venture carries an adequate prospect of becoming a profitable initiative (Barslund and Tarp 2008).

Even if a borrower could obtain access to formal credit sources, he/she may only meet a part of her financial requirements for entrepreneurial activities, leaving a large portion of his/her need to be met by informal lenders (Fisher and Sriram 2002). This inaccessibility of formal finance or partial fulfilment of credit requirements from the formal sector lender creates a spillover of unmet demand (Bell et al. 1997) into both the informal (e.g. money lenders, middlemen, input dealers, output traders, friends and relatives) and semiformal (such as microfinance) credit markets.

Researchers such as Sarap (1990), Pal (2002), Sahu et al. (2004), and Pal and Laha (2015) in India; Yadav et al. (1992) in Nepal; Zeller (1994) in Madagascar; Mohieldin and Wright (2000) in Egypt; Phan and Lensink (2007) in Vietnam; Guirkinger (2008) in Peru; Zhang (2008) in China; and Johnson and Nino Zarazua (2011) in Kenya and Uganda assess a rural household's likelihood of obtaining access to formal credit sources over informal ones. Evidence across all these countries suggests that access to financial services from formal creditors is confined within the domain of resource-rich households.

Studying the loan data of 253 small and medium-sized loaners of an Indian bank, Banerjee and Duflo (2004) find that firms expanded their businesses significantly after they obtained access to credit. Burgess and Pande (2005) show that in India, access to formal sources of financial credit substantially contributed to poverty alleviation. Klapper et al. (2006) find that access to financial services promoted the entry of new firms as well as supported the growth of small enterprises.

3 Type of Value Chain Finance

Value chain finance can be categorized into three types (Shrestha et al. 2010)

- Self-finance value chain finance
- Direct informal 'within chain' value chain finance
- Indirect formal financial services 'from outside the chain' value chain finance.

3.1 Self-finance Value Chain Finance

Self-finance value chain finance is the financing system where producers themselves are able to finance their own production. In this system, producers generally have money from the last saving or retained earnings. In this kind of system, the role of an intermediator is small or there might be no role of intermediators in this kind of system (Shrestha et al. 2010).

3.2 Direct Informal 'Within Chain' Value Chain Finance

Direct value chain finance addresses to the financing system where foundation of the value chain finances the activities of chain. Figure 1 illustrates the mechanics of direct value chain within financing (AfDB 2013 workshop report). In this system, for example, input suppliers provide credit often in kind such as fertilizers, firm equipment, labour, and the producer can repay the input supplier either in kind or in cash (after selling the produce). The direct value chain finance usually consists of short-term loans to ensure a smooth flow of products and to keep the activities going and the value chain functioning. This arrangement largely rests on the trust between the input suppliers and the producers.

3.3 Indirect Formal Financial Services 'From Outside the Chain' Value Chain Finance

The word 'from outside the chain' itself signifies the meaning of this financial system. In this system, some entity (financial institution) from outside the chain finances the chain. The non-actor in this financial arrangement has one-to-one relationship with the participants in the chain. There are different levels in the value chain which varies by level of financial services, and the involved institution in the value chain also varies with the level of chain. There is an external organized financial institution involved in such kind of financial value chain. The elements of external VCF drawn from AFDB (2010) are presented in Fig. 2. The indirect or

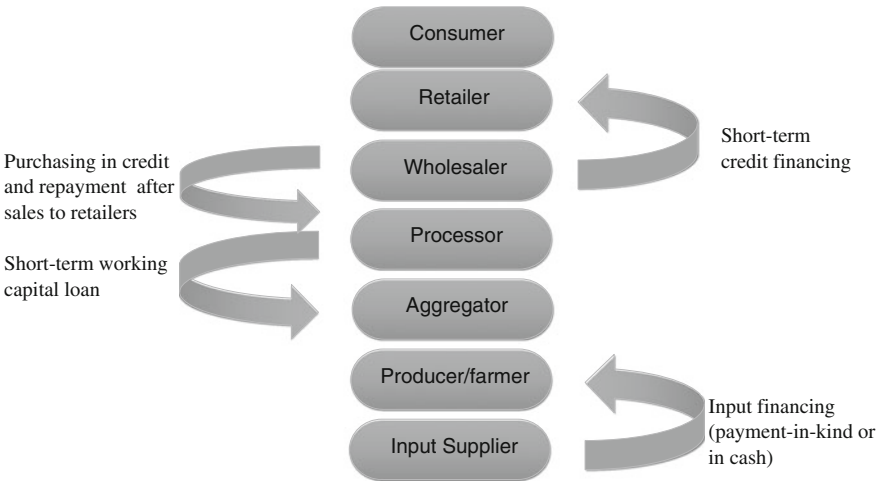

Fig. 1 Illustration of direct informal 'within chain' finance. *Source* Agricultural Value Chain Financing (AVCF) and Development for Enhanced Export Competitiveness

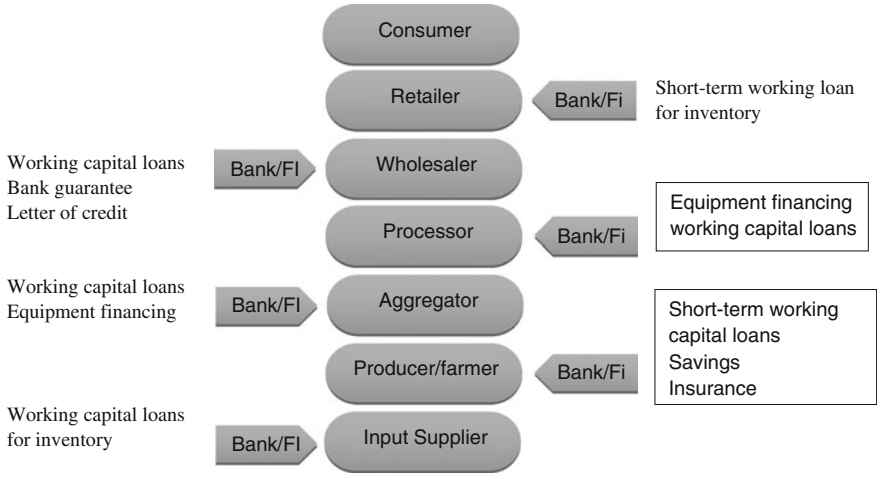

Fig. 2 Illustration of indirect formal financing services 'from outside the chain' value chain finance. *Source* Agricultural Value Chain Financing (AVCF) and Development for Enhanced Export Competitiveness

unorganized finance has various forms of financing such as microcredit, savings, insurance (weather insurance, crop insurance) and/or remittances. This procedure usually survives in long-term financing system as compared to organized or direct finance, and it requires large amount of money to be invested (Shrestha et al. 2010).

The most important and useful benefits of this system are that farmers have low risk of exploitation and there is transparency. Yet, there are important constraints in this mode of finance such as high transaction costs and information asymmetry particularly related to credit worthiness of the borrower that can result in adverse selection.

4 Value Chain Models and Financial Instruments

4.1 Product Financing

4.1.1 Aggregator Credit

Aggregator credit is a credit where aggregator provides advance loans to producer and these loans are repaid just after the harvest, mostly in kind. Under this kind of system, the aggregator provides insurance to producer that he will procure product by financing the production. In this system, producers get readily accessible credits for their production and have guaranteed buyers for their produce. This financing system is short term and depends on seasons as well.

We would like to check on what exactly does the aggregator bring to the financing arrangement. Being risk neutral, the integrator can allow the farmer to exchange the risk in a way that reduces the uncertainty faced by him/her. The aggregator can charge lower input and output prices are lower for the farmers within the linked financing arrangement.

Aggregators may be medium or large farmers or cooperatives or other farmer producer organization.

Since aggregators are continuously in touch with farmers and monitor farmer's production, farmers and aggregators both work together and try to minimize the risk associated with operations. The long-standing relationship and repeated interaction between aggregators and farmers help in further advances of the next production cycle (Carlos and Pagura 2016).

4.1.2 Input Supplier Credit

Input supplier credit is the primary source of credit to small and poor farmers. Input supplier credit is direct but a unorganized financing system is based on the loyalty relationship between the input supplier and the producers. This relationship reduces the cost of client selection and monitoring over time (Pearce 2003). Under this system, input suppliers provide agricultural inputs such as chemicals, seeds, fertilizers and equipment as a loan to the producer, and this loan must be repaid by the producer just after the harvest or any other mutually decided time. This repayment of loan is either in kind or in cash. Input suppliers generally do not give any discount to the producers because there is cost attachment with the short-term loans.

4.1.3 Marketing Company Credit

In this financing system, marketing agency, processor or other company provides credit in cash or in kind to farmers, producer, aggregators or other value chain enterprises. The mode of repayment is most often in kind. For example, a marketing company provides equipment for harvesting to the farmers and farmers must pay rent to the marketing company just after harvesting.

4.2 Lead Firm Financing

In this system, a lead firm gives direct credit to foundation player in the chain including producers. Lead firm financing system is same as the contract farming. In contract farming, the producer receives technical assistance and market access from the lead firm and ensures quality and timely products to the lead firm (Miller and Jones 2010).

This arrangement differs from aggregator, input supplier and marketing company credit where the farmer produces crop under guaranteed buyback agreement and the lead firm finances all requirements at the production stage. The lead firm not only supplies inputs and working capital but also finances extension services, high-quality crop seeds, technology transfer, training and supervision of production. The lead firm plays a very crucial and central role in the production cycle (IFAD 2012).

The financial market imperfections clearly affect the smallholders proportionally more than the well-off farmers. Often, the reason the smallholders do not invest and are thus unattractive for firms is credit market imperfection. Not only do they lack adequate collateral to acquire credit, the interest rates and prices paid for credit services by small farmers are also usually much higher. Hence, if the contract linkage requires farmers to invest or have sufficient supply of working capital, innovation requires correcting (to the best possible extent) the credit market imperfection in a way that it continues to be profitable for the participants in the value chain.

Hence, in contractual arrangements with smallholders in agricultural value chains, it is common to provide technical assistance, inputs and credit that would otherwise not be affordable to the smallholders. The innovation in the arrangement lies in devising institutions that make it incentive compatible for small farmers to repay in terms of honouring their contracts, as well as being financially viable for value chain participants to extend credit and inputs. It often requires ensuring returns to farmers over and above their outside option of side selling, akin to the efficiency wage in the labour markets.

4.2.1 Some Examples of Contract Farming by Firms in India

Birthal et al. (2005) study the contract farming arrangements by two large firms in India. The first case is of Nestle India Limited in dairy and the other is Venkateshwara Hatcheries in poultry. Both milk and poultry are highly prone to production and marketing risks that threaten the profitability, particularly on small farms. These risks also affect the profitability of the firms. To minimize risks, Nestle started contracting with milk suppliers in the early 1960s in Punjab while Venkateshwara Hatcheries began integrating its activities with that of broiler production through contract farming beginning in the late 1980s.

Nestle follows a twofold contracting arrangement. For those having more than 25 milch animals, it enters a formal contract. For small producers, the milk is procured through the agents, with whom the firm has a formal contract. The second form of linkage dominates. In the poultry contract, contract growers are provided day-old chicks, feed and medicines by the other contract party. The contract growers are supposed to have land and labour. The farmers receive net price by the firm at the end of the production cycle, and the firm continuously monitors the quality of chicks. Once the firm is satisfied with the quality, only then the payment to the farmers is made. If they find any less quality of chicks, they deduct money from the contract amount.

The net price received by the farmers fluctuates within a narrow band, and the firm also provides insurance to farmers for mortality rates up to 5%. The results from the primary surveys in these two cases reveal significant difference in the average profits of contract and non-contract farmers in both milk and poultry. Compared to almost double profits for milk contract farmer, the profits for the contract poultry producers were 13% higher. The source of advantage that contract farmers had over non-contract farmers was mainly due to savings in production and marketing costs. The costs of milk production for contract farmers were lower by approximately 21%. In poultry, the estimated cost savings for contract growers from cheaper feed and medicine (provided by the firm) equal approximately Rs. 1.9 per kg of bird, a saving of nearly 8%. The input chicks, medicines and feed accounted for about 75% in the total cost of broiler production and were the critical inputs for productivity and profitability.

In both these cases, as part of value chain financing, the contract farmers were enjoying indirect credit for important inputs without any interest and transferring some risks to the firm. Ramaswami et al. (2006) show indirect credit as the main source of gain for the contract producers for Venkateshwara Hatcheries. Hence, the extent to which the contract farmers are relatively better off depends on the implicit interest cost savings. The statistical difference in the net income of the two groups of poultry farmers depends on the assumption regarding the counterfactual interest rates faced by the contract farmers in absence of indirect credit from the firm. Since the firm provides inputs and training along with the credit to the farmers, the firm is induced to protect investments by reducing defaults.

4.3 Receivable Financing

4.3.1 Trade Receivable Financing

Receivables finance is generally used for immediate cash flow by businesses to convert sales on credit terms. In the receivable financing method, the receivable credit line shows the financial strength of the buyer rather than the seller. Receivables mechanism works where there is a generically weak credit environment. There could be several reasons for it. For example, collection might be difficult. 'This characteristic of export receivables allows exporters to use it as an alternative source of financing when conventional financing is difficult due to lack of a supportive financing environment' (FAO 2010).

The most difficult and critical time for the farmer is usually the harvesting. At harvest, farmers generally fall short in terms of finance and they tend to go to money lenders or local traders for the funding. Farmers often sell their produce to money lenders or traders at extremely low prices (FAO 2010). Most farmers need financing before the payment for sales are realized for services such as hiring labour for harvest and other purposes. In summary, trade finance, which provides funding structured around purchases and sales transactions, guaranteed by products and

accounts receivables, is very important and widely used. In times of financial crisis, it plays an even more important role when other funding is restricted and the overall fear of risk is heightened.

5 Risk Mitigation Products

One of the essential elements of VCF is how it mitigates risks. Farmers' experience has shown that there are several ways to reduce risk. There are many different types of risks, viz. information risk, market knowledge risk or chain knowledge risk (Tiffen 2006). Attenuating risk is one of the most important elements in credit finance. These risks are categorized into three types of risk—production risk, price risk and credit (client) risk. The price risk can be secured through market and sales while production risks can be reduced through quality seeds, technology and agricultural enhancement services. The client risk can be attenuated through trust and having better understanding between them.

5.1 Crop/Weather Insurance

While financing through an agricultural value chain can reduce many procurement, market and repayment risks, its dependence on a single chain can also increase risk when there are external, uncontrollable problems that affect the chain. A most important and very commonly known example of insurance is weather insurance. To some extent, the value chain foundation actor can reduce risk through diversification of sources of procurement and markets. ICICI bank in India, for example, offers insurance services that cover (1) weather risk; (2) accident; (3) theft; (4) fire; (5) critical illness; (6) life; (7) motor vehicles and (8) cash in transit (Hegbe 2007).

Despite the difficulties and costs, agricultural weather risk products are growing in importance but, unless subsidized, their overall uptake has been low. Farmers in India have been reluctant to voluntarily pay for insurance. However, other actors upstream or downstream may want to have insurance and may require it or embed the insurance costs into operational costs. The rationale for such a stance is clear; if a marketing company has binding sales contracts, it is important to have secured procurement. If a crop fails, not only will the crop not be available but the loan repayments for any advances that may have been given will also be in jeopardy. Consequently, the funds for purchasing from other producers might also be lacking on the side of the firm. Indeed, in India as part of getting agriculture loan in India, a precondition often is to have insurance.

While weather is the most unpredictable and hence the most difficult risk to insure, other sources of risk are important as well. For commodities, the most important duty of commodity manager is to ensure quality of commodity and safety in store and transit. They provide this assurance not only through careful

management and control of the products entrusted to them but also use insurance products to cover their uncontrollable and unforeseen risks (FAO 2010).

5.2 Forward Contract

Forward markets and futures options are other risk mitigating instruments used in agricultural marketing by producers, investors and traders. Forward contracts stimulate the producer to sell a fixed amount of product at a future date and compel investors to buy a certain amount of production at a future date. Usually, the date of payment, price parameters and amount of product are set between producers and investors by the agreement in advance.

6 Innovations

6.1 Microfinance and Revolving Loan Initiatives

Among the enabling factors that make small farmers competitive, access to credit is the most important. Traditionally in India, non-institutional sources (like moneylenders) have been the main source of credit for the farmers. Immediately after independence, policymakers tried to change the system by formalizing credit delivery for farmers. Various policy measures were taken which met with a fair degree of success. Still, total agricultural credit disbursed remains low and farmers, especially smallholders, still have difficulty accessing credit.

Lending to small farmers could be costly and risky and to make it profitable, innovations are needed to lower the costs of lending and more importantly create a system with lower defaults. One such initiative is the Kisan Credit Card Scheme (KCC) introduced by the Government of India in 1998–1999 which facilitated farmers' access to short-term credit from formal financial institutions. Before discussing KCC, we briefly discuss the elements of the prior system and the progress under it.

6.1.1 The Traditional Targeting Approach to Rural Lending

In 1969, 14 of India's largest commercial banks were nationalized and brought under the direct control of the Indian central bank. The traditional approach to rural lending in India has been mandate-based where financial institutions were required by fiat to lend to farmers and other priority sectors. There was also within-sector targeting. Because of these measures, farmers did increasingly substitute credit from informal sources that came down from around 93% in 1951 to 31% in 1991 in

favour of institutional sources which has gone up from 7 to 66% (All India Debt and Investment Survey and RBI Bulletin, February 2000; Quoted in Mohan 2004).

However, the risk of lending to small farmers has remained a major concern. This is reflected in the restricted lending by the banks to the weaker sections. As on March 2003, public sector banks had extended only 6.8% of NBC to weaker section. Only 6 of the 27 public sector banks had achieved the 10% goal, with the rest ranging from 2 to 9.4% (Vyas Committee Report 2004). The amount borrowed by small farmers from scheduled commercial banks has gone up marginally from around 25% in 1980–1981 to 27% in 2001–2002, and farmers with more than 5 acres still account for 47% of total loans disbursed.

6.1.2 Innovations in the Form of Kisan Credit Card Scheme (KCC)

The KCC can be used like an ordinary credit card with provisions like revolving cash credit facility involving any number of withdrawals and repayments within the prescribed limit. The revolving cash credit facility implies smoothening of cash flows, a necessity in smallholder rural economy. Most importantly, there is a provision of incentives and penalty wherein no defaulters and those who make payments in time are rewarded by lower rates of interests or enhancement in credit limits, and defaulters are penalized by late payment fees and a reduction in drawing limit.

In the KCC, the limit on credit is fixed based on operational land holding, cropping pattern and scale of production credit requirement. In case of crop failure or damage due to natural calamities, the system allows rescheduling of loans. As an innovation aimed at reducing defaults, these elements are extremely important. The reasons for default are twofold: (i) weak incentives (ii) the borrower suffers an income shock that does not enable him to repay.

Along with the system of incentives, under KCC, an improvement in quality of credit flow has occurred on two fronts, customizing credit to the borrowers' characteristics and insurance through rescheduling of repayments if the borrower suffers a shock. The KCC offers personal insurance cover ranging from Rs. 25,000 to Rs. 50,000 to all cardholders, against permanent disability or accidental death.

For KCC to be sustainable and scalable, it is crucial that the credit delivery costs are reduced and recovery rates on loans disbursed are improved. The KCC card is valid for 3 years and is subject to only an annual review, which means fewer formalities in completing the paperwork. The monitoring and contract enforcement costs are also reduced if the system of incentives reduces the risk of defaults. Sharma (2005) also computed the costs of borrowing at the farm level based on interest paid, costs on travel, processing and administrative expenses and commission paid, if any.

These are still an underestimate as the opportunity costs of time saved by farmers is not factored in. Still, data shows that there has been around 6% decrease in costs of borrowings for farmers after they were given KCCs. The decrease in costs varies from 5 to 5.5% for marginal and small farmers and 7% for medium and large

farmers. Also, the costs of borrowings of KCC holders were approximately 3% lower than those who do not have KCCs. With the KCC scheme, the financial institutions have indeed recorded a sizeable decline in operating expenses and hence net margin (difference between spread and operating expenses) has increased. Between 1996 and 2003, the operating expenses as percentage of total assets for the four groups of banks, commercial banks (2.8–2.4%), regional rural banks (3.2–2.7%), state cooperative banks (0.79–0.72%) and district cooperative banks (2.2–1.6%) have gone down.

Though not intended as an initiative to channel credit to the smallholders, the KCC has performed well in increasing the access to formal credit for the smallholders. Since its inception, short-term credit at the farm level from formal sources has increased. Sharma (2005) showed that the amount borrowed by KCC holders was 2.8 times the amount borrowed by those who do not have KCCs. Among KCC borrowers, there has been around 50% increase in amount borrowed before and after KCCs were issued. Data also shows an increase of approximately 46% for small farmers and 49% for marginal farmers. Among the four categories of farmers, the difference in amounts borrowed by KCC holders and those who do not have KCCs is more than 200% for small and large farmers and around 133 and 85% for marginal and medium farmers.

The most important aim of the KCC was to improve the rates of recovery. The branch-level data post-KCC does not show significant improvement in rates of recovery. However, within this aggregate picture, there are variations. Most importantly, the implementation of the KCC scheme is not uniform across regions. Some regions have implemented the guidelines more strictly in practice. This is one factor that is attributable to the observed regional variation. Among banks, there has been a drop in recovery performance of cooperative and commercial banks but the Regional Rural Banks (RRBs) have witnessed a significant improvement. Hence, while KCC has performed well based on different parameters including access to credit for the smallholders, there are still some indicators on which the KCC needs improvement. These indicators are not indicative of the failure of the institutional innovation but its implementation.

6.1.3 Using Firm Farm Linkages for Value Chain Financing

The Vyas Committee (2004) set up by the Indian government to suggest banking reforms reported that while there has been an impressive network of banks, there has been limited reach with a declining share of small farmers in credit disbursed. In this regard, the agencies that already have established linkages in the rural economy can be utilized to expand credit delivery.

The Vyas Committee recommended that banks might consider associating with contract farming to expand credit outreach. But this can be expanded to include other institutions that already have pre-established links with farmers like input suppliers, contract farming entities or processing firms.

What are the channels other than banks that could be instrumental in improving credit access for the farmers? Credit can be channelled through Non-Banking Financial Intermediaries (NBFIs) with whom small farmers already have pre-established links. The key is to take advantage of the margin between institutional and non-institutional sources of credit. The basis for this intermediation comes from two facts: (i) The lending rates for the informal sources from where smallholders traditionally borrow is substantially higher than formal rates and (ii) When the firms link up with farmers, they create a network that can work towards saving the transactions costs for credit delivery and management.

Given the difference in the formal versus informal lending rates, the credit delivery could be at rates higher than the market rate but could still be substantially lower than the informal rates. The banks can charge a prime lending rate of *y* percent to these institutions who, in turn, can adjust for risk and charge a rate of say *z* percent from farmers. This *z* percent could be higher than the market rates but might still be less than the *x* percent that is charged by the informal sources. The margin between z and y is where institutions can make a profit.

This approach has the following advantages:

1. It will increase credit outreach and increase smallholders' access to agricultural finance.
2. Profit Margins: For the organized sector, the margin between z and y represents a profit, especially after considering scale issues. The amount borrowed by individual farmers might be small but their numbers represent a viable opportunity.
3. Higher Stake: The already established links that processors, contract farming institutions or input suppliers have with farmers increase their stake in the rural economy, where success of the rural economy is vital for their business.
4. Transaction Costs: Approaching many borrowers spread over an extensive geographical area has been identified as a cost-intensive proposition. These can now be outsourced to the agencies operating at the village level.
5. Collateral: The problem of borrowers' inability to provide security can be addressed due to the pre-established linkages of farmers and institutional agencies. In the contract farming arrangement for instance, the repayment system can be linked to payments agreed under the contract.

However, for this approach to be successful, it is vital that proper legal and regulatory framework be enacted so that both sides are protected from any discrepancies. The government in this credit channel operates more as a facilitator as opposed to the traditional channel characterized by government fiat. For the same reason that the local moneylenders can charge high rates of interest (lack of competition), exploitation of farmers can be prevented by ensuring competition among the banks as well as intermediating institutions.

6.2 Technological Innovations

In the value chain finance, new technologies and their innovative applications have a very important role and galvanized the development of finance of value chain finance. Nowadays, farmers get information on their mobile related to market price of their commodity on daily basis and get information on weather that whether today it will rain or not. If the foundation player in the value chain has information on say fertilizers' price, so he can spread this information in value chain through technology like SMS, Internet (World Bank 2005).

Issues of accessibility are the biggest issues in the value chain finance, thus technological innovations have come. In the developing countries, around two-thirds of the population still face the issues of accessibility despite the global expansion of financial services. The main reason behind this is the relatively high average cost of credit (FAO 2010).

In the value chain finance, management information systems (MIS) play a very crucial role in analysing data and producing relevant report. In terms of the value chain enhancement, MIS have supported processes such as traceability of agricultural products (from where it is coming and where it is going, it has all information related to its transportation), tracking of warehouse goods and agglomeration of products for sale. Regarding finance, MIS allow producers/investors/foundation players to detect fraud and keep records of finance appliance. Thus, MIS provide several facilities that enhance access to needed information, support sound decision-making that circumscribes analysis of client risk, product security, prospective for trade and profitability (Robertson 2001).

Enhancement in Internet access into rural area allows the benefit of agricultural trade. This happens in two main ways: the delivery of critical information to farming communities such as market demand, pricing and technical advice, and the creation of exchanges that support the trade of agricultural outputs. The example from India describes an Internet application that serves both as an information network for farmers as well as an electronic exchange for substituting of fruits and vegetables (Gallardo et al. 2003).

7 Conclusions

Value chain finance is an inclusive and holistic 'approach' to gain sustainable development goal (SDG). Value chain finance involves systemic analysis of an entire value chain and the relationship amongst its actors. This holistic approach allows investors to design financial interventions that may amalgamate one or various financial instruments. The approach allows money lenders to better access creditworthiness of individuals or groups of businesses within the chain through identifying risks and analysing the competitiveness of that chain (FAO 2010).

Value chain financing is advocated as a promising approach for enhancing financing to agriculture at all stages of the chain. More learning and a deeper analysis are necessitated for tackling key limiting factors. Most important among these is research to help improve: (1) policies and regulation for some of the value chain finance instruments; (2) approaches for optimal financial inclusion and (3) contract enforcement. In addition, greater diffusion of the experiences and learning is needed in the universities, banking institutes and among development agencies and governments (IFAD 2012).

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Different Models of Financing Small Farmers' Agricultural Value Chains

K.V. Gouri and Vijay Mahajan

1 Introduction

The share of agriculture in gross domestic product (GDP) is smaller than that of industry and services sectors, but with the largest employment, agriculture sector plays a vital role in the economy of India. Over 58%[1] of the rural households in the country depend on agriculture as their principal means of livelihood. Agriculture and allied sectors constituted 16.1% of the gross value added in 2014–2015 (Source: Central Statistics Office estimates). But due to small size of holdings—63% of landholdings in India are of less than 1 ha[2] and the average size is 1.4 ha—most farmers are not able to meet even their basic needs from agriculture alone and have to look for supplementary occupations. The involvement of farmers is mostly limited to the farm gate where value addition is minimal. The postharvest part of the value chain is what contributes to the major returns, and the farmer would benefit if he is involved in this part of the value chain.

Gouri KV is the CEO and Managing Director of Basix Consulting and Technology Services Ltd. Vijay Mahajan is the Founder and CEO of the Basix Social Enterprise Group. Basix has worked with over three million low-income households to promote and stabilize their livelihoods. Basix works extensively with organizing farmers' producer organizations, linking them with inputs and markets, providing technical, skill and entrepreneurial training, running a chain of common service centers (IT kiosks) to offer government to citizens and banking services.

[1]Situational report on agricultural households, NSS 70th Round (National Sample Survey Organization 2014).
[2]State of India's Livelihoods (SOIL) Report 2013.

K.V. Gouri (✉)
Basix Consulting and Technology Services Limited, Hyderabad, Telangana, India
e-mail: gouri.krishna@basixindia.com

V. Mahajan
Basix Social Enterprise Group, Hyderabad, Telangana, India

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1.1 The Concept of Agri-value Chain

The phrase *value chain* describes the full range of activities that are required to bring a product or service from primary production stage to processing to packaging and distribution phases of delivery to final consumers. The concept of "*agricultural value chain*" covers the full range of activities and participants involved in producing and moving agricultural commodities from farmers' fields to consumers' tables.

According to Datta et al. (2014), to understand a value chain, one needs to understand the meaning of "value addition". Value addition is the difference between total income and total costs of all purchased inputs and services and may be mathematically represented by Eq. (1)

$$\mathrm{VA} = (P * Q) - (\Sigma \mathrm{Ci}) \text{ where } \Sigma \mathrm{Ci} = w + r + i + y + \pi \tag{1}$$

Here, P refers to price, Q is the quantity produced, and ΣCi is the summation of cost of all purchased inputs and services. Further, Ci constitutes the economic value of all the "factors of production" such as wages (w) for labor, rent (r) for land, interest (i) on capital, royalty (y) on technology, and profit (π) for the enterprise or the entrepreneur.

Each player wants to increase his or her share of the value, depending on the market and its competitiveness. The generic value chain can be depicted as a tree with numerous roots and branches. The roots represent a large number of producers; the stem having three stages of processing, viz., primary, secondary, and tertiary leading to numerous branches representing consumers (Fig. 1).

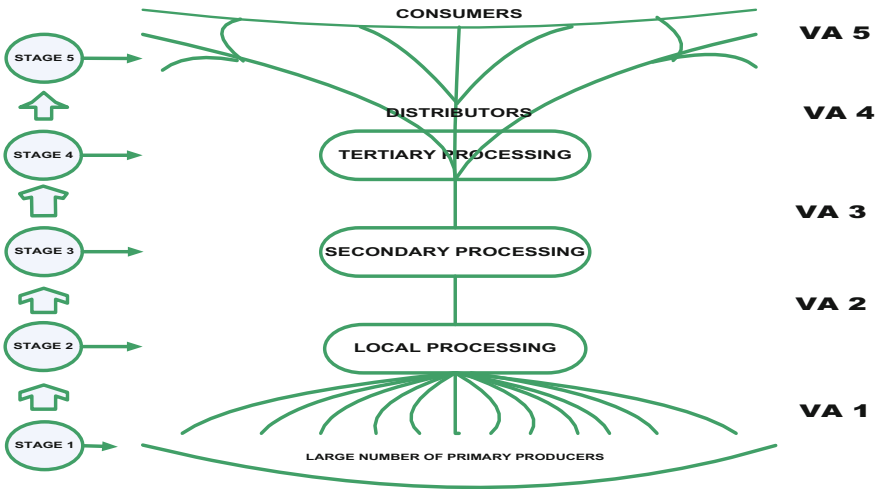

Fig. 1 The value chain stages—a schematic representation

Stage 1 = Producers—dairy farmers and paddy farmers
Stage 2 = Local processing—drying, threshing, bagging, etc.
Stage 3 = Secondary processing—pasteurization, homogenization and milling
Stage 4 = Tertiary processing—skimmed milk powder, pouches, flakes and rice
Stage 5 = Distribution—retails
VA = Value addition

Primary production: There is high transactional cost and high risk, which can be mitigated to some extent by forming producers' collectives such as farmers groups who can be jointly liable and the risks can be managed using insurance services.

Local processing: It is largely done by the farmers themselves through self-financing or with some loans from a katcha adatiya (a local trader who sells onward to a larger trader). There is scope for such lending for collective activities.

Secondary processing: It needs substantial capital investment, both term loans and working capital. This stage witnesses entrepreneurs largely from an agricultural or commercial background who take term loans from banks.

Tertiary processing: It needs larger capital investment, both term loans for plant, machinery, and buildings and working capital for inventory. Banks, Small Industries Development Bank of India (SIDBI), and International Finance Corporation (IFC) are involved in providing such capital. Institutions such as IFC may even consider holding equity in such initiatives.

Distribution: There are two types of distribution: localized and nationwide. The latter needs larger capital investment, both term loans and working capital, for building warehouses, transport vehicles, and retail outlets. There is scope for building distribution and retail chains. Banks, SIDBI, IFC, etc., provide investment. Private equity is also needed for such initiatives.

1.2 Defining Agri-value Chain Finance

Financial products and services that support in value addition at any point in the value chain resulting in value-added products and services and hence increased returns are termed as value chain finance. Agricultural value chain finance is a structured way of financing agriculture that links stakeholders operating within the value chains and lending institutions, and reduces the risks that are commonly associated with traditional agricultural financing. Agriculture value chain finance helps the smallholder farmers to participate in value chain operations that enhance their production, productivity and most importantly, price realization. For the financial institutions, value chain finance helps in looking beyond the direct beneficiary of finance to understand the full subsector, the risks, and opportunities of the subsector and therefore, design appropriate products that fit the businesses in the value chain. Value chain financing is of two types, direct and indirect.

Direct value chain finance is when financial services from banks and other financial institutions are provided directly to the producer (Fig. 2), one of the most important players in the value chain. Some examples are

- A buyer advancing credit to small producers
- Producer organizations providing inputs on credit to members
- Agro-processors advancing credit to its suppliers
- Input supply shops selling products on credit
- Financing against warehouse receipts, where farmers take their produce to a warehouse and use this warehouse receipt as collateral for a loan for immediate use, and not having to sell their produce at a harvest season low price
- Factoring against the invoice produced by the farmer on the sale made to a buyer. Here, a factoring house pays farmer immediately (for a fee), then submits the invoice to the buyer for payment

Indirect value chain finance is when financial institutions finance any of the players in the value chain, either for filling up a gap/bottleneck in the value chain, or for enhancing the efficiency of the player(s) in the chain, whereby the financing will indirectly benefit small and marginal producers (Fig. 3). Some examples of indirect value chain finance include

- Financing transporters for purchase of trucks to facilitate transport of produce to market yards, in an area where transport is the major constraint; helping overcome a bottleneck.
- Short-term working capital loans for the traders; facilitating quicker payments to the small and marginal farmers; helping the system of payment to become more efficient.
- Long-term loans for establishment of processing units, in an area where processing capacity is the major constraint; helping overcome a bottleneck.
- Lease purchase where farmer borrows equipment from a leasing company on a contract basis and at the end of the lease period can either own the equipment or return it (Fig. 3).

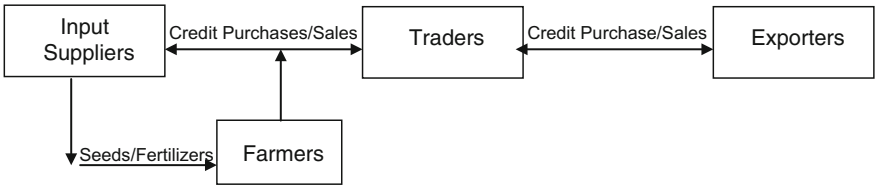

Fig. 2 Direct value chain finance

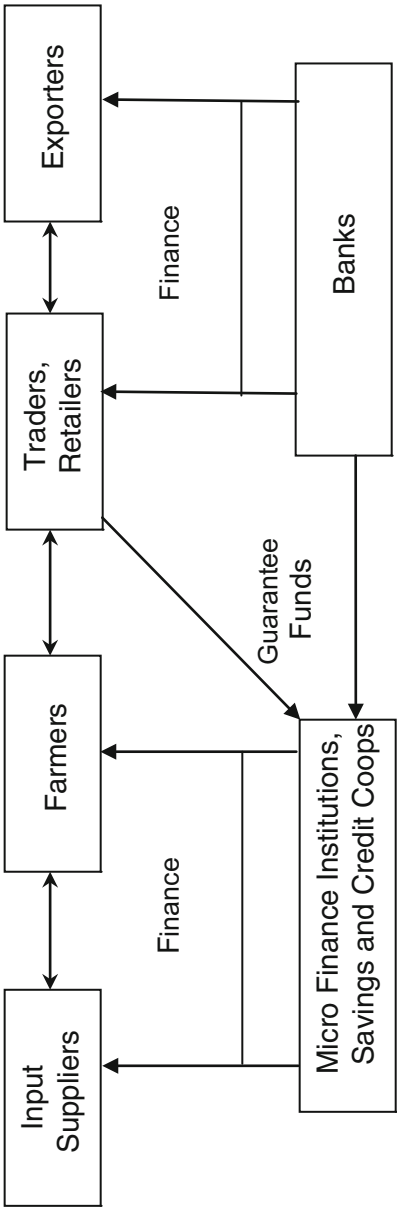

Fig. 3 Indirect value chain finance

Box 1 Value Chain Finance

Value chain finance meets the working capital needs of the customers, thereby helping them in managing their cash flows. Accurately forecasting cash flows, determining working capital requirements and effectively managing the accounts receivables and payables are the building blocks for effective cash management; enhancing the supply chain.

Supplier Finance Solutions

Supply chain finance is a transaction between seller, buyer, and the financing institution. It helps in minimizing the cost of finance and increasing efficiency of business. It meets the short-term working capital needs of both seller and buyer. This arrangement is solely based on the relation between the buyer and the financing institution and the buyer's credit rating which helps in access to capital.

In this arrangement when a company buys goods, the supplier gets paid by the financing institution on the prior agreed terms with the company and gets repaid by the company. The benefit to the supplier is that he is paid immediately and therefore has no credit risk. The company, on the other hand, has an assured source of supply supported by supply chain finance and has the possibility of getting extended credit period from the financing institution.

Distributor Finance Solutions

Distributor finance, usually referred as channel finance, supports manufacturers who deal with large network of distributors for sale of their products to reach the end customer. Manufacturers dealing in products and services such as fast moving consumer goods, telecom, pharmaceuticals, etc., benefit by this finance solution.

This finance solution helps the manufacturers to finance their distributors for purchase of their products by providing finance through banks. The distributor repays as they sell the stock and can borrow to add new stock. The manufacturers benefit by increasing the revenues with little impact on the balance sheet as the bank finances take the credit risk of the distributors. The distributor benefits as he has a line of credit to replenish his inventory.

2 Benefits[3] of Agri-value Chain Financing

2.1 Supports Sustainable Agriculture Development

Achieving sustainability in agriculture is an important development objective since agriculture is the backbone of Indian economy and the majority of population in

[3]Adapted from AVCF and Development for Enhanced Export Competitiveness, African Development Paper.

rural areas in the country depend on agriculture for livelihoods. Sustainable agriculture contributes to meeting the food needs of the population, ensures economic viability of farm operations, and enhances quality of life of the farmers and the society. Value chain finance supports the increasing transformation and commercialization of agriculture that is key to sustainability.

Appropriate value chain financial instruments provide the necessary financial, logistics, and market access support to promote transformation and commercialization of agriculture. Availability of timely finance helps in productivity enhancement where farmers can purchase high-yielding seed and other inputs that increase agricultural productivity, encourages farmers to invest in agriculture, helps in reducing economic imbalances and inter-farm disparities, and supports inclusive growth.

2.2 Increases Financial Inclusion

To support farmers to transact their financial needs through formal financial institutions is the objective of financial inclusion. Small farmers often face challenges in accessing bank loans owing to stringent processes which deter them. They resort to borrowing from local money lenders who charge high borrowing rates. The quantum and period of borrowing are too small to invest in agriculture and produce substantial impact or benefits.

With no adequate resources to invest for productivity enhancement or value addition, farmers resort to distress selling of their produce. Value chain financing, therefore, helps the farmers where the design of financial instruments is in tune with the requirements of the farmers. Involvement of banks in value chain financing benefits the farmers in availing interest subsidy on credit, investment subsidies linked to credit, crop insurance, and participation in value chain activities.

2.3 Enables Value Addition and Exports

International trade in agricultural commodities has been growing very rapidly. Smallholder farmers are unable to contribute and avail the benefits of export markets as their capacity to invest in production practices that result in high quality produce to meet the standards of international markets is low. Value chain finance enables the smallholders to move up the value chain and increase productivity and quality of their produce. Value chain instruments that are designed to help smallholders to meet the requirements and compete in the international markets, help increase competitiveness of smallholders.

2.4 Helps in Poverty Reduction

Lack of financing in agriculture is a vicious cycle; producers are not able to realize the full potential and hence produce much less than they can. It affects other players in the value chain such as input suppliers who supply less, processors who process less, and traders who sell less which spirals into the markets and consumption. If poor small farmers are given access to finance, it helps in increasing their capacity to invest in farm cultivation and therefore increase productivity leading to increased incomes and improved quality of life. This directly contributes to overall economic growth, social harmony, and poverty reduction of the country.

3 Value Chain Models

The relationships between buyer and seller determine the linkages within the value chain. Value chain models are based on these relationships. The simplest form of such relationship is the instant or spot market sales where the producer brings his produce to the market for sale and setting up of price is in the hands of buyer and where there is scope for large-scale fluctuations. The second type of relationship is that in which the buyer and seller are bound by a contract where the producer commits to produce for the buyer and the buyer commits to buy at an assured price. The third type of arrangement is an informal arrangement between buyers and sellers based on mutual trust or interdependency. A processing unit buys produce from the producers in its catchment area who sell their produce to the plant without any written agreement.

The other arrangement is one in which the buyer makes a capital investment that benefits the producer in his production activity which provides a high level of credible relationship of dependence between the stakeholders. The highest end of value chain relationships is where a company has full vertical integration with all the stakeholders of the value chain. Usually, the financiers prefer a binding relationship among the stakeholders of the value chain rather than a spot market sales where price fluctuations are at the highest.

While agri-value chain finance deals with financing all the value chain partners across the value chain, value chain finance is most useful for smallholder farmers to link them with the next level in the value chain than being limited to their involvement up to farm gate where the value addition is at the lowest in the value chain.

Smallholder's production is crucial for many value chains for economic and social aspects and they are more important contributors for modern agriculture systems. It, therefore, has become an important issue to focus on the models which ensure that the smallholders participate fully in the value chains. Following are some of the value chain models that illustrate how production and marketing are organized to the larger system and thereby benefiting the farmers.

Box 2 Samarth Kisan Producer Company
Government of Madhya Pradesh under its district poverty initiatives project has promoted many Farmer Producer Companies. Samarth Kisan Producer Company is one such company located in Agar in dist Shajapur. With 6500 members and Rs. 9.17 lakhs paid up capital, it is a well-established company in the region. It has received support from the state and central governments both financial and nonfinancial in the form of land for construction of warehouse. The members include both landholders and lease farmers cultivating soya bean and wheat. The company undertakes input trading and seed production activities. Seed production in foundation and certified seeds benefited the farmers in earning premium amount. The company is able to provide services to 50–60% of its members and exploring for access to more working capital to serve more members.

3.1 Producer-Driven Models

Producer-driven models are more often associations of farmers who come together with a common goal. These groups are registered as cooperatives or new generation collectives called Farmer Producer Companies, which is gaining prominence in India. The associations are designed to provide technical assistance, inputs, marketing, and financial linkages to the members. Some issues with the model are that the producer associations are at the bottom end of the value chain and do not understand the other stakeholders nearer to the end users. Access to finance is another major hurdle faced by these associations. While cooperatives are well known to banks and financial institutes, Producer Companies are the lesser known entities. They also face difficulties in the initial years when they lack capacities and economies of scale.

Box 3 ITC PepsiCo contract farming with potato farmers
BASIX is a livelihood promoting organization known for innovative models to promote livelihoods. One such model helped the potato farmers within Jharkhand where small and marginal farmers grow potato. Rainy season crop sown in July–August commands very high prices when it is harvested in October–November in other parts of eastern India. BASIX identified the potentiality and scope for farmers where it could be a major source of livelihood. PepsiCo needed potato for its Frito lay factory especially during lean season from Jharkhand and a credible institute to initiate large-scale potato farming. PepsiCo heard about BASIX initiative with potato farmers and proposed contract farming. BASIX discussed the benefits of contract

farming with farmers, and after a series of deliberations spread over a year between PepsiCo and farmers both agreed to enter into a contract. BASIX was the facilitator and was also to provide financial and technical assistance to farmers. The aim was to create a revenue model that covers its costs and allows a deal that is profitable to the farmers.

BASIX helped to form a Potato Grower's Association with whom PepsiCo entered into procurement and input contract. PepsiCo provided potato seeds to Association at predetermined price and farmers bought it from association with credit provided by BASIX. PepsiCo purchased the produce of the farmers that satisfied its quality standards at a price declared at the beginning of the season.

3.2 Buyer-Driven Models

Processors, exporters, retailers, traders, and wholesalers are the main drivers of this model. Buyers use finance as a way for committing the producers, thereby they have assured supply of products. When finance is involved, the conditions are bound by contracts which form the basis for loan recovery. The most common form of buyer-driven model is contract farming. This can be at farmer level or producer association level. Usually, the contracts originate from further up the value chain which could be processors, exporters, etc. The arrangements are mostly legal when these value chain players are involved, but can be informal arrangements also. The contracts may involve advancing finance, inputs, technical support or it may involve output sales with conditions such as price, quantity, quality, and delivery dates. Contract farming is gaining importance with more opportunities across the agro-food chain opening up as it provides access to finance to the players across the value chain. The commitment between buyer and seller in the form of written contract provides the agro-business firms and bank a notion of seriousness and security to provide credit to farmers. In the case of agro-business firms such as agro-processors, their raw material is assured which reduced operational risk and improved the credit rating of the processor and hence, improved access to finance. Banks consider producers more credit-worthy with assured market for their produce through contracts which serve as virtual collateral. The success of this arrangement solely depends on the integrity of both the parties involved in fulfilling the contractual obligations. If market prices increase beyond the contractually agreed rate and if there is alternate buyer available to buy the produce, small farmers are tempted to renege the conditions of contract and sell elsewhere.

Box 4 Farmer Producer Companies in Uttar Pradesh

BASIX has been working with 100 Farmer Producer Companies (FPCs) in the state of Uttar Pradesh. FPCs are formed with smallholder farmers whose sodic lands are reclaimed to suit for agriculture. BASIX helped in formation of Producer Associations of these farmers and registered them as Farmer Producer Companies (FPCs). The FPCs are provided with institution building services through capacity building programs for members, governing body members on the concept of developing the FPCs as strong business enterprises and governance issues.

BASIX facilitated linkages with input suppliers to serve the aggregated demand for seeds, fertilizers, and pesticides of FPCs. Market linkages are facilitated with traders, agribusiness companies, and big corporates who benefit from assured availability of commodities from the FPCs in bulk. The major crops of these FPCs include potato, cereals, and pulses. BASIX also facilitated access to finance to the FPCs by representing their case with banks, NBFCs, and other financial institutes for meeting the working capital needs of the FPCs. BASIX actively engages with government for ensuring convergence of various government schemes that support the FPCs and its members. In addition to supporting business operations, BASIX also provides management support to train the staff of the FPCs in management of FPCs, building systems and processes in functioning of the FPC, development of business plans and bankable proposals. The overall support of a facilitating agency helps the FPCs in sustainable growth.

3.3 Facilitated Value Chains

Facilitation by development organizations and government agencies to support smallholder farmers in value chain integration and financing has helped in building successful value chains. These agencies facilitate in mobilization of farmers to organize themselves into associations, build their capacities through trainings and technical assistance, and provide critical management support to run these entities as business enterprises. The agencies facilitate relationships with input suppliers and financial institutes for direct output marketing of produce to value chain players high up in the value chain such as wholesalers and processors. The agencies facilitate with banks and other financial institutes for raising working capital requirements and lobby for convergence of government schemes through the producer associations for capital investment in infrastructure. The contract farming model and other models of value chains are dependent on the facilitation or service provided by these agencies to farmers' associations, especially in the initial formation years of these entities.

3.4 Integrated Value Chains

Integrated value chains connect producers to others in the chain such as input suppliers, processors, traders, other service providers including finance and also integrates through ownership or formal contract arrangements. The most common form of integrated model is vertical integration. A large wholesaler focused on consumer demand wants to source quality product. An example of vertical integration is supermarkets which provide the data about consumer-accepted product specifications to wholesaler and the information is passed down the chain to the producers to ensure compliance. Such vertical integration is seen in fruits and vegetables. Horticulture value chains offer an excellent integrated value chain model.

4 Financing Mechanism and Instruments

Value chain finance mechanism and instruments of finance that are availed by smallholder farmers can be categorized as follows.

4.1 Product Financing

Aggregator credit—This is a form of credit provided to the farmers for investing in farm cultivation activities with an understanding that repayment will be made in kind at the time of harvest. This arrangement is usually short term and seasonal in nature. This is beneficial for producers as they get easily accessible finance and guaranteed buyers for the produce. However, the producers have limited bargaining power as they are dependent on the credit for undertaking production activity.
Input supplier credit—This is direct informal financing based on trust between the producer and the input supplier. The input supplier advances seeds, fertilizers, chemicals, and equipment to producers who agree to make payments at harvest or on mutually agreed time in either kind or cash. The input supplier does not provide cash discounts on such transactions.
Marketing company credit—In this arrangement, marketing company, processor, or other players in value chain provide credit in cash or kind to producer, aggregator, or other value chain players. The mode of repayment is usually in kind. This ensures the upstream buyers assured produce at predetermined purchase prices and in turn, the producer and others in value chain receive assured credit and supplies and market for their produce.
Lead firm financing—This model is also known as contract farming and differs from the above-discussed instruments in that the lead firm guarantees buyback of the produce of the farmer and all the requirements for production of crop are

financed by the lead firm. Apart from inputs and working capital, the lead firm provides quality seed, extension services, training, and package of practices for production of quality output that suits its needs. It plays a central role in production activity.

Warehouse receipts financing—This financial instrument is a direct informal finance provided to producers or other value chain enterprises in possession of produce which is stored for safekeeping at a certified warehouse. Banks and financial institutes lend against the warehouse receipt which acts as collateral to the loan. The credit risk mitigation in this mode of financing is that the marketable produce stored at an independent warehouse to which the lender has a charge till the loan is fully repaid. The warehouse keeps the produce secure and safe. The lender is assured of repayment of his loan whenever the produce is sold as he has control of the stored produce. The ownership of produce vests with the producer who has an option to sell to the highest bidder to whom he can transfer the warehouse receipt.

The other categories of value chain finance instruments mostly suitable to the value chain player higher up the value chain are more complex. These can be categorized as

a. *Receivables Financing—Trade Receivables, Factoring, and Forfaiting*
b. *Physical Asset Collateralization—Repurchase Agreements, Financial Lease*
c. *Risk Mitigation Products—Crop Insurance, Forward Contracting, Futures*
d. *Financial Enhancements—Securitization, Loan Guarantee, Joint Venture*

A brief description of the above instruments is provided in Box 5.

Box 5 Categories of Value Chain Finance Instruments

Receivables financing

Trade receivables finance: Working capital advances to suppliers, processors and for marketing and export activities in agribusiness by banks and financiers on the basis of confirmed orders or pending receivables is termed as trade receivable finance. The company's credit history is a primary consideration for this.

Factoring: This is a type of finance in which a business will sell its accounts receivables (invoices) to a financial intermediary called factor. The factor agrees to pay the company the value of the invoice less its commission.

Forfaiting: This type of financing is related to international trade used by exporters. The exporters sell their receivables at discount to forfaiter to eliminate risk. Once the sale is made, the exporter has no responsibility of the receivables from the importer. The importer directly pays to the forfaiter.

Physical Asset Collateralization

Warehouse receipts: Warehouse receipt is a document that indicates the proof of ownership of commodity stored in a warehouse. The farmers or owner of the commodity can use the receipt as a collateral to avail loan from banks and financial institutions. The sellers have the choice of waiting for higher market price to sell the produce and repay the loan.

Repos–Repurchase agreements: A repurchase agreement (repo) is a form of short-term borrowing. It is similar to bilateral loan agreement. The company which is the seller of the commodity is the borrower and the buyer of the commodity is the lender/bank. In repo, the bank does not lend to the company but purchases the commodity on an agreed price on condition that the company repurchases the commodity on a particular date at an agreed price.

Lease Purchase: This is the credit provided by the financing institutes for purchase of goods/assets on which the buyer makes lease payments with an understanding that ownership transfer happens after full repayment. The ownership of the goods/asset remains with the financing institute till the total payment is made. Farmers avail this for purchase of farm machinery, tractors, and other high-cost agri-equipment.

Risk Mitigation products

Insurance: One of the risk-mitigating measures in agriculture is insurance. Insurance cover helps farmers to face adverse conditions in case of natural calamities. Regular premium payments insulate farmers from the losses due to unforeseen situations and receive timely payouts.

Forward contracts: Forward contract is a contract between two parties to buy or sell goods/asset at a specified price on a future date. Hedging or speculation is possible in forward contract. These are not traded on centralized exchanges.

Futures: Futures are financial contracts between buyer and seller to buy or sell commodities/asset at a predetermined future date and price. Futures contract details specify quality and quantity of the commodities/asset and are standardized to facilitate trading on futures exchange.

Financial enhancements

Securitization: Securitization is a process in which financial instruments are created as securities by pooling cash-generating financial assets. These are packaged as marketable securities and offered to investors.

Loan guarantees: Third-party loan guarantees to agriculture loans by public or private organizations reduce lending risks to banks and other lending entities. This facilitates increased lending to agriculture sector.

Joint venture: Joint ventures facilitate increase in investment in the value addition in agribusiness through direct capital investment by equity investors. This provides shared ownership and responsibilities among the partners.

Source Chapter *Agriculture value chain finance-Tools and Lessons* (*Miller and Jones* 2010).

5 Examples of Access to Finance for Small Farmers

5.1 Credit Guarantee Fund—SFAC

Small Farmers' Agribusiness Consortium (SFAC)—The Government of India has developed a credit guarantee scheme for small and marginal farmers in India as the banks and formal financial institutions are wary of lending to this class of farmers. SFAC has been instrumental in promoting over 1000 collectives of smallholder farmers in all the states of India. These Farmer Producer Organizations are registered as Producer Companies under the provisions of Indian Companies Act, 1956. Credit Guarantee is provided to the banks and other financial institutes who extend credit to the Farmer Producer Companies (FPCs).

Credit Guarantee Fund (CGF)—Credit Guarantee Fund provides risk cover to banks and other financial institutes against their lending to FPCs for loans not more than Rs. 100 lakhs.

The FPCs that are interested in availing this scheme must have a minimum membership of 500 members, with 33% of shareholders being small farmers. The maximum shareholding of any one individual member should not exceed 5% of the total equity of the FPC. The financial institutes can lend any amount to the FPCs, but the maximum guarantee cover provided by SFAC is limited to Rs. 100 lakh. The CGF cover helps the FPC to borrow from banks to finance its operations.[4]

5.2 Producers Organization Development Fund—NABARD

National Bank for Agriculture and Rural Development (NABARD) has set up a separate fund titled "Producers Organization Development Fund" (PODF) to tackle the issues of nonavailability of timely credit for smallholder farmers. The PODF will be used to support Producers Organizations across three levers, viz., credit support, capacity building, and market linkage. The objective of the fund is to meet end-to-end requirements of Producers Organization as well as to ensure their sustainability and economic viability. The fund provides direct lending to a Producers Organization for term loans or composite loans comprising both working capital and term loan requirements, or working capital as composite loan, subordinated debt as tier II capital based on the requirements of the PO. Funds are also provided for various types of capacity-building initiatives such as skill development in order to enable the members to produce goods in both farm and nonfarm sectors, business

[4]http://sfacindia.com/PDFs/Equity-Grant-Scheme-and-Credit-Guarantee-Fund.pdf.

planning, technological extension through classroom training, exposure visits, agricultural university tie-ups, expert meetings, etc.

Support for capacity building could be in the form of grant, loans, or a combination of the two based on the need of the situation. The fund also caters to the developing Market Linkages for the PO by providing credit and/or grant support for setting up of marketing infrastructure facilities for sale of produce; support could even be in the lines of Rural Haat and Rural Mart if the situation so desires or it could be structured differently based on the need; NABARD will explore tie-ups with buyers for Producers Organization's produce; NABARD shall help form partnerships between Producers Organizations and local and large companies, through existing schemes of MoRD and NHM; NABARD will promote creation of infrastructure wherever possible.[5]

5.3 *Commodity Exchange Platforms and Warehouse Receipts—NBHC*

Commodity exchange platforms are formed at regional and national levels to address the issues of finance, markets, and risks faced by farmers. National Commodity and Derivatives Exchange, National Multi-Commodity Exchange of India, National Spot Exchange, Multi-Commodity Exchange are some of the commodity exchanges which act as platforms for farmers and other value chain players to access finance and markets. They provide market intelligence on prices, movement of commodities, futures, and spot exchanges which help in decision-making of the stakeholders in the value chain.

The National Bulk Handling Corporation is the provider of integrated commodity and collateral management services through a network of storage facilities. Farmers can access warehousing and financial services. The warehouse receipts for the stored produce help the farmer access to finance from the banks, thus preventing distress sales due to price fluctuations. Farmers are also provided with market intelligence and sale through commodity exchange platforms that enhance their returns and reduce the intermediation costs. In addition to farmers, NBHC services processors, traders, corporates, commodity exchanges, and banks for their warehousing and logistics requirements.

[5]https://www.nabard.org/english/Financing.aspx.

6 Case Studies of Small Farmers' Agri-value Chain Finance[6]

6.1 Warehouse Financing for Small Farmers

A collaborative effort between NABARD and a collateral management firm, ORIGO commodities, aims at providing farmers with "warehouse receipt financing" to enable them to deposit their crops at a warehouse nearest to their own farms and in return, pledge financing from banks; this is an example of value chain finance that is focused on increasing returns to smallholder farmers. The farmer would get approximately 70–75% of the commodity value deposited. The initiative was implemented through Primary Agriculture Cooperative Societies (PACS) with sponsorship from NABARD. Using Negotiable Warehouse Receipts and facilities of Warehousing Development and Regulatory Authority (WDRA)-approved warehouses, farmers have the option of selling their produce at the right time to get the right price for their crops. They gain during the postharvest period by getting loans at the rate of 7% per annum with interest subvention.

Under the intervention, the existing warehousing facilities with the PACS were revamped to meet the WDRA standards with financial support from NABARD. Additional warehouses of equal standards are provided by ORIGO. The PACS staff are trained on Negotiable Warehouse Receipt (NWR) warehousing, WDRA certification processes, and commodity management practices essential in building market linkages. In the first phase of the pilot project, 55 PACS which met the selection criteria in six districts of undivided Andhra Pradesh dealing in commodities such as maize, paddy, soya, jowar, Bengal gram, and black gram were selected. Subsequently, 50 more PACS will be included. Diversified commodity base, financial strength, accessibility and quality of warehousing infrastructure, and willingness to participate in the intensive training program were the criteria for selection of the PACS for intervention.

ORIGO undertook collateral management on behalf of financing institutions and trained PACS to act as aggregator and traders in commodity exchanges. It issued quality certificates for farmers' produce as and when requested by buyers. It facilitated accreditation of warehouses with WDRA and provided advice on market process to enable decision on when to sell. It had partnerships with large agribusiness companies, government procurement institutions, commercial banks, NBFCs, and several commodity exchanges to enable corporate and institutional procurement directly from PACS.

NABARD as the principal financing agency provided multipronged financing support for the intervention. It refinanced the agricultural loans extended by PACS against the NWRs, extended an interest subvention of 7% to farmers availing the

[6]This section is largely based on Datta et al. (2015). *Innovative Financial Tools for Agricultural Value Chain Financing—Case studies on Innovative Agro-Value Chain finance in India*. Access Development Services, New Delhi.

scheme for loans, undertook capacity building programs, provided loans to the state governments to build storage capacities and warehouses at the PACS level, and financed PACS for establishing procurement, storage, and processing infrastructure. NABCONS, a subsidiary of NABARAD undertook accreditation of PACS warehouses on behalf of the WDRA. The intervention benefitted the farmers through

- Strengthening the value chain with lesser intermediaries and transparent margins at each stage. The earlier value chain usually had four intermediaries between the farmer and processor which were reduced to one, i.e., PACS between farmer and processor.
- Reduced crop losses and increased price realization. With strict quality parameters in place, farmers are careful in adopting processes which reduce losses. PACS being the intermediary, transit losses are reduced; scientific storage practices reduced the storage losses. An 11% reduction in losses and 28–39% increase in price realization are recorded at the end of intervention.
- The capacity building of the farmers through nonfinancial capacity building and training programs enhances the knowledge of farmers on the market price, decision-making process to sell or hold, scientific methods to reduce losses, NWR financing, among others.

The lessons from the intervention can be summarized as

The intervention shows that the benefit of programs targeted at small farmers works effectively if they are provided closer to the farm level, where the farmers can avail them easily. It demonstrates that PACS, being the smallest cooperative unit composed of the farmers themselves, can be leveraged effectively and in a financially viable manner to deliver essential services at the farm gate.

Another lesson that can be drawn from the intervention is that an approximate mix of finance and other services is helpful in achieving the end goals. The value chain instrument coupled with nonfinancial services such as capacity building, physical infrastructure, information services on prices, markets helped in higher returns.

The coming together of various agencies providing different services has contributed to the success of the intervention. Each agency has provided diverse knowledge and skills in optimizing the intervention results. A multi-agency approach helped in each agency focusing and refining its approach in making the intervention successful.

The agencies involved in the intervention had high credibility and expertise in their respective fields which helped increase the bargaining power of farmers through PACS. As a collateral management firm, ORIGO had access to current market information and network of buyers which is critical to the intervention. ORIGO also represented several buyers.

Some of the risks associated with this model arise if farmers are not willing to bring their produce to PACS for storage and selling, if PACS staff are not trained enough to handle the transactions, and if suitable buyer is not identified in time. A more serious risk is if the buyer rejects the produce on quality issues at the end of storage period and farmer will not be able to sell to traditional buyers in the market

who purchase stocks immediately after harvest. Damage to stock due to improper storage may force the farmer to sell at a lower price. Smallholder farmers face liquidity risk where there is a lag time between harvest and sale in this model. In case the farmer decides to hold off sale and wait for prices to increase, he may face difficulty in getting credit from bank for the next cycle.

6.2 Cascade Financing Loans Across the Value Chain

Cascading finance refers to financing value chain players at multiple levels within the same chain where activities are related. In this model, the cash flows of one activity are built on the other. The wholesaler, processor, and aggregator are the borrowers of the same financial institution. When the processor receives the money from the wholesaler who markets its products, he makes the payments to the primary aggregator, who in turn releases the funds to the farmers. This facilitates cash flows without huge collaterals for borrowing. The lender has information advantage as all the borrowers are within the same value chain.

Ratnakar Bank Ltd (RBL), one of the scheduled commercial bank in Maharashtra, uses the cascade finance model to finance cotton value chain. RBL provides crop loans and term loans to farmers, warehousing finance, and credit for processors of ginning mills. RBL has designed products based on the needs of the value chain players across different value chains. It has adapted and tuned its entire finance products and processes to enable credit provision for small farmers. In place of standardized product and process portfolio, it has adapted products based on the needs of small farmers. It has involved product innovation, process innovation and has built institutional collaboration for providing finance to the value chain players.

Under product innovation, RBL has customized the loan products as per the type of crop. For example, the sugarcane farmer cannot pay the first installment of loan immediately after harvest as it takes one more month for price realization. RBL has designed a product where the first installment can be paid after 16 months with a moratorium of six months. Whereas for vegetable growers, the repayment is after a shorter period since the harvest happens 2–3 times a year. Similarly, RBL has adapted process innovation in its disbursal process. First, it has adapted its lending process to accommodate those farmers who have already taken a loan from some other bank. RBL Bank provides a second loan to a farmer in addition to an existing loan, the concept behind this being that the farmer needs money for several "small" activities in addition to the main activity for which they had borrowed. This approach helped building relationship with the borrower. The RBL team on the ground can assess the borrowers and also reach the borrowers through partner agencies. In the cases of sugarcane, the bank accepts the corporate guarantee from large processing. The bank has done away with the need for a Registered Mortgage to enable the farmer to save on 1% registration fee for mortgage.

RBL seeks to partner with the existing institutions on the ground. This collaboration facilitates the process of getting to know the borrower, loan disbursement,

and management. It usually partners with local institutions which have sound technical knowledge about the crops for which they work with the farmers. It has also developed linkages with input suppliers, equipment suppliers, and has signed MoUs to facilitate supply to farmers, thus ensures sustainable productivity. RBL has strategically positioned itself to lend to smallholder farmers and has adapted a strategy to cater to the needs of this segment. It is engaged with various stakeholders in the value chain and therefore has information advantage of the entire value chain and where it needs to be strengthened so it can be engaged profitably. It has successfully engaged with 20 different value chains in the region.

7 Conclusions

One of the big issues in agricultural policy in India is how to enhance farmers' income? The emphasis so far was to do so through increasing the productivity of crop production—higher yield per acre. But increasingly, it has been found that crop production is a small part of the value chain of any agricultural product, be it food or fiber. Most of the value added is in secondary processing and in tertiary activities such as packaging, storage, transport, distribution, and retailing. For example, a roti weighing 50 g is priced Rs. 30.00 in a restaurant. The farmer, who is the producer of the wheat gets Rs. 0.60 of this which is 5% of the final price. Thus, the conclusion is that farmers need to participate in the full value chain to benefit from agriculture (Mahajan 2014).

Value chain participation by farmers can be merely as suppliers, in which case they do not get any share of the further value addition. If, however, the farmers are aggregated into large numbers and enabled to own parts of the value chain, they can benefit from the downstream value addition as well. For this, they need to invest capital and the value chain has to be integrated. One of the best examples of this is AMUL—which is a four-tier structure—starting with individual small dairy farmers, often owning only one or two cow or buffalo, to village-level milk producers' cooperative society (MPCS) to the district-level milk union like the Anand Milk Union Ltd (AMUL), and finally, the state-level body like the Gujarat Cooperative Milk Marketing Federation (GCMMF). The farmers not only own their cows but also have shares in the MPCS, while the MPCS has shares in AMUL and AMUL has shares in GCCMMF, which is a USD 3 billion behemoth. The farmer not only benefits from the fair price of milk he gets at the doorstep and the steadiness of purchase, but also from veterinary services for animals.

To create more durable agricultural value chains like AMUL, financing of agricultural value chains is a very important need. While Dr. Kurien managed to finance the building of the cooperative dairy value chain in India by creatively using the proceeds from the sale of donated milk powder from the Northern countries, this model could not be replicated. What we need is a system which finances all the levels of the value chain, with appropriate combinations of debt, leveraging

member equity. Where needed, such as in remote areas, the state may also provide viability gap funding or capital grants.

As this study shows, a number of approaches are emerging in financing the building of agricultural value chains and many more innovative approaches are required, particularly to support small farmers become an integral part of profitable value chains. This will then open up a second front to improve the farmers' lot—from just improving crop productivity to sharing in the value added throughout the value chain, which can be several times more than the value added on just crop production.

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Part II
Agriculture Value Chain Financing in Case of Select Commodities

Formal Versus Informal: Efficiency, Inclusiveness and Financing of Dairy Value Chains in Indian Punjab

Pratap S. Birthal, Ramesh Chand, P.K. Joshi, Raka Saxena, Pallavi Rajkhowa, Md. Tajuddin Khan, Mohd. Arshad Khan and Khyali R. Chaudhary

1 Introduction

India's dairy sector has not only grown but also undergone a structural transformation during the past four decades. From a subsistence activity in the 1960s and 1970s, dairying has emerged as the largest economic activity in Indian agriculture. Milk production that had rarely exceeded 25 million tonnes until the mid-1970s, increased to 146 million tonnes in 2014–2015, lifting the annual growth rate from 1.8% during 1961–1975 to 4.5% thereafter, and raising the per capita milk availability to 315 g/day in 2014–2015 from 110 g/day in 1971 (GoI 2015). This progress is termed as 'White Revolution' and is as celebrated as 'Green Revolution'.

Dairying contributes one-fifth to the gross value of agricultural output in India. Its importance, however, transcends its income contribution. Dairying, besides being an important source of food and nutrition security, makes substantial contributions towards social development. It is an important source of livelihood for the poor and the marginalized—more than half of the female bovines are owned by the households possessing landholdings of less than or equal to one hectare (GoI 2014), and women by contributing three-fourths to the total labour requirement are the

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P.S. Birthal (✉) · R. Saxena · Mohd. Arshad Khan · K.R. Chaudhary
National Institute of Agricultural Economics and Policy Research, New Delhi 110012, India
e-mail: ps.birthal@icar.gov.in

R. Chand
NITI Aayog, Government of India, New Delhi, India

P.K. Joshi · P. Rajkhowa · Md. Tajuddin Khan
International Food Policy Research Institute (IFPRI),
South Asia Office, New Delhi 110012, India

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main custodian of dairying (Birthal and Taneja 2006). Animals generate a continuous stream of outputs (or incomes); and being a reproducible asset, can be multiplied fast to scale up the activity for higher income and employment. Dairying, thus, is considered a potential pathway to cushion agricultural growth, reduce poverty, improve nutrition and empower women (Birthal and Negi 2012; Jumrani and Birthal 2015).

Notwithstanding the growing importance of dairying in rural transformation, Indian dairying is low producing. For example, the average milk yield of a cow in India is 1350 kg per annum; 42% less than the world average. Among several constraints, the lack of access to markets and institutional credit is considered an important barrier to commercialization of dairying. A rural household, on average, owns one–two dairy animals producing a small quantity of milk for own consumption and sale. Local rural markets for milk and milk products are thin, and trading in distant consumption centres, i.e. urban markets is not remunerative due to higher fixed costs in relation to the available surplus for sale (Birthal et al. 2005). Milk markets are unorganized, fragmented and dominated by intermediaries, except a few pockets of modernization. Over 71% of the marketed surplus of milk is handled by the unorganized sector (GoI 2014). Farmers also lack access to credit—dairying (including animal husbandry) has rarely received 5% of the total institutional advances to the agricultural sector (Birthal and Negi 2012). Although financial requirements of small dairy farmers are not big, commercial banks and other financial institutions shy financing them, because of the high cost of lending relative to the size of loan and higher lending risks. Further, smallholders have limited assets, often less-documented, making it difficult for them to use these as collateral against loans from financial institutions.

Added to these is the apprehension that the process of globalization in the presence of continued producer support in the countries with greater share in global dairy exports, higher volatility in food prices and stringent food safety standards may adversely affect the small-scale producers, entrepreneurs and processors who often lack resources, especially capital to improve upon their technological and entrepreneurial capabilities to face the global competition (Casuga et al. 2008). Smallholder production systems, thus, need to adjust to the emerging market trends, which, of course, may not be possible in the absence of adequate marketing and financial support.

But, there is an increasing recognition that some of the constraints related to product and financial markets can be alleviated using a value chain approach that brings together different chain actors, including farmers, aggregators, traders, processors and financial institutions in order to gain control over the processes of production, marketing, processing and distribution to realize scale economies, reduce transaction costs and minimize uncertainties in the supplies and quality of inputs and outputs (Meyer 2007; Trienekens 2011). In India, the rapidly growing demand for milk and milk products (Kumar and Joshi 2016) offers an opportunity for processors and organized retailers to expand their businesses by integrating their 'front-end' activities of wholesaling, processing, logistics and retailing to the 'back-end' activities of production through institutional arrangements such as

contract farming and producers' associations. Farmers too benefit from such arrangements in terms of their enhanced access to markets, inputs, technology, information and financial products. Birthal et al. (2005) and Ramaswami et al. (2006) have shown that through contracts farmers reduce marketing and transaction costs and price risks significantly.

For financial institutions, a value chain can be an entry point to improve their outreach to different chain actors, and to reduce transaction costs and lending risks, especially at the upstream of the chain which is dominated by smallholders. The financial institutions lack information on the potential borrowers, while the value chain actors being part of the same system are better informed about the activities and relationships of one another. This may enable the financial institutions to access information at little or no cost (Meyer 2007; Casuga et al. 2008; Miller and Jones 2010). The value chain with its product market orientation can itself serve as guarantee or collateral against loans. In this context, Miller and Jones (2010) argue that 'if the financial institutions can tailor their services along the value chains, these can reduce transaction costs, enhance their outreach to small-scale producers and entrepreneurs, and improve their repayments'.

The aim of this chapter is to identify dairy value chains prevailing in the rural areas and examine their efficiency, inclusiveness and financing; and to draw lessons for strengthening these to enable smallholders to capture benefits of the value addition. Specifically, we analyse

- The dairy value chains and their performance in terms of efficiency and inclusiveness,
- Mechanisms of financing of dairy value chains at their upstream.

By examining efficiency and inclusiveness of formal and informal dairy value chains and their financing mechanisms, this study adds to the thin empirical literature on agricultural value chains and their financing mechanisms in the developing countries.

Rest of the paper is organized as follows. In the next section, we provide a brief background of the dairy sector of Punjab and contrast it with the national status. A brief description of data and sampling procedure is given in Sect. 3. Section 4 discusses milk production structure and estimates of marketed surplus by farm size. A description of the dairy value chains and participation rates of different farm categories in these is provided in Sect. 5. Section 6 discusses productivity, prices and profitability under different value chains. The econometric estimates of farmers' choices of value chains and their impacts on farm efficiency are discussed in Sect. 7. The sources of finance for farmers associated with different value chains are discussed in Sect. 8. Concluding remarks are made in the last section.

2 Dairy Sector Status and Policies

From the acute shortages in the 1960s and 1970s, India emerged as the largest producer of milk in the world in 1997. The milk production that had rarely exceeded 25 million tonnes until the mid-1970s increased to 146 million tonnes in 2014–2015. Milk is now the largest agricultural commodity in India, in physical as well as value terms. It contributes about 20% to the value of agricultural output, more than the combined contribution of rice and wheat.

The revolutionary progress in the dairy sector was enabled by the institutions and policies that emphasized on market access and technological change. In order to improve dairy farmers' access to markets, a three-tier cooperative structure, with village-level cooperative societies at the bottom, federated into a milk union at the level of a district, and a federation of milk unions at state level, was evolved under a programme called 'Operation Flood'.[1] This programme was launched in 1970 and continued up to 1996. By this time, milk production in India had increased to 66 million tonnes. The number of village-level cooperatives had increased to 75 thousand, procuring 4.5 million tonnes of milk from 9.7 million dairy farmers. In 2013–2014, more than 15 million dairy farmers (20% of the total farmers) supplied 12.5 million tonnes of milk (9% of the total milk produced) through 162 thousand village dairy cooperatives (NDDB 2014).

Along with market access, there was also considerable emphasis on genetic enhancement of low-yielding local or indigenous cows through crossbreeding using the semen of high-yielding exotic cattle, the yield potential of which is almost three times that of an indigenous cow. In 2012, the crossbreds comprised 27.9% of the total milch cows, up from 5.2% in 1981.

India's dairy policy too has undergone a sea change since 1991, from protectionism to liberalization. Until then, India followed a policy of import substitution and protectionism. Dairy cooperatives were protected from the internal and external competition. They were financially supported by the government, and the private investment in dairy industry was regulated through licensing, quotas and zoning. Imports of milk and milk products were restricted through quantitative restrictions and tariffs.

In 1991, as part of the economic reforms programme, the dairy industry was liberalized for private sector participation. This attracted a large number of private processors. They, however, started encroaching upon the milkshed areas of

[1]Operation Flood programme was implemented using food aid from the European Union and subsequently, was supplemented raising loans from the World Bank. Its first phase (1970–1980) was financed by the sale of skimmed milk powder and butter oil gifted by the European Union through the World Food Programme. During this phase, the program linked 18 premier milksheds with consumers in metropolitan cities of Delhi, Mumbai, Kolkata and Chennai. In its second phase (1981–1985), the number of milksheds increased to 136 serving 290 urban markets. The development of milksheds remained an important activity in its third phase (1985–1996), but its focus shifted towards enabling dairy cooperatives to expand and strengthen the infrastructure required for improving market linkages.

cooperatives and other established processors rather than developing their own milksheds. This was viewed as a threat to the survival of the cooperatives, and the government re-introduced the regulation in the form of Milk and Milk Products Order (MMPO) in 1992 that mandated the private processors to obtain license and develop their own milksheds. However, the potential entrants in the industry considered MMPO as a barrier to competition, and recognizing that the continuance with the concept of milksheds may give rise to local monopsony and deprive farmers of the benefits of competition, the MMPO was amended in 2002 and removed zonal restrictions on milk procurement.

The reforms had a significant impact on the dairy industry. The milk processing capacity in the private sector that was almost at par with that of cooperatives until 2002–2003 expanded rapidly to surpass that of cooperatives by 70% in 2012–2013 (Table 1). In Punjab, though the private sector had a fairly strong presence even in 1991, it grew faster after the reforms. Between 2002–2003 and 2012–2013, while there was a little, if any, expansion in the size of the cooperative sector, the processing capacity in the private sector almost doubled.

Punjab with a share of 3.5% in the total in-milk bovines (cows and buffaloes) in the country contributes 7.3% to the total milk production and has the highest per capita milk availability (945 g/day). Buffalo is the dominant species, in terms of number as well as milk production. However, there has been a gradual shift in the structure of dairying towards crossbred cows, whose share in the milk production has increased from 23% in 1992–1993 to 29% in 2012–2013. The production structure at the national level is different, but trends therein are almost similar to those in Punjab.

Compared to the national average, milk yields in Punjab are higher, and the gap has widened over time. The higher yields can be attributed to the favourable agro climatic conditions ensuring a high availability of feeds and fodders, relatively well-developed animal health care and breeding services and better access to the markets.

3 Data

To identify dairy value chains and their financing mechanisms at farm level, a survey of dairy farmers was conducted in Punjab during May–June 2014. The main consideration for selecting Punjab for this study is the strong presence of formal sector, especially private sector including multinationals like Nestle and Glaxo SmithKline in the state. And, in our pre-survey exploratory visits, we found co-existence of informal value chains (such as cooperatives and contract farming by multinationals and domestic private processors), and informal value chains driven by local traders or vendors and consumer households.

We followed a multistage random sampling procedure to gather the desired information from the farm households. The state is divided into three geographical zones, viz. central plains, undulating plains and western zones. From each zone, we

Table 1 Trends in key indicators of dairy development in India and Punjab

Variable	Punjab			India		
	1992–93	2002–03	2012–13	1992–93	2002–03	2012–13
Milk production (million tonnes)						
Crossbred cows	1.27	1.97	2.78	8.59	14.89	32.84
Local cows	0.23	0.12	0.30	16.76	19.72	27.42
Buffaloes	4.01	4.62	6.57	32.53	46.51	67.68
Total	5.58	8.17	9.72	57.96	86.16	132.40
In-milk animals (millions)						
Crossbred cows	0.47	0.63	0.69	3.73	6.5	12.64
Local cows	0.19	0.14	0.13	27.85	27.58	31.87
Buffaloes	1.94	2.48	2.08	24.56	31	38.64
Yield (kg/in-milk animal)						
Crossbred cows	7.4	8.6	11.0	5.6	6.5	7.0
Local cows	3.3	2.4	6.5	1.7	1.9	2.4
Buffaloes	5.7	6.7	8.6	3.5	4.2	4.8
Infrastructure						
Veterinary institutions	1904	2841	2899	39,804	54,912	57,724
Artificial inseminations (million)	1.1	2.74	3.6	16.0	21.5	41.2
Number of dairy plants						
Cooperatives	12	13	13	194	212	263
Private sector	21	31	64	250	403	765
Others	0	0	0	65	63	37
Total	33	44	77	509	678	1065
Processing capacity, '000 l/day)						
Cooperatives	1530	1630	1820	24,207	28,394	43,251
Private sector	3090	3805	6529	24,432	32,415	73,252
Others	0	0	0	7270	12,170	3046
Total	4620	5435	8349	55,909	72,979	119,549

Source GoI (2014)

randomly selected two districts, viz. Ludhiana and Sangrur from the central plains zone, Bhatinda and Muktsar from the western zone, and Hoshiarpur and Ropar form the undulating plains zone. At the next stage, we selected 14 development blocks,[2] three each from Ludhiana and Sangrur districts and two each from Bhatinda, Muktsar, Hoshiarpur and Ropar districts taking into consideration that one or more of the formal buyers were present there. Further, we randomly selected 18 villages each from Ludhiana and Sangrur, 10 from Hoshiarpur, 9 from Bhatinda and 6 from Muktsar and 6 from Ropar.

[2]A block is a subunit of district.

At the final stage of sampling, we decided to draw a sample of around 600 farmers from the three zones in proportion of their share in the total milch population in the state. The sample was drawn in such a way that each household had at least one animal in-milk and it was engaged in sale of milk at the time of survey, and was representative of the size distribution of dairy herds. Accordingly, we selected 325 dairy farmers from the central plains zone, 148 from the undulating plains zone and 139 from the western plains zone. For selection of different farm sizes, we relied on a Census of Bovine Population conducted by the Guru Angad Dev Veterinary and Animal Science University (GADVASU 2014) in some villages in these zones. We classified census households into small (less than 5 milch animals), medium (5–10 milch animals) and large (more than 10 milch animals), and estimated their proportions in total households. We based our sampling of farmers in these proportions.

4 Production Structure and Marketed Surplus

Table 2 shows the distribution of farmers by their herd size and landholding size. Sixty-one percent of the farmers own less than 5 milch animals averaging 2.6 per household. Twenty-three percent households have 5–10 dairy animals with an average herd size of 7.6. Only 16% of the households own more than 10 dairy animals and their average herd size was 22.6. By landholding size, the distribution is fairly well spread. Of the total households, 28% are landless, and among the landed- households, 24% each belong to small (<2 ha), medium (2–4 ha) and large (>4 ha) categories. The herd size, however, is positively associated with landholding size.

Buffaloes and crossbred cows have almost an equal proportion in the average herd size. On larger dairy farms, the production structure is in favour of crossbred cows. Across land classes too, there are significant differences in the herd structure. And, interestingly, the share of crossbred cows increases with increase in landholding size.

A crossbred cow produces more milk than a buffalo (see Table 1), but with less fat content. The average fat content in buffalo milk is estimated to be 7.6% as compared to 4.02% in cow milk (GADVASU 2014). For analytical purpose, we have standardized cow and buffalo milk at fat content of 4%[3]. Thus, on average, a dairy farmer produces 46.5 l of milk per day, of which 88% is sold and the rest is utilized for home consumption (Table 3). As expected, the marketed surplus increases with herd size, with large farmers selling 97% of the milk they produce as compared to 72% by the small dairy farmers. These findings indicate a fairly high degree of commercialization of dairying, and are in contrast to the observations of

[3]The formula for fat-corrected milk at 4% fat is:
0.4 * quantity of milk + [(15 * fat.%/100) * quantity of milk]

Table 2 Distribution of households by herd size and landholding size in Punjab

Size category	Number of households	Herd size (No. of in-milk animals/household)		
		Total	Cows	Buffaloes
Herd size				
<5	373	2.64 (1.24)	0.90 (1.08)	1.74 (1.33)
5–10	143	7.60 (1.41)	2.55 (2.41)	5.06 (2.48)
>10	96	22.61 (17.93)	15.41 (14.39)	7.21 (13.90)
All	612	6.93 (10.07)	3.56 (7.80)	3.37 (6.10)
Land size				
Landless	177	2.35 (2.20)	0.75 (1.10)	1.60 (2.15)
>0–2 ha	146	5.93 (5.54)	2.90 (5.29)	3.03 (2.86)
2–4 ha	141	7.52 (7.06)	3.40 (5.50)	4.12 (5.60)
>4 ha	148	12.84 (16.62)	7.72 (12.95)	5.12 (10.17)
All	612	6.93 (10.07)	3.56 (7.80)	3.37 (6.10)

Source Field survey
Notes Figures in parentheses are standard errors

Vandeplas et al. (2013) which indicated dairying as a subsistence activity for a majority of the households in Punjab.

The large dairy farmers contribute 54% to the total marketed surplus, followed by medium (26%) and small (20%) farmers. By landholding size too, we find a similar pattern; the large farmers account for half of the milk sales, as compared to 8% by the landless and 19% by the small landholders.

5 Farmers' Choice of Value Chains

Farmers sell milk to the formal buyers such as cooperatives controlled by the Punjab State Cooperative Milk Producers Federation Ltd., popularly known as Milkfed, private domestic processors, and multinationals like Nestle India Ltd. and Glaxo SmithKline, and also to the informal buyers comprising local traders or vendors and a variety of consumers including households, *halwais* (sweet-makers), restaurants and tea stalls. The local traders aggregate milk from farmers and sell it to the consumers in urban markets.

The cooperatives procure milk from their members, and the multinationals from their contract farmers. The contracts are often written. Generally, they have direct contracts with large farmers, usually with those having 25 or more milch animals, and provide them necessary infrastructure, inputs and services such as milk coolers and milking machines, cattle feed, and healthcare and breeding services. To integrate small producers into their value chains, they outsource milk collection to a local dairy farmer on a commission basis. He provides space for milk collection centre and also acts as aggregator for the firm. So is the case with the private domestic processors.

Table 3 Production and marketed surplus of milk in Punjab

Size category	Milk production (l/household/day)			Milk sold (l//household/day)	
	Cows	Buffaloes	Total	Milk sold	% Share in sale
Herd size					
<5	5.83 (7.91)	12.74 (9.88)	18.58 (11.93)	13.31 (9.94)	19.84
5–10	16.30 (17.7)	36.38 (22.43)	52.69 (24.55)	45.20 (24.42)	25.83
>10	103.13 (108.45)	42.89 (136.76)	146.02 (141.24)	141.62 (141.27)	54.33
All	23.54 (69.93)	23.00 (50.77)	46.54 (73.28)	40.89 (73.24)	100.0
Land size					
Landless	4.04 (7.9)	10.79 (13.4)	14.82 (13.83)	10.69 (12.77)	7.56
>0–2 ha	16.65 (37.3)	19.59 (20.8)	36.24 (36.84)	32.79 (50.17)	19.13
2–4 ha	21.30 (41.53)	26.80 (28.3)	48.09 (40.04)	41.63 (40.14)	23.46
>4 ha	55.81 (105.98)	37.33 (94.2)	93.14 (125.38)	84.27 (122.58)	49.85
All	23.54 (69.93)	23.00 (50.77)	46.54 (73.28)	40.89 (73.24)	100.00

Source Field survey
Notes Figures in parentheses are standard deviations

Table 4 shows the pattern of milk sales by farm size to the formal and informal buyers. The majority of the dairy farmers in Punjab sell milk to the formal buyers. More than 62% of the farmers, representing 69% of the marketed surplus, are associated with the formal value chains (panel a of Table 4). Within the formal sector, the cooperatives appear to be the most preferred channel for farmers in terms of both sales and suppliers—30% of the households representing one-third of the sales are associated with the cooperatives. The domestic processors stand next to cooperatives. The multinationals have a smaller share in the marketed surplus of milk (16%). The informal sector comprising local traders and consumers shares rest of the milk sales.

Often, it is argued that the formal value chains exclude small-scale producers due to the higher cost of contracting with a large number of them. Our findings indicate that the majority of farmers, irrespective of their scale of production, sell their produce to the formal sector, though the proportion of such farmers is less among the smallholders. The cooperatives remain the most important channel for all. For small farmers, local traders and consumers are the next important buyers. More than 85% of the households selling milk to consumers, and 62% selling to local traders are small-scale producers. Yet, they do not seem to be excluded from the formal value chains—more than half of the farmers associated with cooperatives, private processors and multinationals have a herd size of less than 5. This is contrary to the perception that formal value chains, particularly those driven by the private sector exclude smallholders. By involving smallholders in their value chains, the processors spread procurement risk that otherwise could be higher if they were to depend solely on a few larger farmers.

Further, it is also argued that the private processors, even if they involve smallholders in their value chains, prefer partnership with the resource-rich among

Table 4 Patterns of milk sales to different value chains

Size category	Multinationals	Private processors	Cooperatives	Local traders	Consumers	Total
(a) Number of farmers selling milk to different value chains						
Herd size						
<5	41	62	103	77	90	373
5–10	19	30	55	31	8	143
>10	19	24	30	16	7	96
All	79	116	188	124	105	612
Land size						
Landless	17	30	41	37	52	177
>0-2 ha	13	40	47	25	21	146
2-4 ha	20	23	42	36	20	141
>4 ha	29	23	58	26	12	148
All	79	116	188	124	105	612
(b) Share of different value chains in marketed surplus of milk (%)						
Herd size						
<5	10.4	16.2	32.7	18.6	22.1	100.0
5–10	14.4	21.5	38.2	18.6	7.4	100.0
>10	26.4	22.8	30.1	9.4	11.4	100.0
All	20.1	21.2	32.7	13.6	12.5	100.0
Land size						
Landless	8.8	19.9	23.9	18.1	29.4	100.0
>0–2 ha	13.7	25.1	29.2	12.1	19.9	100.0
2–4 ha	13.4	19.4	32.6	21.0	13.5	100.0
>4 ha	27.4	20.7	35.4	10.0	6.6	100.0
All	20.1	21.2	32.7	13.6	12.5	100.0
(c) Share of farmers in marketed surplus of milk (%)						
Herd size						
<5	10.3	15.2	19.9	27.1	35.2	19.8
5–10	18.5	26.2	30.1	35.4	15.3	25.8
>10	71.3	58.6	50.0	37.5	49.5	54.3
All	100.0	100.0	100.0	100.0	100.0	100.0
Land size						
Landless	3.3	7.1	5.5	10.1	17.9	7.6
>0–2 ha	13.1	22.7	17.1	17.0	30.5	19.1
2–4 ha	15.7	21.6	23.4	36.3	25.4	23.5
>4 ha	67.9	48.7	54.0	36.7	26.3	49.9
All	100.0	100.0	100.0	100.0	100.0	100.0

Source Field survey

them (Maertens and Swinnen 2009). Our results indicate that the landless households—usually the poorest of all—are more associated with the informal value chains. On the other hand, the households with larger landholdings have a stronger representation in the formal value chains driven by multinationals and cooperatives. We probe this further by analysing the milk sales by herd size and landholding size. Seventy-one percent of the milk supplies to the multinationals, 59% to the private processors and 50% to the cooperatives come from large dairy farmers. Also, we find an equally strong association of milk supplies with landholding size. These findings indicate that while choosing their partners, the formal sector buyers consider scale of production, asset base and supply risks.

6 Productivity, Price and Profitability

To have an idea about the efficiency of different value chains, we compare means of fat-corrected milk yield, price and net returns on farmers associated with different chains (Table 5). The net returns are estimated by deducting the unit cost of production (dry fodder, green fodder, concentrates, veterinary expenses and wages) from the milk price that producers receive.

The average milk yield has been estimated to be 9.64 l per animal per day. The farmers in the multinational and cooperative value chains obtain a slightly higher yield as compared to those associated with the informal value chains. Further, we do not find any significant difference in the yield across herd sizes.

On average, a farmer realizes a price of Rs. 24 per litre (Table 6). Large dairy farmers receive 5% more than others, but the difference is not statistically significant. Multinationals offer slightly higher price as compared to cooperatives and private domestic processors. Generally, multinationals use the cooperative price as floor price, and offer higher than it so as to keep their supply base intact. In the informal sector, mean price received from direct sales to consumers is almost same to that offered by the formal sector buyers. The local traders, however, offer slightly lower price. The non-significant difference in the milk prices across value chains indicates towards milk market being competitive in the state. Earlier, Birthal et al. (2008) have also noted that the entry of institutional buyers creates competition in the milk markets.

Further, a comparison of prices by scale of production shows that large dairy farmers receive a higher price. For example, in the case of multinational-driven value chains, large farmers on average receive 7.5% more as compared to small farmers. The difference could be due to the difference in the quality or the bargaining power or both. Note that multinationals source two-thirds of their total milk from large dairy farmers.

Table 7 presents the estimated profits from milk sales to different buyers. Direct sales to consumers are the most profitable, and to local traders, the least. Those selling to cooperatives earn more profit compared to those associated with

Table 5 Herd-size-wise and land-size-wise milk yield on farms associated with different value chains (l/animal/day)

Size category	Multinationals	Private processors	Cooperatives	Local traders	Consumers	Total
Herd size						
≤ 5	10.63 (4.33)	8.76 (3.39)	10.38 (4.34)	9.04 (3.53)	10.21 (3.6)	9.82 (3.9)
5–10	10.27 (2.58)	8.42 (3.49)	9.48 (2.43)	7.82 (2.69)	10.01 (3.42)	9.03 (2.9)
>10	10.74 (3.31)	9.29 (3.93)	10.34 (3.4)	8.55 (3.31)	10.49 (1.14)	9.87 (3.43)
All	10.57 (3.7)	8.78 (3.52)	10.11 (3.73)	8.67 (3.33)	10.22 (3.46)	9.64 (3.63)
Land size						
Landless	8.35 (2.76)	7.95 (2.8)	8.58 (3.06)	7.63 (2.6)	9.09 (3.48)	8.40 (3.05)
>0–2 ha	10.09 (3.42)	8.47 (3.2)	10.14 (4.69)	9.74 (3.87)	10.89 (3.01)	9.72 (3.89)
2–4 ha	11.36 (5.07)	8.67 (3.78)	9.66 (2.85)	8.51 (2.95)	11.17 (3.07)	9.66 (3.58)
>4 ha	11.54 (2.62)	10.51 (4.18)	11.49 (3.43)	9.35 (3.86)	12.34 (3.26)	11.04 (3.56)
All	10.57 (3.7)	8.78 (3.52)	10.11 (3.73)	8.67 (3.33)	10.22 (3.46)	9.64 (3.63)

Source Field survey

Notes Figures in parentheses are standard errors

Table 6 Mean farm-gate prices offered by different milk buyers (Rs./l)

Size category	Multinationals	Private processors	Cooperatives	Local traders	Consumers	Total
Herds size						
≤ 5	23.99 (1.46)	24.00 (1.59)	24.07 (1.43)	23.25 (1.07)	24.22 (1.78)	23.92 (1.52)
5–10	23.72 (1.01)	23.74 (1.47)	24.00 (1.28)	23.51 (1.17)	23.87 (0.51)	23.79 (1.24)
>10	25.79 (1.17)	24.89 (1.79)	25.15 (1.22)	23.67 (0.95)	25.38 (1.48)	24.98 (1.49)
All	24.34 (1.51)	24.12 (1.64)	24.22 (1.41)	23.37 (1.08)	24.28 (1.72)	24.05 (1.51)
Land size						
Landless	23.70 (1.42)	23.97 (1.7)	23.98 (1.36)	23.05 (0.79)	24.09 (1.77)	23.79 (1.51)
>0–2 ha	24.51 (1.59)	24.22 (1.7)	24.07 (1.4)	23.46 (1.45)	24.92 (1.73)	24.17 (1.6)
2–4 ha	24.62 (1.47)	23.73 (1.56)	24.20 (1.25)	23.50 (0.94)	23.85 (1.44)	23.96 (1.33)
>4 ha	24.45 (1.54)	24.52 (1.51)	24.52 (1.54)	23.55 (1.19)	24.69 (1.7)	24.35 (1.52)
All	24.34 (1.51)	24.12 (1.64)	24.22 (1.41)	23.37 (1.08)	24.28 (1.72)	24.05 (1.51)

Source Field survey

Note Figures in parentheses are standard errors

Table 7 Farm profits associated with different milk value chains (Rs./l)

Size category	Multinationals	Private processors	Cooperatives	Local traders	Consumers	Total
Herd size						
<5	7.28 (2.76)	5.77 (4.81)	7.19 (3.55)	5.56 (3.43)	7.59 (2.83)	6.72 (3.62)
5–10	6.39 (2.98)	6.37 (4.86)	7.62 (3.67)	5.31 (4.19)	9.78 (1.58)	6.82 (4.03)
>10	6.30 (2.07)	6.46 (3.1)	5.24 (3.98)	7.12 (2.34)	9.87 (2.97)	6.44 (3.31)
All	6.84 (2.68)	6.07 (4.5)	7.00 (3.72)	5.70 (3.54)	7.92 (2.86)	6.70 (3.67)
Land size						
Landless	6.21 (2.74)	5.77 (4.06)	6.29 (3.71)	6.03 (2.95)	6.80 (2.8)	6.29 (3.27)
>0–2 ha	6.89 (2.63)	6.08 (5.03)	7.90 (4.09)	5.95 (4.27)	8.02 (3.04)	7.00 (4.22)
2–4 ha	7.25 (2.83)	5.24 (3.82)	6.71 (3.59)	5.15 (3.57)	9.77 (1.64)	6.58 (3.61)
>4 ha	6.9 (2.65)	7.25 (4.72)	7.00 (3.45)	5.74 (3.62)	9.46 (2.23)	7.01 (3.56)
All	6.84 (2.68)	6.07 (4.5)	7.00 (3.72)	5.70 (3.54)	7.92 (2.86)	6.70 (3.67)

Source Field survey
Notes Figures in parentheses are standard errors

multinationals and domestic private processors. By herd size, there is no definite pattern in farm profits. Small farmers earn more by selling to multinationals; medium farmers to cooperatives; and large farmers to domestic private processors.

7 Econometric Estimates of Farm Performance Under Different Value Chains

The choice of a value chain reflects the selection process; wherein a buyer may prefer partnering with a particular class of farmers, say those having large herds, land and capital so as to minimize the transaction costs associated with contracting with a large number of smaller farmers. He/she may also prefer contracts with smaller farmers to have a control over production process to spread supply risks. On the other hand, a farmer's choice into a value chain could be due to self-selection. Certain observable and non-observable farm-specific characteristics may motivate him/her to associate with a specific value chain. This poses an econometric challenge in identifying the impact of value chain on farm performance, as the choice of value chain is endogenous and is jointly determined with the indicators of farm performance.

Let us consider the following model:

$$y_i = X_i\beta + \theta_{1i}T_{1i} + \theta_{2i}T_{2i} + \theta_{3i}T_{3i} + \theta_{4i}T_{4i} + v_i \quad (1)$$

where y_i is an indicator of farm performance; X_i is a vector of farmer, farm and location characteristics and T is a dummy variable for the farmer's choice of a value chain. The vector X_i includes a set of variables representing the personal, household

and village characteristics. The village-level characteristics include human population (proxy for milk supply as well as demand), infrastructure, banking facilities and distance from the nearest town or city that influence dairying activity and also the market structure. We expect a larger presence of the formal buyers in larger villages due to higher availability of milk there; and also in the villages nearer to the demand centres because of the logistic convenience.

Further, we hypothesize that a formal sector prefers contracts with a few large producers to reduce transaction costs of contracting with a large number of small producers, or with small producers to spread supply risks associated with a few large producers. A supplementary hypothesis is that the formal sector prefers partnership with the resource-rich producers, for example with the large landholders. Hence, we included dummies for landholding classes to represent the asset position of the farmers. Additionally, we included controls for farmer- and household-specific characteristics such as age and schooling of the household head, dummy for training in commercial dairying, main occupation, social status (caste), labour availability (family size and hired labour) and illiterate females in the household.

If the selection is only on the observables, the estimated parameters, θs provide unbiased estimates of the impact of a value chain on farm performance. In the analysis based on survey data, the issue of self-selection bias cannot be resolved just by including control covariates (Deb and Trivedi 2006b) as the error term, v_i in Eq. (1) contains unobserved characteristics, l_{ji} common to individual i's choice of value chain j, and can be written as

$$v_i = \sum_j \lambda_j l_{ji} + \varepsilon_i \tag{2}$$

where ε_i is the idiosyncratic independently distributed random error. Now, the underlying propensity, $P_{ji,}$ of a farmer to choose a particular value chain, j, can be expressed as

$$P_{ji} = Z_i \alpha_j + \delta_j l_{ji} + \upsilon_{ji} \tag{3}$$

where Z_i denotes exogenous covariates, and υ_{ji} are the random error terms assumed to be independent of ε_i. Note that the latent factors, l_{ji}, determine both the farm performance (Eq. 1) and the choice of a value chain (Eq. 3). The joint distribution of selection and outcome variables, conditional on the common unobserved factors, l_{ji}, can be written as

$$\begin{aligned}\Pr\left(Y_i = y_i, T_{ji} = 1 | X_i, Z_i, l_{ji}\right) = & f\left(X_i\beta + \theta_{1i}T_{1i} + \theta_{2i}T_{2i} + \theta_{3i}T_{3i} + \theta_{4i}T_{4i} + \sum_j \lambda_j l_{ji}\right) \\ & \times g\left(Z_i\alpha_j + \delta_j l_{ji}\right)\end{aligned} \tag{4}$$

Table 8 Summary statistics of the variables used in estimation

Household characteristics	Informal		Formal			Total
	Consumer	Local trader	Private processor	Multinational	Cooperative	
Owned land (ha)	1.48	2.40	2.14	3.13	2.92	2.45
	(0.25)	(0.296)	(0.3)	(0.338)	(0.241)	(0.128)
Household size (no.)	5.45	5.29	5.94	5.75	5.66	5.61
	(0.198)	(0.188)	(0.253)	(0.263)	(0.175)	(0.095)
Proportion of illiterate females (%)	0.07	0.12	0.14	0.10	0.09	0.10
	(0.012)	(0.014)	(0.017)	(0.017)	(0.009)	(0.006)
Household head age (years)	47.09	48.36	49.26	47.57	48.19	48.16
	(1.19)	(1.087)	(1.155)	(1.463)	(0.921)	(0.503)
Household head schooling (years)	7.36	6.82	7.31	8.04	7.89	7.49
	(0.436)	(0.391)	(0.446)	(0.487)	(0.286)	(0.176)
Proportion of literate household heads	0.79	0.77	0.78	0.85	0.88	0.82
	(0.04)	(0.038)	(0.039)	(0.041)	(0.024)	(0.016)
Herd size (no.)	4.31	5.44	8.03	10.06	7.39	6.93
	(0.658)	(0.431)	(0.941)	(1.988)	(0.68)	(0.407)
Proportion of crossbreds in the herd	0.30	0.22	0.39	0.44	0.42	0.36
	(0.037)	(0.027)	(0.036)	(0.044)	(0.028)	(0.015)
Occupation: proportion in cultivation	0.37	0.55	0.47	0.61	0.58	0.52
	(0.047)	(0.045)	(0.047)	(0.055)	(0.036)	(0.02)
Occupation: proportion in dairying	0.10	0.16	0.28	0.15	0.21	0.19
	(0.029)	(0.033)	(0.042)	(0.041)	(0.03)	(0.016)
Occupation: proportion in agricultural labour	0.20	0.16	0.14	0.14	0.12	0.15
	(0.039)	(0.033)	(0.032)	(0.039)	(0.024)	(0.014)
Occupation: proportion in others	0.33	0.13	0.10	0.10	0.09	0.14
	(0.046)	(0.03)	(0.028)	(0.034)	(0.021)	(0.014)
Land class: proportion of landless	0.50	0.30	0.26	0.22	0.22	0.29
	(0.049)	(0.041)	(0.041)	(0.047)	(0.03)	(0.018)
Land class: proportion of marginal farms	0.11	0.07	0.19	0.06	0.11	0.11
	(0.031)	(0.022)	(0.037)	(0.028)	(0.023)	(0.013)
Land class: proportion of small farms	0.09	0.14	0.16	0.10	0.14	0.13
	(0.027)	(0.031)	(0.034)	(0.034)	(0.025)	(0.013)

(continued)

Table 8 (continued)

Household characteristics	Informal		Formal			Total
	Consumer	Local trader	Private processor	Multinational	Cooperative	
Land class: proportion of medium farms	0.19	0.29	0.20	0.25	0.22	0.23
	(0.039)	(0.041)	(0.037)	(0.049)	(0.03)	(0.017)
Land class: proportion of large farms	0.11	0.21	0.20	0.37	0.31	0.24
	(0.031)	(0.037)	(0.037)	(0.055)	(0.034)	(0.017)
Social group: proportion of SC/ ST households	0.36	0.27	0.22	0.25	0.20	0.25
	(0.047)	(0.04)	(0.039)	(0.049)	(0.029)	(0.018)
Social group: proportion OBC households	0.19	0.16	0.21	0.20	0.20	0.19
	(0.039)	(0.033)	(0.038)	(0.046)	(0.029)	(0.016)
Social group: proportion of other households	0.45	0.57	0.57	0.54	0.60	0.55
	(0.049)	(0.045)	(0.046)	(0.056)	(0.036)	(0.02)
Proportion of households with hired labour	0.15	0.27	0.35	0.35	0.37	0.31
	(0.035)	(0.04)	(0.044)	(0.054)	(0.035)	(0.019)
Proportion of household heads attended training	0.06	0.03	0.11	0.19	0.11	0.10
	(0.023)	(0.016)	(0.029)	(0.044)	(0.023)	(0.012)
Information on food safety (no. of sources)	2.82	2.41	2.48	3.00	2.84	2.70
	(0.104)	(0.094)	(0.098)	(0.126)	(0.081)	(0.044)

Note The figures in parentheses are standard errors

Equation (4) represents the multinomial treatment effect model. The parameters of the model are estimated using maximum simulated likelihood procedure, as suggested by Deb and Trivedi (2006a, b). Table 8 shows the key characteristics of farmers associated with different value chains.

The results of first stage multinomial treatment effect model are presented in Table 9. These need to be interpreted in relation to those selling directly to the consumers. The regression coefficient on village population is negative, suggesting that larger local demand for milk reduces the probability of entry of formal sector buyers there. Such villages may also be nearer to the demand centres, motivating producers to directly sell milk to consumers there. Our results indicate that relative probability of formal buyers procuring milk is higher from the villages farther away from the cities and towns. Logistically, it may be costly, but it is easy to procure sufficient supplies from there possibly due to lack of competition among the buyers. The multinationals also prefer sourcing milk from villages that have banking facilities.

Table 9 Multinomial logit model of choice of marketing channel

Variable	Private processor	Multinational	Local trader	Cooperative
Land class				
Landless = 1, zero otherwise	−0.4663	−1.9474**	−1.9217***	−1.1797*
	(0.6126)	(0.8159)	(0.7133)	(0.6446)
Marginal farmers = 1, zero otherwise	0.1215	−1.0921*	−1.0921*	−0.8812*
	(0.5922)	(0.5793)	(0.5784)	(0.5065)
Small farmers = 1, zero otherwise	0.1171	−0.3733	−0.1313	−0.4214
	(0.4692)	(0.5700)	(0.4972)	(0.4582)
Medium farmers = 1, zero otherwise	−0.3610	−0.4049	−0.4068	−0.6988**
	(0.3633)	(0.3784)	(0.3513)	(0.3427)
Household head schooling (years)	−0.0374	0.0740	0.0819	0.1189*
	(0.0659)	(0.0857)	(0.0868)	(0.0649)
Household head schooling squared	0.0018	−0.0049	−0.0080	−0.0091*
	(0.0048)	(0.0062)	(0.0066)	(0.0050)
Household size (no.)	−0.0421	−0.0350	−0.2256*	−0.1002
	(0.1279)	(0.1242)	(0.1154)	(0.1130)
Household size squared	0.0054	0.0009	0.0090	0.0047
	(0.0074)	(0.0069)	(0.0067)	(0.0069)
Proportion of illiterate females in the household	2.4767***	1.0462	1.3746**	0.7410
	(0.8594)	(0.8376)	(0.7003)	(0.6670)
Proportion of crossbred cows in the herd	0.2713	0.5547*	−0.8151**	0.5260*
	(0.3273)	(0.3254)	(0.3250)	(0.3013)
Herd size (No.)	0.0749*	0.0361	0.0691	0.0284
	(0.0383)	(0.0309)	(0.0484)	(0.0294)
Herd size squared	−0.0007	−0.0002	−0.0016	−0.0003
	(0.0006)	(0.0002)	(0.0013)	(0.0002)
Main occupation				
Cultivation = 1, zero otherwise	0.7766	−0.0272	−0.4347	0.8069*
	(0.5354)	(0.6446)	(0.4987)	(0.4785)
Dairying = 1, zero otherwise	0.5722	0.0363	−0.2501	0.8087**
	(0.3854)	(0.5459)	(0.3495)	(0.3987)
Agricultural labour = 1, zero otherwise	−0.3171	0.0474	−0.7256*	0.0943
	(0.3815)	(0.4258)	(0.4070)	(0.3642)
Caste				
SC or ST = 1, zero otherwise	−0.0814	0.6290*	−0.0322	−0.1116
	(0.3427)	(0.3788)	(0.3367)	(0.3726)
OBC = 1, zero otherwise	0.2269	0.5547*	0.1635	0.3076
	(0.2295)	(0.2866)	(0.2547)	(0.2308)
Intensity of information on food safety	0.0317	0.2196	0.0569	0.3276***
	(0.1200)	(0.1355)	(0.1168)	(0.1253)

(continued)

Table 9 (continued)

Variable	Private processor	Multinational	Local trader	Cooperative
Bank branch in the village = 1, zero otherwise	−0.0087	0.6838*	−0.2593	0.4567
	(0.3257)	(0.4059)	(0.2828)	(0.3282)
Veterinary facility in the village = 1, zero otherwise	−0.0683	−0.2198	0.3382	−0.3016
	(0.3790)	(0.4634)	(0.3945)	(0.3970)
Village population (no.)	−0.0000	−0.0000	−0.0002**	−0.0001*
	(0.0001)	(0.0000)	(0.0001)	(0.0001)
Distance from nearest town (km)	0.0687***	0.0769**	0.0473*	0.1014***
	(0.0258)	(0.0315)	(0.0253)	(0.0259)
District				
Hoshiarpur	0.7688	−1.3137**	−0.4643	−0.8130
	(0.5369)	(0.5438)	(0.5451)	(0.6012)
Ludhiana	2.3154***	0.2857	1.7010**	1.9747***
	(0.7039)	(0.7385)	(0.6779)	(0.6601)
Muktsar	−0.1198	−0.1432	1.2813*	0.4286
	(0.7997)	(0.4342)	(0.7439)	(0.5305)
Ropar	1.4030***	−1.4234**	0.0461	0.2514
	(0.4998)	(0.5744)	(0.7593)	(0.5401)
Sangrur	2.1117***	0.6908	2.5986***	0.9026
	(0.6786)	(0.6787)	(0.5707)	(0.6075)
Constant term	−2.6458**	−1.3700	0.8130	−1.9307*
	(1.0674)	(1.2567)	(1.0439)	(1.1211)
No. of observations	612			

Notes Figures in parentheses are village-clustered standard errors
***, ** and * denote significance at 1, 5 and 10% levels, respectively

The herd size carries a positive coefficient, meaning that relative to the direct sales to consumers, the probability of sale to formal sector is higher among the larger farmers. Alternatively, smaller farmers tend to sell milk to consumers. In terms of land size too, large farmers have a relatively higher probability of being into formal value chains. The negative coefficient on the landless and marginal landholders also lends support to this observation. This implies that buyers from the formal sector tend to partner with resource-rich dairy farmers. Formal value chains place greater emphasis on food safety and quality product, and our results indicate that these partner with those who have the understanding of food safety standards and capability to comply with these standards. Interestingly, the likelihood of selling milk to multinationals is higher among the households belonging to the scheduled castes/tribes who often face discrimination in the local market because of their poor social status.

Table 10 presents the results of the second stage of the multinomial treatment effect model. The inverse Mills ratio is positive and significant in the case of

Table 10 Results of multiple treatment effect regression with endogenous choice of buyer

Variable	ln (profit)	ln (yield)
Difference form base category: 1 if private processor, zero otherwise	−0.2801	−0.0774
	(0.1782)	(0.1144)
Difference form base category: 1 if multinational, zero otherwise	−0.0467	−0.3038***
	(0.0969)	(0.0876)
Difference form base category: 1 if local trader, zero otherwise	0.1322	−0.0357
	(0.1528)	(0.1365)
Difference form base category: 1 if cooperative; 0 otherwise	0.2807*	0.0937
	(0.1550)	(0.0744)
Landless farmers = 1, zero otherwise	0.0070	−0.2414***
	(0.1986)	(0.0793)
Marginal farmers = 1, zero otherwise	−0.1074	−0.1737**
	(0.1960)	(0.0717)
Small farmers = 1, zero otherwise	−0.0032	−0.1230**
	(0.1244)	(0.0531)
Medium farmers = 1, zero otherwise	−0.2222	−0.0804*
	(0.1608)	(0.0462)
Household head schooling (years)	−0.0164	0.0013
	(0.0339)	(0.0108)
Household head schooling squared	0.0010	−0.0001
	(0.0019)	(0.0008)
Household size (no.)	0.0657	−0.0157
	(0.0775)	(0.0258)
Household size squared	−0.0036	0.0009
	(0.0040)	(0.0014)
Proportion of illiterate females in the household	−1.3664	−0.2832**
	(0.9089)	(0.1225)
Proportion of crossbred cows in the herd	0.1057	−0.1825***
	(0.0881)	(0.0492)
Herd size (no.)	0.0175***	−0.0004
	(0.0067)	(0.0031)
Herd size squared	−0.0001**	0.0000
	(0.0000)	(0.0000)
Main occupation		
Cultivation = 1, zero otherwise	−0.0211	−0.1455**
	(0.1398)	(0.0704)
Dairying = 1, zero otherwise	0.1408	−0.0912
	(0.1321)	(0.0841)
Agricultural labour = 1, zero otherwise	−0.0418	−0.0319
	(0.1233)	(0.0499)

(continued)

Table 10 (continued)

Variable	ln (profit)	ln (yield)
Caste		
SC or ST = 1, zero otherwise	0.1016	−0.0150
	(0.1164)	(0.0465)
OBC = 1, zero otherwise	0.0552	0.0033
	(0.0878)	(0.0423)
Intensity of information on food safety:	0.0491	0.0077
	(0.0396)	(0.0165)
Bank branch in village = 1, 0 otherwise	0.1656	0.0134
	(0.1345)	(0.0467)
Veterinary facility in the village = 1, zero otherwise	0.0021	0.0446
	(0.1161)	(0.0474)
Permanent hired labour = 1, zero otherwise	−0.2076	0.0049
	(0.1622)	(0.0427)
Training = 1, zero otherwise	−0.2784***	0.1304**
	(0.0985)	(0.0519)
District dummies		
Hoshiarpur	0.2629***	−0.0236
	(0.0945)	(0.0577)
Ludhiana	−0.6230***	−0.3983***
	(0.1628)	(0.0717)
Muktsar	−0.1419	−0.0353
	(0.0882)	(0.0594)
Ropar	0.2067**	−0.1348**
	(0.1028)	(0.0539)
Sangrur	−0.6529***	−0.3804***
	(0.1469)	(0.0716)
ln (sigma)	0.0814	−1.6540***
	(0.1862)	(0.2953)
Lambda (domestic private processor)	0.0132	0.0146
	(0.0515)	(0.0441)
Lambda (multinational)	0.0491	0.1439***
	(0.0554)	(0.0273)
Lambda (local trader)	−0.1446**	0.0014
	(0.0695)	(0.0519)
Lambda (cooperative)	−0.2612**	−0.0151
	(0.1248)	(0.0317)
Constant term	1.6379***	2.7593***
	(0.4292)	(0.1470)
No. of observations	591	612

Notes Figures in parentheses are village-clustered standard errors
***, ** and * denote significance at 1, 5 and 10% levels, respectively

multinational-driven value chains, indicating that without controlling for the selection bias (in the first stage), their estimated impact on farm performance would have been upwardly biased. Alternatively, the farmers who are inherently more efficient based on their unobserved characteristics self-select to partners with multinationals.

The regression coefficients of milk yield of those associated with cooperatives, private processors and local traders are not statistically different from the one catering to the local milk requirements, i.e. consumers. Surprisingly, the relative milk yield on farms associated with multinationals turns out to be significantly less than others. This is possible. The multinationals prefer low-fat cow milk, and the dairy farms, in particular, the larger ones that supply milk to multinationals have a larger proportion of crossbred cows. This is also confirmed by a negative and significant coefficient on the crossbred cows. The regression coefficient indicates higher milk yield under cooperative value chain. Further, we do not find a significant relationship between herd size and milk yield, indicating that dairy productivity is invariant to scale. On the other hand, the landholding size does influence productivity—higher for large landholders due to the presence of positive spillovers of landholdings on dairy production *via* the availability of feeds and fodders.

Table 10 also presents the results on the impact of value chains on farm profits. The inverse Mills ratio is negative and significant in the case of cooperatives and local traders, suggesting that farm profits for those associated with these chains would have been biased downward, had we not controlled for selection bias. The regression results show no significant difference in the profits of those associated with multinationals, domestic private processors and local traders compared to those selling to consumers. However, these are significantly higher for those associated with cooperatives. Further, farm profits increase with herd size, but after a threshold herd-size, these start declining, probably due to the management problems associated with larger herds. Nonetheless, a contrasting relationship between herd size and profits (positively significant) and between herd size and yield (negative but insignificant) is the indication of the better bargaining power of larger farmers in obtaining better price terms.

Some studies (e.g. Birthal et al. 2005; Gupta and Roy 2012; Birthal et al. 2008) have found little if any difference in the milk yield, its cost of production and price between the contract and independent farmers. These studies, however, did find marketing and transaction costs to be significantly less for contract farmers. One of the reasons for the lack of significant difference in the farm profits across value chains is the non-accounting of marketing and transaction costs in estimation of profits.

8 Mechanisms of Financing Value Chains

In India, dairying has remained underfinanced by the commercial banks and other financial institutions. The share of animal husbandry and dairying in the total agricultural credit has hardly ever exceeded 5%, despite their rising contribution to

the agricultural gross domestic product (Birthal and Negi 2012). The constraint could be severe on smallholders to whom the formal financial institutions hesitate to lend because of their poor creditworthiness, and higher cost of lending in relation to size of loan. Miller and Jones (2010) argue that value chain can be an entry point for the financial institutions to reduce their transaction costs and lending risks associated with small loans.

To understand the financing of dairying activities, we elicited information from the sample farmers on their sources of credit for dairying. They avail credit from both within the chain and outside the chain. The internal finance is available from the chain actors, while the external finance is not linked to the chain actors, but is available from financial institutions such as commercial banks, and informal sources such as moneylenders, relatives and friends.

More than half (53%) of the sample farmers borrowed from one or the other source (Table 11). Internal finance is available to one-fourth of the borrowers and the rest borrow from the external sources. The commercial banks and other financial institutions cater to the credit requirements of only one-fifth of the borrowers, and the rest depend on informal sources; 33% borrow from relatives and friends, and 21% from moneylenders.

The incidence of borrowing is higher among those who sell milk to local traders (72%), and to domestic private processors (68%). However, only one-third of them borrow from the chain actors, viz. output buyers. The incidence of borrowing is less among those associated with multinationals (37%) and cooperatives (46%), but in both the cases, the internal financing is confined to a small proportion of the households. Note that cooperatives *per se* do not finance dairy activities; it is the person managing the cooperative milk collection centre who advances loans. Higher internal financing by local traders and domestic private processors is because they, in order to improve their procurement base or maintain it, advance loans to farmers against their commitment of sale of milk. Such loans are often short term and interest free.

Table 11 Incidence of borrowing among dairy farmers

Particulars	Consumers	Local traders	Private processors	Multinationals	Cooperatives	Total
Non-borrowers (no.)	**63**	**35**	**37**	**50**	**101**	**286**
Row per cent	22.03	12.24	12.94	17.48	35.31	100.0
Column per cent	60.00	28.23	31.90	63.29	53.72	46.73
Borrowers (no.)	**42**	**89**	**79**	**29**	**87**	**326**
Row per cent	12.88	27.30	24.23	8.90	26.69	100.0
Column per cent	40.00	71.77	68.10	36.71	46.28	53.27
Total (no.)	**105**	**124**	**116**	**79**	**188**	**612**
Row per cent	17.16	20.26	18.95	12.91	30.72	100.0
Column per cent	100.0	100.0	100.0	100.0	100.0	100.0

Source Field survey

The sources of finance differ by farm size. The institutional finance is more accessible to larger farmers in terms of both herd size and land size (Table 12). Interestingly, the incidence of institutional borrowings is higher among large landholders. This is because of differences in creditworthiness of borrowers as the commercial banks base their lending decisions on creditworthiness. A considerable proportion of smallholders depend on informal sources for their credit needs. The proportion of borrowers availing finance from within the chain is higher among smallholders.

One of the motivations for farmers to choose a specific value chain is the availability of finance from the chain actors. Table 13 shows the distribution of farmer-borrowers availing credit from within and outside the chains. Internal finance dominates the chains driven by local traders and private domestic processors, and external finance dominates the chains driven by cooperatives and consumers. It is, thus, important to understand these differences in the farmers' choice of a financing channel across the value chains, in terms of the possible determinants of such choices. Given this, there arises an important question: why internal finance is more important in the value chains driven by local traders and domestic private processors?

A farm household has many options to borrow. The utility that a farm household obtains from an option is latent or unobservable. On the assumption that the household considers all the possible options and chooses the one that provides maximum utility, we can write the utility associated with each option, *j*, as evaluated by household, *i,* as

$$U_{ij} = X_i\beta_j + \in_{ij} \tag{5}$$

where X_i is a vector of variables including attributes of the alternative financing channels and socio-economic characteristics of the household; and ϵ_{ij} is the random unobserved component of the utility. Under the assumption that the unobserved component of utility is *iid*, and follows extreme value distribution, we can model the probability of choice of a financing channel as a function of observed characteristics of the household by a multinomial logistic model given by Eq. (6) (Train 2009).

$$\Pr(Y_i = j|X_i) = \frac{e^{X_i\beta_j}}{1 + \sum_{k=1}^{J} e^{X_i\beta_j}}, \quad j = \{0, 1, \ldots, J\} \tag{6}$$

We started with identifying the factors that influence farmers' choice of a financing channel with full sample. Of the total 326 borrowers, we dropped those households who availed credit from cooperative collection centres, and input suppliers as these are not important sources of credit. Table 14 presents the results. These need to be interpreted in relation to the borrowers from the commercial banks. The coefficient of the landholding size is found negative and significant in the case of borrowers from local traders, relatives and friends and moneylenders,

Table 12 Number of borrowers by herd size and land size

Size category	Commercial banks	Cooperative collection centres	Local traders	Private collection centres	Relatives and friends	Moneylenders	Feed suppliers	Total
Herd size								
Small	18	10	19	25	84	50		206
Medium	31		8	7	13	14	2	75
Large	19	2	3	4	12	5		45
Overall	68	12	30	36	109	69	2	326
Land size								
Landless	3	8	13	17	59	29		129
>0–2 ha	18	1	5	13	29	17		83
2–4 ha	24	3	7	5	10	14		63
>4 ha	23		5	1	11	9	2	51
Overall	68	12	30	36	109	69	2	326

Source Field survey

Table 13 Classification of borrowers by their source of finance

Financing channel	Informal sources		Formal sources			All
	Consumers	Local traders	Private processors	Multinationals	Cooperatives	
Within chain						
Cooperative collection centre	0	0	0	0	12 (13.8)	12 (3.7)
Feed suppliers	0	0	0	1 (3.4)	1 (1.1)	2 (0.6)
Milk vendors	0	30 (33.7)	0	0	0	30 (9.2)
Private collection centre	0	0	28 (35.4)	8 (27.6)	0	36 (11.0)
Outside chain						
Commercial bank	2 (4.8)	20 (22.5)	12 (15.2)	6 (20.7)	28 (32.2)	68 (20.9)
Relatives and friends	27 (64.3)	19 (21.3)	23 (29.1)	6 (20.7)	34 (39.1)	109 (33.4)
Village moneylender	13 (31.0)	20 (22.5)	16 (20.3)	8 (27.6)	12(13.8)	69 (21.2)
Total	42	89	79	29	87	326

Source Field survey
Note Figures in parentheses are percentages of column total

clearly indicating a relatively better access of larger farmers to formal sources of finance (commercial banks). Likewise, there is a negative relationship between herd size and borrowings from moneylenders. The results indicate a greater reliance of SC/ST households on informal sources. This confirms an earlier observation that financial institutions discriminate lower caste households in their lending decisions (Kumar 2013). These findings clearly indicate that smallholders lack assets to offer as collateral for accessing finance from the commercial banks and other financial institutions, and they are more dependent on informal financial sources such as social networks.

Further, to identify the factors that drive chain-based financing, we estimated multinomial logistic regressions for the subsample of borrowers associated with a particular value chain. We estimate these regressions for those availing finance from the multinationals and consumers to a small number of borrowers. Table 15 presents the results. These need to be interpreted in relation to the base category of lenders; for example, in the case of local traders as lender, we considered this source as the base. The findings indicate that large landholders selling to local traders and private domestic processors prefer borrowings from commercial banks and other financial institutions over the informal sources. The effect of landholding is stronger in the case of processors. A possible reason is that the local traders are more informed about the creditworthiness and socio-cultural background of their clients than the private processors.

Table 14 Determinants of choice of lender: full sample of borrowers

Base category: commercial bank	Local traders	Private collection centre	Relatives and friends	Moneylenders
Owned land (ha)	−0.2231**	−0.5372	−0.5463***	−0.2477**
	(0.0978)	(0.3323)	(0.1432)	(0.0977)
Household size (No.)	−0.0216	0.0621	0.2058**	0.1644*
	(0.1013)	(0.1128)	(0.0984)	(0.0853)
Household head schooling (years)	0.0068	−0.1152	−0.1120	−0.0034
	(0.1445)	(0.1793)	(0.1496)	(0.1663)
Household head schooling squared	0.0036	0.0138	0.0190	0.0130
	(0.0111)	(0.0160)	(0.0135)	(0.0134)
Herd size (no.)	−0.0308	−0.0206	−0.0426	−0.1310***
	(0.0492)	(0.0308)	(0.0609)	(0.0507)
SC/ST = 1, zero otherwise	1.2341**	0.8956	1.2782*	1.0537
	(0.6151)	(0.6985)	(0.6828)	(0.6962)
OBC = 1, zero otherwise	−0.4020	0.0901	−0.1291	−1.0186
	(0.5942)	(0.5537)	(0.4463)	(0.6393)
Constant term	−0.3914	−0.0867	−0.0894	−0.4037
	(0.6953)	(0.5710)	(0.5368)	(0.6398)
No. of observations	312			
Chi^2	141.6			

Note Figures in parentheses are standard errors
***, ** and * denote significance at the 1, 5 and 10% levels, respectively

Table 15 Determinants of choice of lender: subsamples

(a) Farmers selling milk to milk vendors			
Base category: local traders	Commercial banks	Relatives and friends	Moneylenders
Owned land (ha)	0.4430**	−0.3615	−0.0007
	(0.2036)	(0.3300)	(0.2833)
Household size (No.)	−0.0789	0.1205	0.2452**
	(0.1761)	(0.1214)	(0.1160)
Household head schooling (years)	0.4292*	−0.8016*	0.2714
	(0.2512)	(0.4617)	(0.2116)
Household head schooling squared	−0.0627**	0.0764*	−0.0228
	(0.0266)	(0.0444)	(0.0224)
Herd size (no.)	0.1504*	−0.2392***	−0.2050**
	(0.0787)	(0.0807)	(0.0836)
SC/ST = 1, zero otherwise	−0.4758	−1.8471*	0.0540
	(1.0119)	(0.9459)	(1.0305)

(continued)

Table 15 (continued)

(a) Farmers selling milk to milk vendors			
Base category: local traders	Commercial banks	Relatives and friends	Moneylenders
OBC = 1, zero otherwise	0.5145	−0.0337	1.0005
	(1.0156)	(0.8108)	(0.7754)
Constant term	−1.4809	1.4431	−1.4516
	(1.0065)	(1.0918)	(1.3842)
No. of observations	89		
Chi^2	671.1		

(b) Farmers selling milk to private processors			
Base category: private collection centre	Commercial banks	Relatives and friends	Moneylenders
Owned land (ha)	0.9456**	0.3805	0.7581**
	(0.3810)	(0.3033)	(0.3270)
Household size (No.)	−0.3579**	0.1620	0.0829
	(0.1390)	(0.1137)	(0.1092)
Household head schooling (years)	−0.3583	−0.0958	0.1451
	(0.2945)	(0.2342)	(0.3068)
Household head schooling squared	0.0144	0.0117	−0.0025
	(0.0216)	(0.0196)	(0.0233)
Herd size (no.)	0.0809	−0.0439	−0.0898
	(0.0526)	(0.0515)	(0.0611)
SC/ST = 1, zero otherwise	−16.0856***	0.3931	−0.0976
	(0.9584)	(0.7391)	(0.9511)
OBC = 1, zero otherwise	1.2392	1.0444	−16.1066***
	(1.2411)	(0.9872)	(0.8757)
Constant term	0.4314	−1.7019**	−2.1762
	(1.0280)	(0.8247)	(1.4022)
No. of observations	79		
Chi^2	2286.0		

(c) Farmers selling to cooperatives			
Base category: bank	Cooperative collection centre	Relatives and friends	Village money lenders
Owned land (ha)	−0.7379**	−0.4925***	−0.4667**
	(0.2874)	(0.1887)	(0.2219)
Household size (No.)	0.1914	0.1527	0.3688*
	(0.1210)	(0.1348)	(0.1960)
Household head schooling (years)	−0.4533	−0.3187	0.2060
	(0.7877)	(0.6686)	(0.8250)
Household head schooling squared	0.0310	0.0205	0.0051
	(0.0707)	(0.0620)	(0.0635)

(continued)

Table 15 (continued)

(c) Farmers selling to cooperatives			
Base category: bank	Cooperative collection centre	Relatives and friends	Village money lenders
SC/ST = 1, zero otherwise	0.0399	0.0489	−0.1855
	(0.0497)	(0.0383)	(0.1359)
OBC = 1, zero otherwise	2.1696	2.6203*	−0.1984
	(1.6526)	(1.4885)	(1.9584)
Constant term	−0.9801	−0.6929	−2.1563*
	(1.3558)	(0.9591)	(1.1755)
No. of observations	0.1825	0.6557	−2.4821
	(0.7876)	(1.2679)	(2.4950)
No. of observations	86		
Chi^2	203.6		

Notes Figures in parentheses are standard errors
***, ** and * denote significance at the 1, 5 and 10% levels, respectively

The education of household head is positive and significant in the case of commercial banks as lenders; and it is negative and significant in the case of social networks in the subsample of farmers selling milk to local traders. This effect is not visible in the case of private domestic processors as lenders. The direction of regression coefficient on SC/ST households is similar to that in the case of full sample, leading us to conclude that there is caste-based discrimination in institutional financing. The results for subsample of farmers associated with cooperatives are also similar to these observations. These findings confirm that the lack of collateral is an important factor in accessing financial institutions; and in the absence of collaterals, farm households have to depend on other sources of finance, including chain actors.

9 Concluding Remarks

India's dairy sector has witnessed an impressive demand-led growth over the past four decades. The sector is dominated by small-scale producers who often lack access to markets and finances. Using unique data on 612 dairy households from the state of Punjab, this study has evaluated their choices for value chains, their efficiency, inclusiveness and financing mechanisms. The study finds that 62% of the dairy farmers representing 69% of the total milk sales are associated with formal value chains, with cooperatives being the most preferred. The smaller dairy farmers, however, are more dependent on informal value chains. Interestingly, the small farmers outweigh large farmers in formal value chains; but their share in the total

milk sales is not as large. This implies that small dairy farmers are not altogether excluded from the formal value chains.

The econometric results indicate a little, if any, difference in the milk yield across farm categories of farms and also value chains. The price difference is also not significant. But farmers with larger herds realize higher profits, indicating their better bargaining power. We have also looked into the importance of food safety in different value chains, and find that those farmers who are aware of food safety standards, are more associated with the formal value chains, and also realize higher profits.

More than half of the dairy farmers borrow credit from formal as well as informal sources. The incidence of borrowing is higher among the households selling their produce to local traders and private domestic processors. The chain-based financing is limited to about one-fourth of the farmers. The smallholder farmers depend more on relatives and friends, and moneylenders for their financial requirements. Financing by commercial banks is limited, and is largely to larger farmers, implying that lending decisions of the commercial banks and other financing institutions are largely driven by creditworthiness, neglecting the smallholders who lack collateral.

The findings of this study have implications for agribusiness firms as well as financial institutions. For an agribusiness firm, a value chain can itself serve as the collateral for advancing loans to their clients. In the case of financing through value chains, financial institutions can use contracts as collaterals for lending short-term as well as investment credit. There is also a considerable scope for financial institutions to improve their outreach in the dairy sector without integrating with value chains. Presently, the commercial banks treat credit to dairying as investment credit meant for the purchase of animals, construction of cattle sheds, etc. It may be noted that animal being a reproducible asset can be easily multiplied by farmers to scale up their activity, but they are constrained by operational capital. It has direct policy implications for the financial institutions. They should consider providing financial support to farmers for meeting the operational expenses and evolve innovative financial products, e.g. dairy credit cards. Such initiatives would enable the farmers, especially smallholders, to scale up dairying, and adopt yield-enhancing technologies and inputs.

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Smallholder Participation in Supermarket-Driven Agri-Food Supply Chain: A Case Study of Reliance Fresh

Rajib Sutradhar

1 Introduction

Belying the early prediction that outreach of supermarkets would remain limited to the developed world (Goldman 1974; Goldman et al. 2002), supermarkets as a purveyor of food to urban consumers have become prominent in many developing countries over the past few decades, starting early 1990s. In a departure from the trend noted in the developed countries, supermarkets in developing countries have penetrated into fresh fruits and vegetables relatively early in their diffusion (Reardon et al. 2010). Some of these countries such as China (Hu et al. 2004) and those in Latin America (Reardon et al. 2003) have already reported that purchase by supermarket chains for home market is higher than total exports of fresh fruits and vegetables by these countries, underlining the growing importance of supermarkets as a key vehicle for transformation in agri-food system in developing countries.

The rapid diffusion of supermarkets has, on its wake, brought institutional and organizational changes in the agri-food system, with transactions that were traditionally made through spot market, are now being increasingly conducted through contracts between buyers and sellers at various points along the agri-food supply chain (Dolan and Humphrey 2000; Reardon et al. 2003). This shift away from the spot market has been driven by the increasing emphasis by supermarkets on grades and standards, environment and safety concerns and advantages associated with economies of scale (Dolan and Humphrey 2000; Henson and Reardon 2005). However, such a shift away from the spot market translates into higher investment in the farm, posing challenges for smallholders who often do not have the required inputs and lack access to formal capital to undertake the required investment (Reardon et al. 2009). The gradual withdrawal by the governments from the

R. Sutradhar (✉)
Omeo Kumar Das Institute of Social Change and Development (OKDISCD), Upper Hengrabari, Guwahati 781036, India
e-mail: rajibsutradhar@gmail.com

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provision of input services as a part of structural adjustment programme means that the problem of access to inputs has become more acute now than before, especially when the private sector is also unable to fill the void left by the government. If smallholders do not possess the required capacity, they risk exclusion from the supermarket-driven marketing chains, as the latter aim to 'drive cost out of the system' by procuring produce of the required quality and standards from a fewer number of larger farmers.

However, supermarkets may also bring opportunities to smallholders, who may manage to secure resource provision contracts from supermarkets. Such contracts may help smallholders overcome idiosyncratic market failures that they typically face in the traditional rural settings and capture more remunerative markets that are, hitherto, inaccessible to them. Moreover, smallholders, endowed with their surplus family labour, can move higher up the value chain by undertaking labour-intensive activities such as grading, packaging and sorting. Such value-added activities allow them to reap higher returns than earlier from their engagement in agricultural activities.

Thus, the question of whether small and marginal farmers can participate in such dynamic but more demanding agri-food systems, has significant implications for rural poverty. After all, smallholders are home to some 2 billion people, including half of the world's undernourished and poor (IFPRI 2005). According to Lipton (2006), improvement in their condition is 'a key to cut mass poverty in rural areas'. In fact, a large strand of literature has identified the impact of supermarkets on small farmers as a vital element in modern agri-food system (Andersson et al. 2015; Rao and Qaim 2010; Neven et al. 2009; Berdegue et al. 2005; Hernández et al. 2007; Dolan and Humphrey 2000; Dries and Swinnen 2004; Jaffee and Masakure 2005; Henson and Reardon 2005; Reardon et al. 2003). In this background, this chapter examines the question of smallholders participation in Indian context by drawing on survey evidence collected from the state of Rajasthan.

A review of extant literature on smallholders participation in supermarket-driven agri-food system shows a mixed pattern. It has revealed that exclusion of small farmers has become more common in scale-dualistic agriculture where supermarkets have the option of procuring fresh produce from large farmers (Andersson et al. 2015; Rao and Qaim 2010; Neven et al. 2009; Berdegue et al. 2005; Reardon et al. 2007). They have, however, been included in a setting where the option of sourcing from large farmers is simply not available to the supermarkets (Blandon et al. 2009; Reardon et al. 2007; Berdegue et al. 2005). For example, the continued dominance of small traders is noted in China, with little or no effect on small farmers who continue to supply fresh produce to supermarkets through traders (Wang et al. 2009). Similarly, smallholders, organized into cooperatives, have managed to participate in supermarket-driven supply chain. Such collectivities help smallholders to reduce transaction costs facing them. The recent literature on collective action by farmers abounds with examples of facilitating role played successfully by the cooperatives or farmer organizations (Rao and Qaim 2010; Blandon et al. 2009; Roy and Thorat 2008).

The recent evidence shows that even within the context of smallholders' dominance, farmers are discriminated based on their access to irrigation and other non-land assets such as crop-specific equipment (Reardon et al. 2009; Hernández et al. 2007; Natawidjaja et al. 2007). In some studies, social capital is also found to be an important determinant in supermarket participation (Anderson et al. 2015; Michelson 2013). This chapter revisits the question of smallholders' participation in Indian context by drawing on primary data collected from farmers growing vegetables in villages near Jaipur, the capital city of Rajasthan.

2 Diffusion of Supermarkets in India

The diffusion of supermarkets has been relatively recent in India and has started noticeably only in the second half of 2000s. The recent regulatory changes, which include, *inter alia,* the decision to allow 100% FDI in single brand retail and 51% in multi-brand retail, are expected to further facilitate the diffusion of supermarkets in India. Perhaps, in a reflection of growing importance of fruits and vegetables in the diet of an average Indian consumer[1], these chains have already started treating fresh fruits and vegetables (FFVs) as 'destination category' to attract people to the stores[2]. Such a strategy by supermarkets, however, implies that it requires reliable supply of FFVs that is consistent in quality. The first decade of 2000s has also been marked by the reforms in Agricultural Produce and Marketing Committee (APMC) Act which till recently mandated that transaction of fresh produce must take place in the regulated wholesale markets. The amended APMC Act, however, allows the transaction of agricultural produce outside the premises of a regulated market. The rationale behind reforms in the marketing laws is that buyers can purchase produce in the form and quality that they require outside the regulated markets through contracts or otherwise and the sellers can sell their produce to whomsoever they want to without going to the wholesale market.

Taking advantage of the liberalized environment, most supermarket chains in India, early in their diffusion, have already developed their back-end operation to procure fresh produce directly from farmers, applying quality and standards higher than those prevailing in the traditional markets (Singh and Singla 2010; Bathla 2012; Mangala and Chengappa 2008). Such a trend is departure from the one noted in the developed countries where the supermarkets first invest in the processed foods and only later in the fresh fruits and vegetables, which require a higher investment. Such changes in the marketing of agricultural produce have been described as sudden and rapid (Reardon and Minten 2011), sparking a debate on

[1]Reardon and Minten (2011) estimated that some 25–30% of population in India is vegetarian and another 25% is mainly vegetarian.

[2]The term 'destination category' was first used by Shepherd (2005) to refer to a category of products that are used by a supermarket chain to earn loyalty among consumers.

whether smallholders have resources to face challenges in the highly demanding supermarket-driven agri-food system.

In India, small landholdings, measuring less than or equal to 2 ha of land, account for 85% of total landholdings. The smallholders also figure prominently in production of fruits and vegetables, accounting for 61% of the total production of vegetables and 52% of total production of fruits, as compared to their share of 41% in total arable land (Birthal et al. 2007). However, smallholders face numerous constraints in input and output markets, leading to higher cost of production per unit, making them uncompetitive compared to their larger counterparts (NCEUS 2008). They lack access to formal credit, as evident in prevalence rate of formal institutional sources of credit among them being much lower compared to medium and large farmers who are better endowed in terms of assets to offer as collateral. Only 25.9% of small farmers are indebted to formal sources of credit as compared to 34.7% of larger farmers (>2 ha). They are also poor in terms of social capital, with only 30% of them reporting membership of cooperatives as compared to 50% of larger farmers (NCEUS 2008).

Given the poor resource base of smallholders, the concern for smallholders is not misplaced. While one strand of literature argues that these changes will endanger the future of small farmers (Singh 2012; Shah 2011; Sreenivasa and Gopalakrishna 2009), there are others such as Kohli and Bhagawati (2011) who argue that farmers will stand to benefit from higher efficiency brought in the supply chains of agri-food commodities. The evidence on smallholders' participation in the supermarket-driven marketing system is mixed in India. Some studies have noted that farmers supplying fresh produce to supermarket have landholdings that are larger than the average landholding in the regions (Singh 2012; Pritchard et al. 2010; Mangala and Chengappa 2008). Some of these studies have further noted that possession of non-land assets such as access to irrigation facilities is a key to participation in supermarket (Mangala and Chengappa 2008). There are, however, other studies that find no bias against smallholders (Bathla 2012; Singh and Singla 2010; Birthal et al. 2007). Most of these studies are, however, descriptive in nature. A few studies that have used econometric methods have methodological problems as the issue of endogeneity and reverse causality has not been addressed properly. This study revisits the question of smallholders' participation by addressing these methodological issues. The data used in the study were drawn through household survey implemented with farmer households in villages near Jaipur city, the capital city of the state of Rajasthan. Relying on the qualitative data collected in the study from participants and non-participants, the study tries to shed light on how the dynamics of participation in the supermarket-driven agri-food system has changed over time.

3 Agrarian Context of Rajasthan

Located in the semi-arid region of western part of India, Rajasthan is the largest and one of the lagging considered states in India. Despite growing importance of manufacturing and tourism, the state is largely an agrarian economy, with over 60% of its population still drawing their livelihood from agriculture. Small and marginal farmers dominate agrarian scenario of the state, accounting for 77.78% of the total number of operational landholdings. The average size of landholdings in the state is 3.5 ha, significantly higher than all-India average of 1.3 ha, but the poor natural resource base means that it is not much of an advantage. Only 34.46% of agricultural land in the state is irrigated as compared to national average of 45.18%. The average rainfall varies from less than 10 cm in northwest part of Jaisalmer to over 100 cm in Jhalawar, the average for the state being 46.5 cm and for all India being 125 cm. The state reports low yield of vegetable cultivation, with 5.9 tonnes/ha vis-à-vis all-India average of 16.2 tonnes/ha (RACP 2012).

Recently, the report on Rajasthan Agricultural Competitiveness Project (RACP) prepared by the state government acknowledged that allocating state's scarce water resources to low-value water-intensive crops such as rice and wheat has led to a pattern of agriculture that is economically inefficient and environmentally unsustainable. The report further recognizes that the solution lies in diversification towards higher value and less water-intensive horticulture, floriculture, spice crops and medicinal plants. In this context, restructuring of supply chain that links rural producers with urban consumers is considered as a key element of the strategy of diversification in favour of horticulture. Towards this, the state government has amended the law regulating marketing of agricultural produce in line with the model APMC Act proposed by the central government.

4 Emergence of Supermarkets in Rajasthan

In the liberalized environment, the emergence of supermarkets in fast growing urban centres such as the state capital Jaipur is expected to play a key role in the transformation of agri-food chain. With an estimated population of 3.1 million, Jaipur is the largest city in the state. Always known as a tourist destination, the city has recently emerged as a hub of education and information technology (IT). The city ranked 31 among 50 emerging global outsourcing cities. In mid-2000s, a number of supermarket chains, both private and cooperative, came up in the city, to tap the growing urban consumption demand. National Handloom Corporation was the first one to set up retail outlets in the city, which was soon followed by 'Reliance Fresh', 'More', 'Big Bazaar', 'Vishal Mega Mart', 'Spencer', '6Ten', 'Mother Dairy' and 'Easy Day'. Some of these chains started with an ambitious plan, rolling out retail outlets in numbers perhaps more than reasonable at that time. In a repeat of its model in National Capital Region where Mother Dairy operates

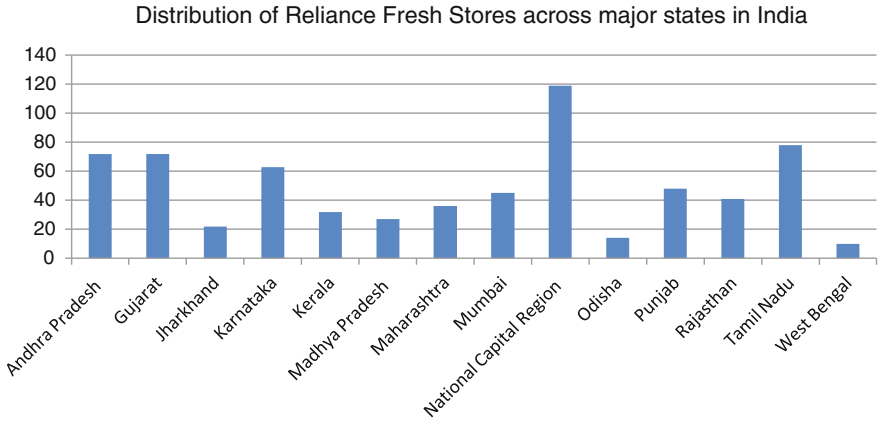

Fig. 1 The distribution of Reliance Fresh stores across states in India. (*Source* Data collected from the procurement manager of Reliance Fresh in Jaipur 2010)

franchise model under the brand name '*Safal*', the cooperative chain set up 16 *Safal* outlets in Jaipur in 2008, but all its outlets were closed down within a year. Among these chains, Reliance Fresh and More, soon after their start up, started procuring fresh produce directly from the farmers around Jaipur city. When we visited the city in mid-2010, 'More' had already reverted back to sourcing from the wholesale market. 'Reliance Fresh' was the only chain to persist with sourcing directly from the farmers.

First started in 2006 in Hyderabad, Reliance Fresh very soon assumed pan-India presence, rolling out retail outlets all over India (Fig. 1). With revenue worth Rs. 14,496 crore from retail stores numbering more than 1500, Reliance Fresh is now the largest retail chain in the country (*The Economic Times*, April 18, 2014). Within the very first year of its start up, the supermarket chain rolled out an ambitious plan to develop back-end infrastructure to source fresh produce directly from the farmers[3].

Within 6 years of its start up, supply network developed by Reliance Fresh sources fresh fruits and vegetables (FFVs) daily from 15,000 farmers, spread over 1000 villages (*Business World*, July 23, 2012). The model of back-end network set up by Reliance Fresh, has thus been sustained and expanded over time, serving as a model of supply chain to be followed by other supermarket chains in India. We believe that the choice of Reliance Fresh will allow us to make more general observations on the likely pattern of procurement to be followed by the supermarket chains in the country.

[3]See Pritchard et al. (2010) for details.

5 Description of Survey Area and Survey Design

The primary survey for our study was implemented in mid-2010. We carried out key informant interviews with procurement agents of Reliance Fresh and found cauliflower and spinach to be the most important crops sourced locally throughout the year. In terms of volume, these two crops together, accounted for 15–20% of total volume of fresh produce sourced through collection centre. These two crops also represented different risk return trade-offs for farmers. From the focused group discussion, we found that while cauliflower is a relatively capital-intensive crop and is more likely to be grown by resource-rich farmers, spinach is a highly perishable and labour-intensive crop grown largely by smallholders, many of whom are endowed with surplus labour. We further identified Chomu and Amer Fort as the two procurement zones for cauliflower and spinach, respectively. Chomu and Amer Fort are two subdivisions of the Jaipur district. While Chomu is located 33 km far in the north of Jaipur city, Amer Fort is part of Jaipur Municipal Corporation and is 11 km far in the north of city. Being located in the semi-arid region, both the regions are fertile and have long been known for producing seasonal and off-season vegetables.

In both the regions, the supermarket chain sources agricultural produce from its listed farmers, using verbal contract with no commitment from either party to buy or sell the produce. The procurement setup used by Reliance Fresh varies across regions. In Amer Fort region, the supermarket chain uses the premises of a local farmer as its collection centre, with the farmer himself managing the centre as its local agent. The farmers bring their leafy produce to the collection centre, typically using their own means of transport, either scooter or bicycle. In Chomu region, there is no fixed setup as Reliance Fresh uses a mobile collection centre, comprising of a truck, which, accompanied by its local agent, roams around the villages to source fresh produce near the farm gate. Apart from keeping account of payment to be received by the farmers, the local agent grades the produce and loads it into truck, for which he receives 1% of the total turnover as his commission.

Relying on the information collected from Reliance Fresh, which we later verified with its local agent, we prepared a list of 'cauliflower villages' in Chomu. We selected three villages randomly from the list and prepared a list of farmers growing cauliflower. In the selected villages, there are very few farmers who sell cauliflower exclusively to Reliance Fresh as the supermarket chain sources cauliflower only in limited quantities depending on the requirement set by the procurement manager. We, therefore, defined a supermarket farmer as the one who had sold at least some portion of his harvest to Reliance Fresh during the past 12 months and the traditional market farmer as the one who had not sold any produce to the supermarket chain during this period. We finally randomly selected 55 supermarket farmers and 45 traditional market farmers for cauliflower study.

Following the same definition of supermarket and traditional market farmers, we conducted a similar exercise for spinach in Amer Fort region to select 45 supermarket farmers and 55 traditional market farmers from three randomly selected

villages. We thus had a sample of 200 farmers with 100 supermarket and 100 traditional market farmers. Within 100 traditional market farmers, we identified two sub-strata—one who once sold their produce to Reliance Fresh but opted out later. They did not have any transaction with the supermarket chain during the past 12 months. In our sample, there were 75 such traditional market farmers. Apart from them, there were 25 other traditional market farmers who never had any experience with Reliance Fresh.

6 Analytical Framework

To examine the dynamics of participation in supermarket-driven agri-food system, we relied on both quantitative and qualitative data. Within the sample of traditional market farmers, we implemented a set of qualitative questions with each stratum, both dropouts of supermarket and those who never sold to the supermarket chain, to elicit their perceptions on the procurement of Reliance Fresh vis-a-vis traditional market. Finally, we estimated the determinants of participation in supermarket-driven marketing channel by applying probit regression

$$\begin{aligned}\text{Channel Choice} &= P\,(\text{Probability of participation in the supermarket} \\ &\quad - \text{driven marketing channel} = 0/1) \\ &= f\left(X_{1,}X_{2,}X_{3,}X_4\right)\end{aligned}$$

where the dependent variable is a dummy variable that takes the value 1 if a farmer participates in supermarket, and 0 otherwise. The independent variables considered in the model included household characteristics, physical assets, social capital and transaction cost. In such econometric exercises, when independent variables are taken at the current period, the model suffers from the reverse causation as these variables may themselves be influenced by the dependent variable. Some earlier studies, such as by Mangala and Chengappa (2008) and Bathla (2012) have ignored such possibilities. Our survey was conducted in 2010, almost 4 years after Reliance Fresh set up its back-end operation in the region. We, therefore, relied on the recall data to collect information on social capital and physical asset variables, lagged at 2005 to avoid the potential problem of reverse causation.

7 Descriptive Statistics

Table 1 presents a comparison of supermarket farmers and traditional market farmers on basic household characteristics, physical assets, transaction costs and social capital variables. The farmer households that supply cauliflower to Reliance Fresh are headed by younger members compared to their traditional counterparts.

Table 1 A comparison of farmers of supermarket and traditional market channels for cauliflower and spinach in Rajasthan

	Cauliflower farmers		Spinach farmers	
Variable	Traditional market	Supermarket	Traditional market	Supermarket
Number of observations	45	55	55	45
Average age of farm household-head (in years)	45.55** (9.03)	41.02** (11.25)	42.40 (9.40)	42.47 (11.13)
Farm size (in acres)	2.98 (2.98)	3.46 (2.59)	1.25 (1.06)	1.35 (1.15)
Household -head with education up to middle and secondary levels (% of households)	59.99	85.46	30.92	53.33
Family size (No. of persons)	6.89 (2.39)	6.62 (2.20)	6.89 (1.71)	6.62 (1.90)
Off-farm occupation (% of households)	53.33	27.27	34.55	37.77
Ownership of mobile telephone (% of households)	84.44	98.18	87.27	77.78
Member of cooperative society (% of households)	42.22	43.30	4.44	36.36
Average distance from Collection Centre -Reliance (km)	5.10 (1.94)	4.5 (1.93)	2.05*** (1.03)	1.26*** (0.94)
Average distance from Reliance Agent (km)	4.24*** (2.76)	2.47*** (2.14)	1.79*** (0.82)	1.14*** (0.74)
Average present value of farm equipment (Rs)	221,715*** (218,405)	342,846*** (166,580)	155,295 (157,022)	192,778 (155,702)
Average present value of livestock (Rs)	67,733 (46,140)	79,381 (63,343)	25,245*** (26,855)	39,888*** (41,768.42)
Ownership of scooter/bicycle (% of households)	48.89	58.18	56.36	55.56
Simpson's diversity index	0.82 (0.65)	0.82 (0.75)	0.74 (0.65)	0.78 (0.73)

Note ***, ** and * indicate level of significance at 1, 5 and 10% levels, respectively
Source Author's survey

Contrary to our expectation, the supermarket and traditional market farmers do not differ much in farm size. The supermarket farmers have a higher literacy level with a higher percentage of household-heads having education up to middle and secondary level compared to their traditional counterparts. The family size does not differ much across supermarket and traditional market farmers for both cauliflower and spinach.

Among cauliflower farmers, a significantly higher proportion of traditional market farmers draw a part of their livelihood from off-farm occupations compared to their traditional counterparts. Spinach is typically grown by poorer households who draw a substantial part of their livelihood from non-farm occupations. We, however, noted little difference in off-farm engagement across marketing channels for spinach farmers. The mobile telephone is a common household asset in our survey region.

Apart from membership in a farmer federation set up by the supermarket chain Mother Dairy, we noted little group activity in the region. Such membership, however, does not differ much across marketing channels in the case of cauliflower, with over 40% farmers from both the groups reporting such association. However, a much higher percentage of supermarket farmers sell their spinach harvest to the Mother Dairy compared to their traditional counterparts. Social capital matters when it comes to participation in supermarket channel. The local agent of Reliance Fresh, who belongs to the same village, is a key actor in the supply network of the supermarket chain. More than 82% of the sample of supermarket farmers reported approaching the local agent of the supermarket chain for enlisting themselves in the suppliers list. Only 11% of the supermarket farmers had enlisted themselves with Reliance Fresh through their friends and neighbours and another 7% of them approached the supermarket manager themselves. Interestingly, proximity with Reliance Fresh agent seems to matter when it comes to participation in the supermarket channel. The supermarket and traditional market farmers growing cauliflower do not differ much in terms of their location vis-a-vis collection centre. As regards spinach, the supermarket farmers are located closer to the collection centre compared to their traditional counterparts, underlining the importance of transaction costs.

The value of farm equipment[4] reported by a farmer is an indicator of his non-land assets. The supermarket farmers growing cauliflower reported significantly higher value of farm equipment compared to their traditional counterparts. However, no such difference was noted among spinach farmers across the marketing channels. Given that spinach is a labour-intensive crop with lower requirement of capital assets, this finding is not surprising. Most households own livestock to supplement their farm income. Though supermarket farmers reported a higher value of livestock compared to their traditional counterparts, the difference was found to be significant only in the case of spinach growers.

The supermarket farmers do not differ in terms of cropping pattern from their traditional counterparts. Simpson's diversity Index was estimated and compared across traditional and supermarket farmers to measure the extent of crop diversification followed by these two groups. While a supermarket chain may prefer to source, at least in the initial stage of diffusion, from farmers who are more diverse and thus offer the procurement manager the option of one-stop shopping for supermarkets (Neven et al. 2009). He may also prefer to source from more specialized farmers to exploit the economies of scale in procurement (Tschirley et al. 2004).

[4]The farm equipment considered for valuation included tractor, trailer, thresher, electrified motor, non-electrified motor, gauge wheel, plough, disc harrow, tiller/cultivator, plough disc, seed drill, power tiller, power sprayer, iron plough, cultivator, harrow, leveller, hoe, weeder, sprayer, winnower, godowns/ warehouse, livestock sheds, bullock cart, chaff cutter, combine harvester, pesticide spray machine, packing shed and other agri equipment. The assets were valued in the present market value.

8 Farmers' Perceptions of Different Marketing Channels

The information collected through field surveys indicated that a significant number of traditional market farmers had supplied to Reliance Fresh but opted out of this supply network. There were some new entrants also to the channel. The dynamics of participation in the new and alternative marketing channels such as supermarkets may change over time, and Glover and Kusterer (1990) have termed it as 'agribusiness normalization'. They have defined these practices as a process where promotional policies such as high prices, low quality standards and generous input and credit support offered by the agribusiness firms to contract growers during their start up stage, may over time give way to less generous policies as the company rationalizes the number of growers by retaining only those who can supply a better quality produce at a lower price. Moreover, the supermarket may behave as a monopsony player in the long run as farmers gradually become dependent on it.

We organized FGDs with respondent farmers and conducted personal interviews with the key informants such as *sarpanch*, mandi traders, procurement manager and local agent of Reliance Fresh to get insights of how the procurement model followed by Reliance Fresh has evolved over time since the supermarket chain first made an entry into the region. At the initial stage, Reliance Fresh had a more formal structure, with the collection centre managed by an incharge and his assistant[5], the incharge is usually a master degree holder in agricultural sciences. During the initial stage, the procurement management of the supermarket chain was more lenient on quality standards as the supermarket chain disposed of the produce that failed to meet its high standards at a lower price in the wholesale market. Reliance Fresh later went into cost cutting drive and replaced its more elaborate setup of collection centre with a mobile collection centre, as noted in the case of cauliflower, or a make shift structure, housed in the premises of a local farmer to source leafy vegetables. The supermarket chain also retrenched its permanent staff and replaced them with a local farmer as its local agent. The FGDs with respondent farmers and key informants brought out several complaints against the local agent of Reliance Fresh about not passing over the price declared by the company to the farmers. The farmers also complained that the quality standards applied by Reliance Fresh were at times arbitrary and had increasingly become stringent over time, leading to higher rejections of their produce.

To get insights into the dynamics of supermarket participation, the sample of traditional farmers, including the drop outs, was asked some qualitative questions on the reasons for disassociation with Reliance Fresh. They were asked to rank, based on their perceptions, the reasons as: (1) *Very important*, (2) *Less important and* (3) *Not important.* In Table 2, we have reported only the percentage of responses considered very important by the respondent farmers. The traditional farmers who had never sold their produce to Reliance Fresh cited high rejection rate of produce on quality grounds to be the most important reason for it. About 47% of

[5]For more details, please refer to Minten and Ghorpade (2007).

Table 2 Reasons for not selling or discontinuing selling their harvest to Reliance Fresh

	Reasons	Farmers who never sold to reliance fresh (%)	Drop-out of reliance fresh supply chain (%)
a	High rejection of produce at the collection centre	62.32	52.63
b	Not procuring enough quantity of produce in one go	47.06	77.78
c	Does not procure regularly	47.76	65
d	Delays settlement of payment	7.35	10.53
e	Prices offered are not attractive	21.74	21.05
e	Not getting credit from supermarket agent	7.25	5.26
f	Long distance to collection centre	18.84	20

Source Author's survey

them cited Reliance Fresh 'not procuring regularly' and in enough quantity at one go as the very important reasons for not associating with the supermarket chain. They probably prefer to sell their harvest in bigger lots to reduce transaction cost. On a given day, Reliance Fresh makes only a limited purchase of fresh produce, as per the order received by the local agent from the distribution centre. Interestingly, the price offered by Reliance Fresh was found to be less of an issue and so was the non-availability of credit. The responses collected from traditional farmers revealed that delayed payment was less of an issue among them.

The supermarket farmers were asked to cite, based on their perceptions, comparative advantages of selling their produce to Reliance Fresh as: (1) *Very important*, (2) *Less important* and (3) *Not important*. Reliance Fresh procures produce from near the farm gate. Not surprisingly, over 80% of the supermarket farmers cited lesser hassles in transactions and savings in transaction costs as a very important reason for being associated with the supermarket chain. Transparency and better prices also appeared as important reasons for persistence with Reliance Fresh. About 64% of the supermarket farmers cited better prices and 46% cited transparency in weighing as very important reasons for selling their produce to the supermarket chain. The supermarket chain does not make any provision of resources nor does it offer any extension facilities for its listed farmers. Very few supermarket farmers cited learning of new cultivation practices as an important reason for selling their produce to Reliance Fresh. Almost all supermarket farmers in the sample, however, continue to sell a major part of their produce to the traditional market. They cited limited procurement by Reliance Fresh as a reason for their persistence with the traditional market channel. Interestingly, a majority of the supermarket farmers also complained about supermarket buying selectively. As many as 76% of them cited that the local agent 'cherry picks' are the only top grade produce that leaves them with no option but to sell the remaining produce in the traditional market at a lower price.

Over 67% of the supermarket farmers cited lack of access to credit and input advance as a very important reason for their persistence with the traditional market channel. As documented in literature (Minten et al. 2007; Dercon and Christiaensen 2007; Bardhan 1984), wholesalers and commission agents constitute the key sources of seasonal input advances for farmers in developing countries. Because of limited access to formal credit, many supermarket farmers continue to approach wholesalers and commission agents for their credit and input requirements.

9 Determinants of Participation in Supermarket Channel

To estimate the importance of different factors in the choice of marketing channel, we ran probit regression. Because of small size of the sample, we estimated the results using a pooled sample of farmers growing cauliflower and spinach. The results of probit regression are reported for each crop separately (Table 3). We expected the households headed by younger and educated members to be more enterprising and capable to meet the higher standards imposed by the procurement manager of Reliance Fresh. These farmers were more receptive to new information on farming and were also more capable to meet the standards demanded by the supermarket chain. Expectedly, the coefficient of education of household head is found to be positive and significant in both the pooled regressions and cauliflower, conforming to the trend noted in the literature that education has positive effect on supermarket participation (Anderson et al. 2015; Rao and Qaim 2010; Neven et al. 2009; Miyata et al. 2009). The younger farmers are more likely to sell their cauliflower harvest to the supermarket chain. The family size, which indicates family labour at the disposal of farmers, has shown no influence on the probability of participation in the supermarket channel.

The larger farm size represents a relatively better economic status and better access to credit from formal institutions (Carter and Weibe 1990), which represents their higher capacities to undertake the required investment for supplying to the supermarkets. From the perspective of supermarket procurement manager, large farm size may denote reduced transaction costs as larger marketed surplus allows him to meet the targeted consignment by sourcing from a fewer number of farmers. Contrary to our expectation, the coefficient of farm size, lagged at 2005, was found to be negative and significant, indicating that everything else remaining the same, farmers with smaller landholdings were more likely to participate in the supermarket channel. Expectedly, farm assets and livestock, both lagged at 2005, positively influenced the probability of supplying fresh produce to Reliance Fresh, indicating that more capitalized farmers with large asset base were more likely to supply to the supermarkets.

Even within the context of smallholders, ownership of non-land assets such as specialized farm equipment was found critical for participation in supermarket-driven marketing system (Reardon et al. 2009; Natawidjaja et al. 2007; Hernández et al. 2007). Farmers with access to such assets are more capable of undertaking the

Table 3 Determinants of farmers' participation in supermarket channel (Probit Results)

	Pooled regression		Cauliflower		Spinach	
Independent variable	Coefficient.	Std. error	Coefficient.	Std. err.	Coefficient.	Std. err.
Age of household-head (years)	−0.004	(0.011)	−0.035*	(0.019)	0.015	(0.015)
Education of household-head (years)	0.150***	(0.055)	0.189*	(0.099)	0.120	(0.083)
Family size (No. of persons)	−0.042	(0.055)	−0.003	(0.083)	−0.128	(0.093)
Farm size, lagged at 2005 (acres)	−0.043*	(0.026)	−0.062*	(0.035)	0.002	(0.060)
Off-farm dummy, lagged at 2005 (1 = family members participate in off-farm, 0 otherwise)	-0.049	(0.223)	-0.558	(0.397)	0.046	(0.326)
Total farm assets, lagged at 2005 ('000 Rs)	0.006***	(0.002)	0.010***	(0.004)	0.003	(0.004)
Total livestock assets lagged at 2005 ('000 Rs)	0.010***	(0.003)	0.005	(0.004)	0.019***	(0.006)
Dummy for cooperative, lagged at 2005 (1 = if member of cooperative, 0 otherwise)	−0.241	(0.313)	−0.715*	(0.429)	−0.131	(0.775)
Distance from Reliance Fresh agent (km)	−0.428***	(0.083)	−0.369***	(0.107)	−0.755***	(0.200)
Distance from traditional market (km)	0.021	(0.042)	−0.008	(0.053)	0.183	(0.162)
Constant	0.086	(0.721)	1.437	(1.355)	−0.150	(1.009)
Number of observations	200		100		100	
Prob > Chi^2	0.00		0.00		0.002	
Pseudo R^2	0.27		0.48		0.20	
log likelihood	−101.69		−35.97		−54.80	

Note ***, ** and * indicate levels of significance at 1, 5 and 10%, respectively
Source Author's Survey

required investment to meet the quality and standards demanded by the supermarkets, especially when the crops sourced by supermarkets are resource-intensive in nature. Survey data showed that cauliflower was a relatively resource-intensive crop compared to spinach, with average per acre expenditure on cauliflower being Rs. 27,033 vis-a-vis Rs. 15,987/acre reported in cultivation of spinach. Not surprisingly, the

ownership of farm equipment differentiates the participants from the non-participants. The coefficient of variable indicating ownership of physical assets was not found to be significant in spinach, indicating that ownership of such assets does not matter much in the choice of supermarket-driven marketing channel. The sign of coefficient of livestock assets, lagged at 2005, was found positive and significant in pooled regression, indicating that ownership of livestock ensures a steady flow of income that provides additional source of investible capital to meet high standards demanded by Reliance Fresh. When analysed separately for individual crops, the coefficient of livestock, lagged at 2005, was found to be significant only for spinach.

Contrary to our expectations, the coefficient of farm size was found to be negative and significant for both pooled regressions and cauliflower, indicating that everything else remaining the same, the farmers with smaller landholdings were more likely to participate in supermarket channel. Given that Reliance Fresh makes limited purchase on a given day, farm size may not be very important as long as smallholders satisfy the quality standards required by the chain. Moreover, from the perspectives of smallholders, the per unit transaction cost of selling their harvest at a distant wholesale market may be quite high because of their small size of marketed surplus. Conversely, relatively low procurement by Reliance Fresh leaves large farmers with no option but to sell their harvest in the traditional wholesale market. Because of their large marketable surplus, the large farmers may, in fact, prefer to sell their harvest in larger quantity and at one go. They can also avail that option because of their higher ability to pay for the transport of produce (Fafchamps and Hill 2005). Such exceptions of smallholders participating successfully in the supermarket-driven domestic agri-food system have been noted in the literature (Reardon et al. 2009; Hernández et al. 2007; Wang et al. 2009).

How membership in a cooperative affects the probability of supplying fresh produce to supermarket depends on the mandate of cooperative. If it is formed by an NGO to facilitate smallholders' participation in supermarket-driven marketing channel (as noted in a case study by Rao and Qaim 2010), then membership in a cooperative has a positive effect on the probability of supplying fresh produce to the supermarket. In our study region, the formation of farmers' federation was initiated by Mother Dairy, which itself presents as a competing channel vis-a-vis Reliance Fresh, offering its members similar services as those offered by the supermarket chain, which included sourcing fresh produce from the nearby villages. That means once farmers become members of such cooperatives, they are less likely to sell to the supermarket. Not surprisingly, the coefficient of dummy denoting membership in a cooperative, lagged at 2005, reduces the probability of selling cauliflower to Reliance Fresh.

The literature on transaction costs (Bardhan 1989; de Janvry et al. 1991; Goetz 1992; Key et al. 2000) reveals that transaction costs do matter in the choice of marketing channel. To denote transaction costs in selling harvest, we considered two variables—distance from Reliance Fresh agent and the distance from either wholesale market or Mother Dairy, whichever is nearer. The coefficient of distance from Reliance Fresh agent, which is used as proxy for transaction costs that farmers

face in Reliance Fresh, is expectedly found to be negative and significant. It indicates that closer a farmer is located to the Reliance Fresh agent, higher is the probability that he will sell his produce to the supermarket collection centre. The result remained unchanged even when the coefficients were estimated for each crop separately. Interestingly, the distance from traditional market did not have any effect on their decision to sell their harvest in supermarkets. In a sense, proximity with the wholesale market did not have any effect on farmers' decision to access the supermarket channel. This may be because almost all farmers carry their harvest in public transport which goes through villages every now and then.

10 Conclusion and Policy Implication

The study presented in this chapter has examined the question of smallholders' participation in supermarket-driven marketing channel, using the primary data collected from farmers supplying cauliflower and spinach to Reliance Fresh in villages near Jaipur city, Rajasthan. The results suggest that in an agrarian setting dominated by smallholders, farm size is not necessarily a key determinant of participation in supermarket-driven agri-food system.

However, even within the context of smallholders' participation in supermarket channel, we notice significant differences between participant and non-participant farmers. The supermarket farmers are more educated and younger compared to their traditional counterparts. They also possess higher resources in terms of farm assets and livestock compared to their traditional counterparts, which indicate their better ability to meet higher standards set by Reliance Fresh. From the perspective of Reliance Fresh, the procurement manager can take advantage of resource base of such farmers to source produce at lesser transaction costs.

In the present setting, the local agent of Reliance Fresh is a key actor in this network, as evident in more than 83% of farmers maintaining that they could get listed with the supermarket through its local agent. The proximity with the local agent of Reliance Fresh does matter for participation in supermarket channel, as farmer households located closer to its local agent are more likely to sell to the supermarket chain. Participation in supermarket channel is a dynamic process and changes over time because of 'agribusiness normalization'. Within the sample of traditional market farmers, there is a sub-strata of farmers who dropped out of the supply network of Reliance Fresh, citing high rejection rate and low and irregular procurement by the supermarket chain as the reasons. Farmers who never associated themselves with the supermarket chain have also cited similar reasons. On the other hand, farmers, who sell their harvest to Reliance Fresh, cite lesser hassles and lesser transaction costs as the very important reasons for their association with the supermarket chain. Finally, we have tested our results econometrically, using probit regression. The results of probit regression have validated our observation that even within the context of smallholders' participation in supermarket-driven marketing channel, farmers are excluded based on access to education and other non-land

assets. Reliance Fresh takes the advantage of resource status of smallholders. From the perspective of Reliance Fresh, transaction costs of sourcing fresh produce from such farmers are less because of reduced uncertainty regarding quality and standard. From the farmers' perspective, transaction costs, measured as the distance from Reliance Fresh agent, also matter in the choice of supermarket channel.

Given the exclusion of resource-poor smallholders in supermarket-driven marketing channel, policy measures to bring these poor farmers within the ambit of formal financial institutions should be taken by the government. As has been noted in the case of technology adoption (Feder et al. 1985), human capital is critical to adoption of any innovation such as modern marketing channel. Better provision of education in rural areas by the government, coupled with better extension service facilities, may go a long way in facilitating smallholders' participation in supermarket channel.

When issues such as food safety and quality are increasingly becoming important, there is also demand for increased coordination among different actors in agri-food supply chain. Farmers facing high transaction costs are not a part of supermarket-driven marketing channel. The government at central and state levels should make a better provision of rural infrastructure so that the 'economic distance' to the collection centres for smallholders is reduced. Such policy measures are particularly important in the backdrop of recent evidence that supermarket chain typically chooses geography over farmers and that regions lacking in infrastructure may be bypassed by the supermarket (Barrett et al. 2012; Michelson 2013; Narayanan 2014).

The government should also encourage institutional innovations such as producer group/farmer associations to reduce their transaction costs. Our results have suggested that when smallholders are given more options such as membership in Farmer Federation managed by Mother Dairy, their likelihood of selling to supermarket channel declines. From the farmer's perspective, what matters at the end of the day is a competitive marketing system where they have better bargaining power. Organizations such as farmers group or cooperatives can be used as a common platform to supply fresh produce to a number of marketing channels. In this context, the recent policy reform introduced by the government to encourage producer-groups is a step in the right direction.

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Innovations in Agricultural Marketing in India: A Case Study of Supermarket in Punjab

Naresh Singla

1 Introduction

Traditionally, the marketing of fresh fruits and vegetables (FFVs) in India takes place through unregulated markets or markets regulated by Agricultural Produce Market Committee Act (APMC). The APMC Act provides for specified market yards or sub-yards, infrastructure and mode of transactions and market fee for agricultural produce (Chand 2012). However, in practice, most of the markets lack in these aspects and the produce is largely disposed of through large number of commission agents and wholesalers. Undue deductions, malpractices, delayed payments, etc., are the common traditions in these markets. The revenue generated through the market is rarely utilized for creating necessary market infrastructure (Sekhon and Rangi 2007). Considering all these, the APMC Act was modified to the Model Act 2003 to allow direct marketing and establishment of agricultural markets in the private and cooperative sectors so that farmers have the option to sell their produce directly to the agribusiness firms in the quality and form required by them (Chand 2012).

In recent years, the agri-food supply chains in most of the developing countries, including India, have been undergoing a structural change due to increasing demand for high-value food products (Reardon et al. 2009; Rao et al. 2012). These changes are largely triggered by market liberalization, rapid urbanization, rise of middle-income class, rising living standards, etc. (Rao et al. 2012). Besides, the consumers have also started demanding safe, quality and convenient fresh food (Pingali et al. 2007; Mergenthaler et al. 2009; Rao et al. 2012). Under this background, the supermarkets are emerging as alternative market channel for producers, and providers of quality, hygienic and convenient food to the consumers in India. The recent changes in foreign direct investment (FDI) norms are expected to

N. Singla (✉)
Centre for Economic Studies, Central University of Punjab,
Bathinda 151001, Punjab, India
e-mail: singla.naresh@gmail.com

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accelerate the growth of supermarkets, and therefore the agri-food marketing structure of the future is likely to be different from the existing one.

In India, most supermarkets work with the primary producers through 'contacts' (not contracts) (Pritchard et al. 2010; Singh and Singla 2011a, b). Several studies have revealed that cost of production is higher for the farmers supplying produce to the supermarkets (Alam and Verma 2007; Joseph et al. 2008), but transaction costs are lower compared to those supplying to the traditional regulated markets (Dhananjaya and Rao 2009; Mangala and Chengappa 2008). The crop yields have been reported to be a mixed bag (Alam and Verma 2007; Mangala and Chengappa 2008). Interestingly, the price realization has been found to be higher from supermarkets compared to open market (Birthal et al. 2005; Joseph et al. 2008; Pritchard et al. 2010). In India, these chains have, so far, not made much difference in the share of producer in the consumer's rupee, other than lowering the cost of marketing (Singh and Singla 2011a, b). It is often argued that supermarkets rarely work with smallholders because of higher transaction costs of contracting with a large number of them.

The participation in supermarket-driven supply chains also influences the farmers' choice of producing high-value crops. For example, the supermarket, Aditya Birla Retail Ltd. (ABRL) in Gujarat, has introduced among farmers quality consciousness, exotic vegetables and package of practices for vegetables like cucumber and long melon (Singh and Singla 2011a). Another supermarket, Namdhari Fresh in Karnataka, adheres to strict requirements of quality, food safety and consistent supply and has introduced the use of reliable irrigation equipment, improved seeds and other modern inputs (Dhananjaya and Rao 2009; Singh and Singla 2011a, b). In some cases, the development organizations such as Himalayan Action Research Centre (HARC) in Uttarakhand have linked the smallholders to the supermarket, Mother Dairy, through technical and institutional support (Alam and Verma 2007). The participation in modern supply chains may also influence the technical efficiency positively as many of the agribusiness firms provide extension and information services also to the contract farmers (Schipmann and Qaim 2010; Rao et al. 2012). In addition, the assured markets and more stable prices for fresh produce in modern supply chains may also lead to gains in scale efficiency (Michelson et al. 2012; Rao et al. 2012).

Against this backdrop, the study presented in this chapter examines the performance of modern and traditional agricultural markets and their impact on farmers' income, efficiency and diversification focusing on the supply chain of one of the major supermarkets, namely 'Reliance Fresh' in Punjab.

2 Reliance Fresh and Its Operation Process

'Reliance Fresh' is operated by the Reliance Group of Industries and has pan-India presence. It procures its requirements of fresh fruits and vegetables directly from the farmers through its collection centres. In Punjab, Reliance Fresh has established

collection centres in Jandiala Guru in Amritsar district, Malerkotla in Sangrur district and Sirhind in Fatehgarh Sahib district. It sources about 70% of its requirement of fresh fruits and vegetables (FFVs) directly from the farmers, and the rest from the open market. The contracts with suppliers are mostly verbal, informal and non-registered. In Jandiala Guru, the domain selected for this study, Reliance Fresh has 125 farmers registered with its collection centre. The farmers bring vegetables themselves to the centre. The vegetables are pre-graded at the farm level and occasionally undergo quality check at the collection centre. For this study, a survey was conducted in 2010–2011. Sample of farmers was drawn from the list of 125 farmers supplying vegetables to Reliance Fresh. Cauliflower and cabbage being the main vegetables, a sample of 25 farmers supplying each of these vegetables was drawn from the supermarket farmers. An equal number of growers of these vegetables was drawn from those selling in the traditional unregulated/regulated market. Thus, the sample comprised 50 supermarket suppliers and 50 traditional market suppliers.

The farmers supplying vegetables to Reliance Fresh are paid in cash on a daily basis. Recently, the supermarket has also opened zero balance accounts with HDFC Bank and farmers' dues are directly credited to their accounts. The farm gate price is generally decided as open market price minus the transportation cost. The price is conveyed in advance in the morning based on the previous day *mandi* price.

Initially, the rejection rate of vegetables at the collection centre was around 10%. However, with farmers' education on quality standards, the rejection rate has come down to less than 5%. The processing and distribution of FFVs to the retail stores are carried out at the company's City Processing Centre (CPC) at Srihind. All city indents are consolidated and demands are placed by the CPC to the collection centres. The CPC undertakes grading, if needed, and does crating, packing, weighing and allocation of FFVs for distribution to its retail stores.

3 Who Supply to the Selected Supermarket and Who Do not?

Table 1 presents a comparison of the selected socio-economic characteristics of vegetable suppliers to Reliance Fresh supermarket with those selling in the traditional agricultural markets. The average landholding size of those farmers associated with this supermarket was smaller (6.2 acres) as compared to those selling in the open market (7.6 acres). The land-wise distribution of the farmers shows that 52% of the supermarket suppliers belonged to the category of small farmers (≤ 5 acres) as against 38% of those selling in the open market. The supermarket suppliers, however, were found to obtain less income from off-farm sources as well as dairying. Their average family size was slightly bigger. Tractor is one of the most common farm machineries in Punjab, and the tractor ownership was also less among those associated with this supermarket. From this comparison, we conclude

Table 1 Socio-economic profile of vegetable suppliers to Reliance Fresh and traditional market

Socio-economic variable	Supermarket suppliers (N = 50)	Traditional market suppliers (N = 50)
Average landholding (acres)	6.17	7.61
Small and marginal farmers (%)	52	38
Illiterate farmers (%)	34	26
Average off-farm income per month (Rs.)	1656	2014
Average income from dairying per month (Rs.)	2213	2958
Average family size (No.)	6.3	6.1
Tractor ownership (%)	42	56

that Reliance Fresh in order to spread procurement risk, sources its vegetable requirements not only from large farmers but also from those who have smaller landholdings and a larger endowment of family labour.

4 Do Farmers Benefit from Their Association with Supermarket?

The direct purchase of produce by supermarkets from the farmers is expected to benefit both the parties. While the supermarkets have an assured procurement of the produce of the desired quality, farmers benefit from assured market, reduction in cost on marketing and transaction, and better access to new technologies, inputs, extension services, credit, etc. In this section, we analyse whether farmers benefited from their association with Reliance Fresh.

Table 2 presents a comparison of yields and costs on production and marketing of cauliflower and cabbage of farmers associated with Reliance Fresh with those selling in the open market. The average yield of cauliflower as well as cabbage was found higher for the supermarket farmers. Reliance Fresh procures only 25% of their production of cauliflower as well as cabbage. The cost of cultivation of both the crops was about 10% higher for Reliance farmers mainly on account of higher use of labour and agro-chemicals. Together these account for about half of the total cost on both the categories of suppliers (Table 10).

The farmers associated with supermarkets incur lower marketing and transaction costs. The transportation cost for suppliers to traditional market is higher than that incurred by the supermarket suppliers. The wastage is also less in the supermarket supply channel. Both the supermarket and non-supermarket farmers pay unloading charges (Re. 0.02/kg) in the mandi. The marketing cost was lower for supermarket suppliers (Re. 0.19/kg) as compared to sellers in open market (Re. 0.36/kg) (Table 11). The average price realized was higher for the supermarket farmers. On

Table 2 Economics of cauliflower and cabbage production for supermarket farmers and traditional market farmers

Particulars	Cauliflower farmers				Cabbage farmers			
	Supermarket			Traditional market	Supermarket			Traditional market
	A grade	B grade	Remaining produce	All in *mandi*	A grade	B grade	Remaining produce	All in *mandi*
Yield (quintal/acre)	92.0			86.8	94.5			90.0
Sold (%)	15	10	75	100	15	10	75	100
Quantity sold (quintal)	13.8	9.2	69.0	86.8	14.2	9.5	70.9	90.0
Price (Rs./kg)	8.00	7.00	7.40	7.2	7.25	6.50	6.35	6.00
Gross returns (Rs.)	11,040	6440	51,060	62,460	10,276	6142	45,005	54,000
Production cost (Rs.)	34,444			30,947	32,418			29,376
Marketing cost (Rs.)	262	174	2484	2602	269	179	2551	2700
Net returns (Rs.)	5611	2820	22,743	28,910	5144	2721	18,140	21,924
	31,175				26,006			21,924
Net returns (Rs./kg)	3.39			3.33	2.80			2.40

the whole, the farmers associated with supermarket realized 10–15% more net income (Table 2).

5 Dynamics in Prices of Cauliflower and Cabbage

The prices of cauliflower and cabbage during peak arrival months, viz. October, November, December and January during 2010–2011, realized by the farmers on supplying to Reliance Fresh and selling in traditional local markets are compared in Table 3. The average price for both cauliflower and cabbage was 7–15% higher in Reliance Fresh than in local wholesale market. In general, the coefficient of variation was higher in local market price than in supermarket price, indicating that prices in local wholesale market are more volatile.

6 Technical Advice

About 76% supermarket farmers responded to the question on their sources of technical advice. Of these, about 32% did not seek advice from any source; for 26%, fellow farmers were the main source of information; 18% sought advice from input dealers; and 8% got advice from state department of agriculture and mass media. The commission agents/wholesalers were the main source of information for 5% farmers. Only 3% supermarket farmers reported to have received technical guidance from Reliance Fresh (Table 4).

7 Technical Efficiency and Scale Efficiency

The technical efficiency (TE) measures the success of producing maximum output at given levels of different inputs. We computed TE scores for cauliflower and cabbage using Data Envelopment Analysis (DEA) programme developed by Coelli (1996) for suppliers to supermarket and traditional market. The mean technical efficiency (OTE) for both cauliflower and cabbage was higher for supermarket suppliers. Twelve percent cauliflower as well as cabbage farmers associated with Reliance Fresh appeared to be fully efficient, as compared to 8 and 4% of their counterparts in the traditional market. The technical efficiency was further decomposed into pure technical efficiency (PTE) and scale efficiency (SE). The PTE that reflects the managerial performance to organize inputs in the production process revealed that supermarket farmers were more efficient in the production of both cauliflower and cabbage. The coefficient of variation in TE was relatively less in the case of supermarket farmers. However, SE scores of the traditional market farmers were relatively more consistent (Table 5).

Table 3 Price realized from sale to supermarket and traditional market during peak arrival period of cauliflower and cabbage

	October, 2010		November, 2010		December, 2010		January, 2011		All (October, 2010–January, 2011)	
	Super market	Traditional market	Super market	Traditional market	Super market	Traditional market	Super market	Traditional market	Super market	Traditional market
Cauliflower										
Price (Rs./kg)	17.32	16.22	12.92	11.91	7.71	6.72	7.19	6.23	11.40	10.38
% difference in price	6.78		8.48		14.72		15.45		9.79	
Standard deviation	2.97	3.12	2.60	2.79	1.98	1.94	1.79	1.69	4.80	4.78
Coefficient of variation (%)	17.14	19.24	20.13	23.46	25.63	28.90	24.94	27.15	42.14	46.04
Cabbage										
Price (Rs./kg)	11.04	9.90	8.34	7.59	5.38	4.66	4.84	4.22	7.35	6.55
% difference in price	11.42		9.88		15.38		14.69		12.18	
Standard deviation	0.81	0.89	2.22	2.21	0.78	0.77	1.26	1.27	2.82	2.67
Coefficient of variation (%)	7.35	8.98	26.67	29.13	14.58	16.47	26.06	30.08	38.30	40.75

Source Author's compilation and www.agmarknet.nic.in

Table 4 Distribution of supermarket farmers by source of advice for production of vegetables

Source of technical advice	No. (%) of farmers reported
Own decisions	12 (31.6)
Fellow farmers	10 (26.3)
Agri-input dealers	7 (18.4)
Agriculture department officials	3 (7.9)
Media (Newspaper, TV, radio, etc.)	3 (7.9)
Supermarket retail chains	1 (2.6)
Commission agents/wholesalers	2 (5.3)

The scale efficiency (SE) provides information about the ability of farmers to choose the optimum scale of production to attain the expected level of production. The proportion of farmers having suboptimal returns to scale was higher in the case of traditional market farmers (76% in cauliflower and 88% in cabbage) vis-à-vis supermarket farmers (60% in cauliflower and 64% in cabbage). This indicates that those farmers who experience increasing returns to scale (also known as economies of scale) allocate a smaller area to cauliflower and cabbage. Thus, inefficiency among traditional market suppliers existed due to less area. Further, 24% of cauliflower and 12% of cabbage supermarket farmers realized supra-optimal returns to scale. Only 16% of cauliflower farmers supplying to the local market realized supra-optimal results. None of the cabbage farmers supplying to the traditional market experienced supra-optimal returns to scale. Also, 16% of cauliflower farmers and 24% of cabbage farmers associated with supermarkets were fully scale efficient compared to 8% of cauliflower farmers and 12% of cabbage farmers supplying to traditional market (Table 6).

8 Farmers' Opinion on the Role of Supermarket in Vegetable Marketing

Eighty percent of the supermarket farmers gave their opinions on the role of supermarkets in making farmer–firm linkage more effective. Of these, about 62% indicated that supermarkets should procure all the produce so that farmers use only one marketing channel rather than selling the un-procured produce in the open market. Opening of more retail outlets was reported by 47% of the farmers, who opined that more organized retail outlets would enhance competition in the market, which would benefit them in obtaining better price terms. Forty percent of the supermarket farmers suggested that supermarket should provide packaging material so as to reduce wastages of produce. Nearly 35% of the supermarket farmers opined that the supermarket should give higher prices for superior grade produce. Need for supplying agri-inputs and for training in vegetable cultivation was indicated by 32 and 25% farmers, respectively. Further, 20% farmers suggested a premium for quality produce (Table 7).

Table 5 Technical efficiency scores for cauliflower and cabbage across reliance fresh and traditional market farmers

Efficiency score	Reliance fresh						Traditional market					
	Overall Technical Efficiency (OTE)		Pure Technical Efficiency (PTE)		Scale Efficiency (SE)		Overall Technical Efficiency (OTE)		Pure Technical Efficiency (PTE)		Scale Efficiency (SE)	
	Cauliflower	Cabbage	Cauliflower	Cabbage	Cauliflower	Cabbage	Cauliflower	Cabbage	Cauliflower	Cabbage	Cauliflower	Cabbage
1.0	3 (12)	3 (12)	5 (20)	8 (32)	6 (24)	6 (24)	2 (8)	1 (4)	3 (12)	3 (12)	4 (16)	3 (12)
0.9–1.0	1 (4)	3 (12)	7 (28)	6 (24)	5 (20)	3 (12)	1 (4)	2 (8)	4 (16)	8 (32)	4 (16)	4 (16)
0.8–0.9	6 (24)	9 (36)	10 (40)	8 (32)	4 (16)	13 (52)	4 (16)	3 (12)	9 (36)	9 (36)	12 (48)	8 (32)
0.7–0.8	8 (32)	6 (24)	2 (8)	3 (9)	6 (24)	3 (12)	6 (24)	11 (44)	5 (20)	2 (8)	2 (8)	5 (20)
0.6–0.7	5 (20)	4 (16)	1 (4)	–	4 (16)	–	7 (28)	5 (20)	3 (12)	3 (12)	3 (12)	4 (16)
0.5–0.6	2 (8)	–	–	–	–	–	3 (12)	3 (12)	1 (4)	–	–	1 (4)
0.4–0.5	–	–	–	–	–	–	2 (8)	–	–	–	–	–
Mean	0.77	0.82	0.91	0.92	0.86	0.89	0.72	0.75	0.84	0.88	0.86	0.85
Maximum	1	1	1	1	1	1	1	1	1	1	1	1
Minimum	0.55	0.62	0.65	0.75	0.63	0.74	0.41	0.55	0.58	0.67	0.63	0.70
Standard deviation	0.13	0.12	0.09	0.08	0.13	0.08	0.16	0.12	0.13	0.11	0.10	0.09
Coefficient of variation (%)	16.63	14.21	9.83	8.35	14.72	8.73	21.58	16.07	14.98	12.07	11.62	10.54

Note Figures within the parentheses indicate percentage of farmers with T.E. scores

Table 6 Scale efficiency of farmers supplying vegetables to supermarket and traditional market

Returns to scale	Cauliflower (%)		Cabbage (%)	
	Supermarket farmers	Traditional market farmers	Supermarket farmers	Traditional market farmers
Increasing	60	76	64	88
Constant	16	8	24	12
Decreasing	24	16	12	–

Table 7 Opinion of farmers on the role of the supermarkets

Particulars	No. of farmers (%)
Procure all the produce and grades	25 (62.5)
Open more retail outlets	19 (47.5)
Provide crates to pack vegetables	16 (40.0)
Give higher prices for A and B grades produce	14 (35.0)
Provide agri-inputs	13 (32.5)
Provide training on quality vegetable cultivation	10 (25.0)
Give incentives for good quality produce	8 (20.0)
Crop insurance in event of crop failure	5 (12.5)

Note Figures within the parentheses indicate the percentage of total number of responses

9 Supermarkets and Crop Diversification

Diversification is one of the several pathways to enhance farm incomes. The growing demand for high-value food commodities in the domestic as well as global markets is an opportunity for small farmers to enhance their incomes through diversification of their production portfolio towards these commodities (Birthal et al. 2006). This issue assumes more importance in a state like Punjab where agriculture is dominated by monoculturing of rice and wheat, causing damage to soil health and water resources. Moreover, land productivity has reached a plateau. Given this situation, an attempt has been made to examine the role of supermarkets in motivating farmers to cultivate high-value crops.

Table 8 shows the area share of different crops across supermarket farmers and traditional market farmers. The proportion of gross cropped area (GCA) under vegetables was higher for supermarket farmers than traditional market farmers. The traditional market farmers grow more of traditional crops such as wheat, paddy and fodder, while supermarket farmers grow more of vegetables. The cropping intensity has also been found higher for the supermarket farmers.

At the time of survey, the Reliance Fresh supermarket has been procuring vegetables for the past 3 years; therefore, we looked into the trend in area under vegetables. The area under vegetables across all farm categories of both supermarket and traditional market suppliers has increased during the past 3 years. The percentage increase was higher across supermarket farmers (13%) than traditional

Table 8 Cropping pattern across supermarket farmers and traditional farmers

Particulars	Supermarket farmers		Traditional market farmers	
	Area (acres)	% of GCA	Area (acres)	% of GCA
Cauliflower	2.09	16.7	1.05	7.7
Cabbage	1.58	12.6	0.97	7.1
Potato	1.45	11.6	2.74	20.0
Cucumber	1.15	9.2	0.39	2.8
Radish	0.90	7.2	0.47	3.4
Carrot	0.75	6.0	0.46	3.3
Other vegetables	0.66	5.3	0.53	3.9
All vegetables	8.58	68.7	6.60	48.4
Wheat	1.73	13.9	3.30	24.2
Paddy	1.40	11.2	2.74	20.0
Fodder	0.78	6.2	1.01	7.4
All traditional crops	3.91	31.3	7.05	51.6
GCA	12.49	100	13.65	100
Net area	6.17		7.61	
Cropping intensity (%)	202.4		179.3	

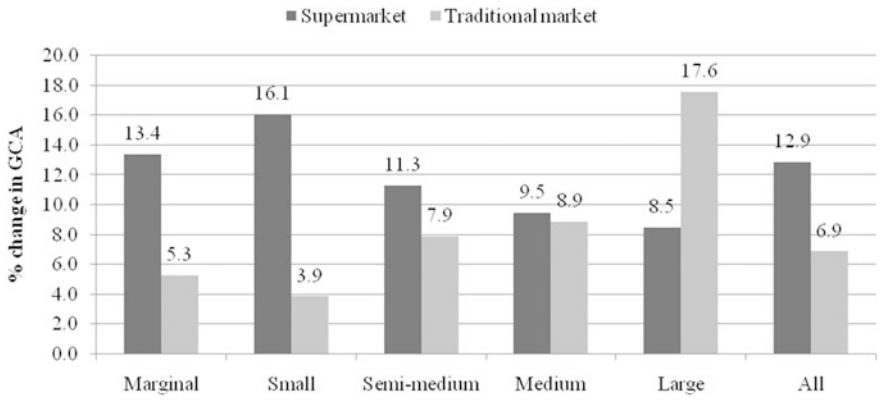

Fig. 1 Farm category-wise % change in GCA under vegetables in past 3 years across upper market farmers and traditional farmers

market farmers (7%). Further, the proportionate increase in area under vegetables was found to be higher for marginal and small supermarket farmers as compared to their counterparts, traditional market suppliers. Increase in area under vegetable cultivation starts declining with increase in landholding size (Fig. 1). Of the 72% supermarket farmers who responded to the reasons for allocating more area to vegetables in the past 3 years, 58% did it for higher income from vegetables. About 44% had shifted due to increase in demand for vegetables. Lack of hired labour was another major reason to shift to vegetable cultivation for 36% of the growers.

Table 9 Distribution of supermarket farmers by reasons for increasing area under vegetables during past three years ($N = 50$)

Reasons for increasing area under vegetables	No. (%) of farmers
Higher income	21 (58.3)
Increase in demand for vegetables	16 (44.4)
Lack of hired labour	13 (36.1)
Regular flow income from vegetables	9 (25.0)
Land more suitable for vegetables	8 (22.2)
Reduction in operational holding size resulting in diseconomies of scale from crops like wheat and paddy	8 (22.2)
Emergence of organized supermarkets	3 (11.1)

Regular flow of income from vegetable cultivation, suitability of land for vegetable cultivation, and reduction in operational landholdings resulting in diseconomies of scale from the traditional crops were some of the other reasons reported by the supermarket farmers for the adoption of vegetable cultivation. Surprisingly, 11% of the farmers attributed their shift to the presence of organized supermarket that provides assured market and pays a higher price (Table 9).

10 Conclusions and Policy Implications

The major findings of this study are summarized below

- The supermarkets, in order to reduce the procurement risks, are associated more with large farmers, and work with a sizable number of small farmers though they have small surpluses for the market. Another reason for contracts with small farmers is their family labour resource, which has advantage in cultivation of labour-intensive crops such as vegetables and in post-harvest activities related to grading, sorting and packaging.
- Farmers benefit from linkages with supermarkets, though they are informal. The supermarket farmers are technically more efficient, reap better harvest and realize better and stable prices from the institutional buyers. The main benefit, however, accrues from reduction in cost on marketing and transportation. They, however, incur more of production costs. Nonetheless, they realize 10% or more net returns from their association with supermarket supply chain. Farmers also benefit from the technical advice on grades and standards. Interestingly, the presence of an assured market motivates the farmers to scale up their production activity, which is important to persuade the farmers away from cultivation of cereals, which has been damaging both land and water resources.

- There are certain suggestions that need attention of the agribusiness firms to strengthen the linkages. One, many firms such as Reliance Fresh link with farmers through contacts and not contracts, probably to avoid transaction costs of enforcement and legal problems associated with disputes if any, which is contrary to the spirit of Modal Act 2003. A formal contract would benefit both the firms and producers in case of violation of the terms and conditions of the contract. Two, farmers need to be educated in crop planning, production and post-harvest management through provision of support services so as to avoid excess production. Note that the majority of farmers have indicated that the firm should procure all that they produce while it procures only a part of it. Three, vegetable production is also cost-intensive; the firm should consider providing credit support to their farmers, which of course is possible if the contract is formal. Four, the government should encourage or facilitate institutional arrangements such as contract farming that motivate the farmers to diversify away from monoculturing of crops like rice and wheat.

Appendix

See Tables 10 and 11.

Table 10 Production costs among supermarket and traditional market supplying farmers

Cost component (Rs./acre)		Cauliflower		Cabbage	
		Supermarket farmers	Traditional market farmers	Supermarket farmers	Traditional market farmers
Land rent		6500 (18.9)	6500 (21.0)	6200 (19.1)	6250 (21.3)
Land preparation		1675 (4.9)	920 (3.0)	1520 (4.7)	876 (3)
Seed		3942 (11.4)	3678 (11.9)	3537 (10.9)	3425 (11.7)
FYM		1120 (3.3)	800 (2.6)	1043 (3.2)	750 (2.6)
Fertilizer		5687 (16.5)	5135 (16.6)	5448 (16.8)	5021 (17.1)
Pesticide		4655 (13.5)	4215 (13.6)	4335 (13.4)	3956 (13.5)
Weedicide		825 (2.4)	770 (2.5)	790 (2.4)	750 (2.6)
Irrigation		956 (2.8)	754 (2.4)	1050 (3.2)	850 (2.9)
Labour	Hired	3048 (8.8)	2884 (9.3)	2755 (8.5)	2442 (8.3)
	Family	6036 (17.5)	5291 (17.1)	5740 (17.7)	5056 (17.2)
Cost of production		34,444 (100)	30,947 (100)	32,418 (100)	29,376 (100)

Note The overall average irrigation cost figures are based only on diesel engine and water hired expense since electricity for tubewells is free in Punjab

Table 11 Marketing costs across supermarket and traditional market supplying farmers

Cost	Cauliflower			Cabbage		
	Supermarket farmers		Traditional market farmers	Supermarket farmers		Traditional market farmers
	A and B grades	Rest in *mandi*	All	A and B grades	Rest in *mandi*	All
Transportation cost	414 (0.18)	2070 (0.30)	2168.8 (0.25)	425.3(0.18)	2126.2 (0.30)	2250.0 (0.25)
Spoilage	23 (0.01)	276 (0.04)	260.3 (0.03)	23.6 (0.01)	283.5 (0.04)	270.0 (0.03)
Unloading charges	–	138 (0.02)	173.5 (0.02)	–	141.8 (0.02)	180.0 (0.02)
Marketing cost	437 (0.19)	2484 (0.36)	2602.5 (0.30)	448.9 (0.19)	2551.5 (0.36)	2700.0 (0.30)

Note Figures within the parentheses indicate the marketing costs in Rs./kg

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Tomato Value Chain in Karnataka

K.B. Ramappa and A.V. Manjunatha

1 Introduction

For the past 25 years, India's agri-food marketing system has been undergoing transformation and the two notable changes that have occurred are (i) rapid growth in horticultural production and (ii) rise of organized supply or value chains, especially for the horticultural commodities to improve marketing efficiency. These changes have been triggered by the rising demand for high-value food commodities, in addition to increasing consumer's awareness about quality and safety aspects. Consequently, the production, processing and distribution systems are adapting to these changes.

This chapter analyses the value chain in tomato—the world's second largest produced vegetable and known for its nutritional value. Tomato and its products are considered healthy, as they possess a remarkable combination of antioxidants, micronutrients and low calories. In India, it is the third largest produced vegetable after potato and onion. A number of tomato products, viz. ketchup, juice, puree, paste, sauce and pickles are available in the market and are the items of common consumption in households, hotels, restaurants and institutions. The recent scientific advances in tomato processing and the emergence of organized food retail chains are helping in matching supply and demand in the urban areas and protecting the interests of farmers during high production. The study presented in this chapter has been conducted with the following objectives:

The chapter contains some portions from a report, submitted by the authors to their affiliated organization—Institute for Social and Economic Change—which was uploaded on the institute's site for a while.

K.B. Ramappa (✉) · A.V. Manjunatha
Agriculture Development and Rural Transformation Centre, Institute for Social and Economic Change, Bengaluru, Karnataka 560072, India
e-mail: ramskb@gmail.com

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- Identification of actors involved in the tomato value chains, including their roles and interactions,
- Estimation of marketing costs and efficiency in the tomato value chains,
- Estimation of product-wise value addition in processing of tomato, and
- Identification of constraints and financial requirements (specifically investment) at each stage of tomato value chains.

The study has been conducted in Karnataka—the second largest state in terms of area (5780 ha) and production of tomato (1916.6 million tonnes) in 2012–13 (NHB 2012–13). In the state, Kolar, Chikkaballapur and Belgaum are the top tomato-producing districts and are the domain for this study. The existing markets for the sale of tomatoes in each district were selected for collecting information from various market functionaries. A few processing industries engaged in manufacturing of tomato products were also selected to understand the value addition to tomatoes.

To select villages, markets, market functionaries, processors and farmers, random sampling technique was used. From each selected district, 50 farmers, 20 commission agents, 20 retailers, 15 wholesalers and 20 consumers were selected. Besides, three processors in and around Bangalore and Kolar were also selected.

The data were collected from the selected chain actors during August–September 2015. A structured schedule was used to collect relevant information from the tomato farmers. For other actors, separate questionnaires were designed seeking information on costs, returns, processes, financial requirements and marketing practices. We also identified and mapped value chain for tomato in Karnataka based on survey and interviews with the value chain actors involved in the marketing channel. The value chain participants included producers, intermediary traders, exporters (domestic), supermarkets and input suppliers.

2 Analytical Framework

Marketing Cost—The total cost associated with the transfer of commodity from producers to consumers was calculated, following Acharya and Agarwal (2006), as per Eq. (1):

$$C = C_f + C_{m1} + C_{m2} + C_{m3} + \cdots + C_{mi} \quad (1)$$

where, C is the total cost of marketing; C_f is the cost incurred by the producer from the time the product leaves the farm, and C_{mi} is the cost incurred by the ith middleman.

Marketing Margin—The marketing margin is the difference between receipts (sale price) of the ith middleman and total payment (costs + purchase price)

(Acharya and Agarwal 2006). The absolute margin of the *i*th middleman is worked out as per Eq. (2):

$$A_{mi} = PR_i - (PP_i + C_{mi}) \tag{2}$$

where, A_{mi} is the absolute margin of the *i*th middleman; PR_i is the total value of receipts per unit (sale price); PP_i is the purchase value of goods per unit (purchase price); and C_{mi} is the cost incurred on marketing per unit.

Price Spread—Price spread is worked out for each marketing channel as the difference between the price paid by the consumer and price received by the producer for an equivalent quantity of farm produce, i.e.

$$\text{Price spread} = \text{Consumer price} - \text{Producer}'\text{s price} \tag{3}$$

Producer's Share in Consumer's Rupee—It is the price received by the farmer expressed as a percentage of the retail price (the price paid by the consumer). If P_r is the retail price, the producer's share in consumer's rupee (P_s) may be expressed as per Eq. (4):

$$P_S = (P_f/P_r) \times 100 \tag{4}$$

Marketing Efficiency—It is the effectiveness of a marketing system with which it operates. For calculating the marketing efficiency (Acharya and Agarwal 1994):

$$\text{ME} = \frac{\text{FP}}{\text{MC} + \text{MM}} \tag{5}$$

where, ME is the marketing efficiency; FP is the net price received by the farmer; MC is the total marketing cost and MM is the total marketing margin.

The marketing efficiency for the processed products is calculated as per equation (6):

$$\text{ME} = \frac{V}{I} - 1 \tag{6}$$

where, V is the value added for the tomato; I is the total marketing cost incurred and ME is the index of marketing efficiency.

Value Addition—It reflects the difference between the price for which a firm sells its products and the cost incurred on the purchase of inputs by it. This difference represents the value addition by the productive activities of the firm (Kohls and Uhls 1967).

$$\text{Value Addition} = (\text{Selling price of product}) - (\text{Cost of total inputs}) \tag{7}$$

Garret's Ranking Technique—To identify the major constraints to tomato production, the Garret Ranking technique (Garret and Woodworth 1969; Kathiravan et al. 1999; Sedaghat 2011) was used. The constraints were prioritized as follows:

$$\text{Percentage position} = \frac{100(R_{ij} - 0.5)}{N_j} \tag{8}$$

where R_{ij} is the rank given for the ith item by the jth respondent and N_j is the number of items ranked by the jth respondent.

The percentage position of each rank was converted into scores using Garret table. For each constraint, scores of individual respondents were added together and divided by the total number of respondents for whom scores were added. Then, the mean score for each constraint was ranked by arranging them in descending order.

3 Mapping Tomato Value Chain

The value chain analysis is the process of breaking a chain into various components to better understand its structure and functioning.

Tomatoes and tomato products reach the final consumers through three channels, viz. traditional channel, supermarket channel and processor channel (Fig. 1). The processed tomato products are mostly sold as a paste to manufacturers of ketchup and sauce. The ketchup and sauce are sold to individuals and bulk consumers (hotels and institutions) in smaller packets. A part of it is also exported. The value chains of tomatoes and its products are presented in a systematic way in the value chain map (Fig. 1). We have differentiated between the processes in the chain (left side of the figure, denoted by black arrows); actors associated with different processes in each channel are denoted separately (rectangle for the traditional channel and oval shape for organized retailers and hexagons for processors). If the processes include more than one function, it is depicted by a larger black arrow. The tomato value chain comprises input suppliers, producers, commission agents, wholesalers, collection centres, central warehouses, vendors, processors, retailers, distributors, exporters and consumers as depicted in Fig. 1.

3.1 Channel I: Traditional Market Channel

This traditional channel dominates over other channels for fresh tomatoes. The yard of Agricultural Produce Market Committee (APMC) is the platform for this channel and the activities are administered by the concerned authorities of APMC. The chain comprises input suppliers, producers (all landholding-size categories of farmers), commission agents, wholesalers, exporters (domestic) and retailers.

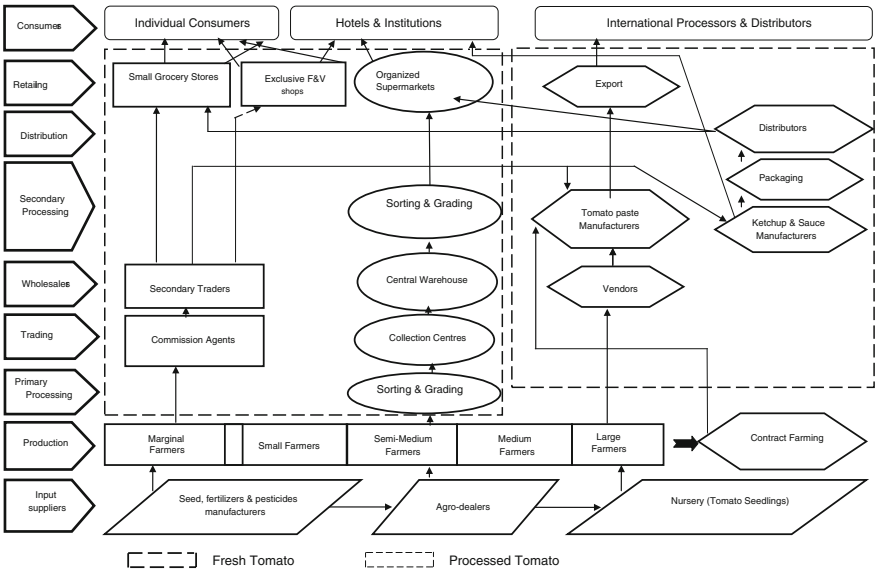

Fig. 1 Overall tomato value chain mapping in Karnataka

As the volume of produce is larger in this channel, the sale prices are lower as compared to other channels. There is no quality specification as the whole lot of the farmers is put for bidding by the commission agents. The competition among wholesalers is based on the best value proposition to the overall quality of the lot. Usually, the prices in this channel are low during the peak arrival season. The transactions are mostly formal, but usually underreported by the commission agents for recording in APMC. They exercise physical control and negotiate the sales charging 5–8% commission from sellers and not from wholesalers mainly to attract wholesalers. The farmers sell through these commission agents as they avail credit from them against their commitment of sales to them. There is a lack of sanitary measures and quality tests in the market yard. Superficial sampling tests are conducted on the spot before bidding. Usually, the wholesalers buy tomatoes from the commission agents, processors also participate in the bidding but rarely. The majority of these wholesalers have a good network with other traders (at local and distant markets) including exporters. Through this network, they sell produce to various retailers (both organized and unorganized) such as small grocery stores, exclusive fruit and vegetable shops, supermarkets, and processors and manufacturers of tomato paste and other tomato products. Many consumers prefer to purchase tomatoes from the exclusive fruit and vegetable shops due to better quality compared to supermarkets and grocery stores where the produce stays on the shelf for a longer time.

3.2 Channel II: Organized Retailers/ Supermarket Channel

The organized retailing in the case of fresh fruits and vegetables started in India in the beginning of the twentieth century in Bengaluru because the surrounding districts were the hub for sourcing of vegetables from the southern part of the country. These organized retail chains have attempted many changes in the supply chain management and have established an institutional mechanism for linking farmers with modern markets. The channel is growing at a fast rate and is projected to grow with various formats. This channel is the main mode of sales for tomato-based products.

In India, the supermarkets have established collection centres in major vegetable production areas. We came across few collection centres in Chikkaballapur and Kolar APMCs. These organized retailers usually source local fresh tomatoes directly from the growers and rarely from wholesalers in the market. They have a list of registered farmers, to whom they provide technical advice on production and quality aspects of vegetables in general and tomatoes in particular. Organized retailers look for consistent supply from a limited number of trusted growers/ suppliers. They purchase tomatoes from these registered/trusted farmers at the collection centres as per the daily indent received from their central warehouse team.

Generally, farmers bring sorted and graded produce to these collection centres, but the produce is again subjected to sorting and grading at the collection centres under the supervision of quality assessment incharge. They specify quality standards which growers have to meet if they want to sell to these chains. The produce received from different collection centres is pooled at the central warehouse and distributed to each outlet (supermarkets) according to their indent. However, the produce is again put for sorting and grading before distribution. These retailers also purchase unavailable items (out of stock at collection centres) from wholesalers in APMCs. They also create value on front-end by promising quality, freshness and lower prices of produce, besides providing a conducive shopping environment in their supermarkets. The processed tomato products are sourced primarily from the distributors. Both individual and bulk consumers purchase tomatoes and processed tomato products from the supermarkets.

3.3 Channel III: Processed Tomato Products Channel

The demand for processed products has been rising. The processors source raw tomatoes through different channels. Big industries like Mother Dairy have tie-ups with farmers for contract farming. In addition, they also procure tomatoes from the APMCs. Other tomato processing industries usually source their raw tomatoes from wholesalers in APMCs, especially during glut situation as they need bulk quantity at a cheaper price. Sometimes, tomato paste producing industries also depend upon

vendors, who generally aggregate tomatoes from the farmers in a cluster of villages and supply to the processing industries. The ketchup and sauce manufacturers usually procure paste from tomato paste manufacturers. During peak season, they procure raw tomatoes and process it to tomato paste on their own. The tomato paste manufacturers supply a major portion of their product to the secondary processing industries and the rest is exported. Packaged tomato products such as sauce and ketchup are sold directly to bulk consumers like hotels and institutions, and part of it is also sold to retailers through company distributors in smaller packages.

4 Actors in Tomato Value Chain

Input Suppliers: They are the suppliers of agricultural inputs such as seeds, fertilizers, pesticides, mulching sheets, etc. required for the production of raw tomatoes. Usually, they sell their products to the growers through company-owned outlets or company-appointed dealers. They also provide technical guidance on inputs usage and ensure timely supply of inputs to the farming community. They do maintain good relationship with the growers and act as one of the informal sources of credit for them.

Producers: They are the growers of fresh tomatoes at different size categories of landholdings. They generally purchase necessary inputs like seeds, fertilizers, pesticides, etc. from the agro-dealers. In Kolar and Chikkaballapur districts, the majority of farmers use seedlings as the planting material which they purchase from local nurseries. A few producers also had tie-ups with processors for tomato contract farming.

Commission Agents: They are the authorized traders in the APMC who facilitate the sale of tomatoes from producers to buyers (wholesalers, retailers and processors) on open bidding (auction) method to fix prices for the tomatoes. They charge 5–8% commission from the buyers. They maintain good relationships with the farmers and traders in the local and distant markets. They also provide credit to the trusted farmers with a commitment to sell their produce during harvest season to them.

Wholesalers: They are the important buyers in the market who generally procure tomatoes in larger quantities and supply them to retailers (both organized and unorganized), processors and exporters. They operate their business with very thin margins. They sometimes store the produce for a short period and then sell to the retailers at a higher price.

Retailers: Retailers are the sellers of tomatoes to the ultimate consumers through several channels such as small grocery stores, exclusive fruit and vegetable shops, supermarkets and exporters. They normally buy from wholesalers and sell both fresh tomatoes and its products in smaller quantities with a higher profit margin. They also create marketing opportunities through promotional tactics and satisfying consumers' demand. A small volume of produce is sold by street hawkers and on-head sellers.

Processors: They may be considered as the secondary processing industries. Their processed products include tomato paste, sauce and ketchup. They collect fresh tomatoes from the wholesalers, usually during peak arrival season at cheaper prices. The big processors like Mother Dairy purchase tomatoes directly also from the farmers through contract farming.
Distributors: They usually buy processed tomato products from processors and supply to small grocery stores and supermarkets. They generally sell products of different companies in different formats of retailers.
Exporters: They undertake the sale of fresh tomatoes and processed tomato products in the international markets. A few of the wholesalers in Kolar APMC supply fresh tomatoes to the exporters outside the state who export them to the neighbouring countries like Bangladesh and Myanmar. Tomato paste was exported by Mother Dairy to Middle East and East Asian countries.

5 Costs and Returns Along Tomato Value Chains

A number of intermediaries are involved in the marketing of tomatoes. To understand the different aspects of tomato marketing, price structure and efficiency, marketing margins and costs have been estimated for different stages of the value chain. Few farmers sold their entire produce to the processors during the reference year on directly visiting the farmers' field and hence, farmers had not incurred any cost on marketing. However, they were able to sell their entire lot at a slightly better rate (Rs 788/quintal) than the market price (Rs. 777/quintal). However, it is difficult for the farmers to depend upon processors as they procure tomatoes from the field only when there is a need; mostly they procure tomatoes from markets when there is a glut or price fall in the market, especially during the peak arrival season. Hence, the details of costs per quintal incurred by the sample farmers who sold in channel I and channel II are discussed in this chapter. The price spread in different tomato value chains is presented in Table 1. The producer's share in consumers' rupee is comparatively lower in the traditional APMC channel (channel I) (42.2%) due to various factors such as more number of intermediaries, the cost of various market functions rendered by different actors and wastages at each stage.

The producer's share in organized retailers/supermarkets (channel II) was higher (59.5%) largely due to the absence of few intermediaries, viz. commission agents and wholesalers. However, value-addition costs were higher in channel II due to higher rejections during sorting and grading at the collection centre as well as in central warehouse. Thus, margin of retailer was relatively lower (7.03%) in the organized retailer channel vis-a-vis traditional marketing channel (11.32%), but the consumer's price was less in channel II. The reasons for lower price at the organized retailers (super markets) were due to economies of scale, use of modern technology and efficient business management as compared to small traditional retailers. Overall, producer's share in consumer rupee was higher in channel II (59.5%) than in channel I (42.2%), indicating farmer-friendly nature of channel II.

Table 1 Price spread of tomato value chain in Karnataka (Rs./quintal)

Particulars	Channel I	Channel II	% Difference between Channel I & II
Producer			
Net price received	587.62	743.76	−26.57
Marketing cost	153.19	99.20	35.24
Value-added cost	36.91	40.37	−9.37
Total marketing cost	190.11 (13.65)	139.57 (11.17)	26.58
Gross price received	777.73	883.33	−13.58
Wholesaler			
Price paid	777.73	–	–
Traditional marketing cost	174.95	–	–
Value-added cost	14.48	–	–
Total marketing cost	189.43 (13.60)	–	–
Marketing margin	104.17 (7.48)	–	–
Price received	1071.33	–	–
Retailer			
Price paid	1071.33	883.33	17.55
Traditional marketing cost	101.39	196.85	−94.15
Value-added cost	62.67	82.00	−30.84
Total marketing cost	164.06 (11.78)	278.85 (22.31)	−69.97
Marketing margin	157.71 (11.32)	87.82 (7.03)	44.32
Price received	1393.10	1250.00	10.27
Price paid by the consumer	1393.10	1250.00	10.27
Overall marketing cost	543.60	418.42	23.03
Overall marketing margin	261.88	87.82	66.47
Price spread	805.48 (57.81)	506.24 (40.50)	0.37
Producer share in consumer's rupee (%)	42.18	59.50	−41.06

Note Figures in parentheses are percentages to consumer price

The marketing efficiency of fresh tomato under two different value chains was computed using Acharya's modified method and the results are presented in Table 2. The organized retailer channel (channel II) was found more efficient because of higher (1.46) marketing efficiency as compared to traditional marketing channel (0.72) (channel I). The low marketing efficiency in channel I points towards the existence of more intermediaries in the chain, and the possibility of improving their margins by better management of produce during transit.

It was noticed during the survey that tomato paste is the raw material for ketchup and sauce industries. Most of these industries purchase tomato paste from paste manufacturing industries and rarely procure fresh tomatoes and process into paste. Usually, tomato paste industries are bigger in size and manufacture paste in bulk

Table 2 Marketing efficiency for per quintal of tomato under different channels (Rs./quintal)

Particulars	Traditional channel	Supermarket channel
Consumers' purchase price	1393.1	1250
Producers' sale price	777.73	883.33
Total marketing costs (MC)	543.60	418.42
Total margins of intermediaries (MM)	261.88	87.82
Net price received by farmer	587.62	743.76
Marketing efficiency	0.72	1.46

Table 3 Analysis of profit margin from tomato in the channel of tomato processing industries (Rs./quintal)

Particulars	Tomato paste	Tomato ketchup	Tomato sauce
Raw tomato cost	362 (50.63)	362 (32.50)	362 (30.60)
Marketing cost	125 (17.46)	125 (11.26)	125 (10.53)
Value-added cost	176 (24.58)	575 (51.80)	644 (54.25)
Total variable cost	663 (92.60)	1062 (95.68)	1131 (95.28)
Total fixed cost	53 (7.40)	48 (4.32)	56 (4.72)
Total cost	716 (100)	1110 (100)	1187 (100)
Gross income[a]	789	2430	1701
Profit margin	74 (10.19)	1316 (118.91)	518 (43.30)

Note Figures in the parentheses indicate the percent to the total cost

[a]The value of 14 kg of tomato paste, 54 kg of tomato ketchup, 63 kg of tomato sauce at the average wholesale rate of Rs. 56.35, Rs. 45.00 and Rs. 27.00, respectively

and sell, and they hardly process into any other subsidiary product as found in the case of Mother Dairy Fruits and Vegetable Private Limited.

The production and marketing costs involved in the manufacturing of various products of tomato like tomato paste, ketchup and sauce were obtained from the processing plants and product-wise value additions and profit margins were estimated. The results are presented in Table 3. The estimated conversion ratio of fresh tomatoes (one quintal) to other products was 14 kg of paste, 54 kg of ketchup and 63 kg of sauce. Therefore, per quintal raw material (tomato) cost of Rs. 362 was considered uniformly for the production of other processed products. Table 3 reveals that marketing costs were comparatively higher (17%) for tomato paste than for other two products, wherein it was around 11% each. The marketing cost included transportation, loading and unloading and wastage during the transit. On the other hand, the share of value-added cost was found highest (54%) in the production of sauce, followed by ketchup (52%) and paste (25%). The overall variable cost accounted for about 93% in tomato paste, 96% in ketchup and 95% in sauce products. Similarly, the total fixed cost was 7% in paste, 4% each in case of ketchup and around 5% in case of sauce. Since ketchup had high market demand, industries were getting a higher profit margin from ketchup (119%) than from either

sauce (43%) or paste (10%). This clearly shows considerable potential in processing and value addition of tomato, which in turn would create a higher marketing efficiency in the system.

6 Constraints at Different Stages of Tomato Value Chain

This section summarizes the constraints faced by the stakeholders in the tomato value chain.

6.1 Growers' Constraints in Production and Marketing of Tomato

The results of Garret's rankings, presented in Table 4, indicate various constraints experienced by the growers in production and marketing of tomatoes in the study area. At the production level, the biggest challenges revealed by highest number of farmers (51.8%) was the high cost of fertilizers and pesticides, so much so that many of the farmers could not purchase the optimum quantity required for the production of tomato. The second biggest constraint (of 47.8% farmers) was a high prevalence of pests and diseases such as tomato leaf curl, early blight, late blight and wilt along with infestations of whiteflies, aphids, cutworms and pinworms. About 45% farmers complained about unforeseen weather conditions, especially less rainfall for prolonged periods. The other constraints included low yield, labour shortage, huge wage rates and irregular supply of electricity.

In the marketing of tomatoes, the major constraint reported by the majority of farmers (53.35%) was low prices which make it less profitable to cultivate tomatoes. Many farmers (48.76%) complained about the high marketing cost of tomatoes, particularly in the traditional marketing channel of APMC where the farmers have to pay commission charges of around 8–10% of sale price. The commission, in reality, has to be paid by the buyers and not producers, but commission agents try to attract buyers, especially wholesalers, and recover commission from the farmers. It was also true that farmers were pre-committed to sell their produce to specific commission agents from whom they take loan in advance. Among other marketing constraints were a lack of drinking water facilities and poor toilet and sanitation facilities in the APMC marketplace. About 15–20% farmers also reported lack of access to processing industries and modern markets as the marketing constraints in tomato value chain.

Table 4 Constraints faced by tomato farmers at production and marketing levels—Garrett's ranking

Constraints	Mean score	Rank
Production constraints		
High cost of fertilizers and pesticides	51.80	I
High prevalence of pests and diseases	47.79	II
Unforeseen weather (lack of rainfall, floods, etc.)	44.80	III
Low yield due to poor soil fertility	40.45	IV
Labour shortage	37.45	V
High wage rates	22.43	VI
Poor supply of electricity	8.10	VII
Marketing constraints		
Realizing low price for produce	53.35	I
High marketing cost	48.76	II
Difficulties in selling produce	45.63	III
Long distance to market	40.21	IV
Inadequate market infrastructure	37.01	V
Limited market information	35.71	VI
Lack of access to processing plants	21.17	VII
Limited access to modern markets	16.50	VIII
Other(s)	4.43	IX

6.2 Constraints Faced by Different Market Functionaries

Table 5 lists the constraints being faced by different intermediaries of tomato value chain in marketing the produce. About 70% of commission agents and wholesalers and 57% of the unorganized retailers reported lack of basic infrastructure at APMCs such as proper roads, toilets, drinking water, street lights, etc. as the major constraints to marketing activities efficiently. Similarly, about 30% of commission agents and 47% of wholesalers felt that the APMC was highly congested, poorly maintained and was often unclean, and unhygienic with little or no solid waste management measures. About 40% of wholesalers and 11% of the unorganized retailers complained about the lack of storage facilities such as godowns, cold storages, etc.

The main constraint (60%) faced by the organized retailers was a lack of grading of tomatoes by the farmers. This constraint was also reported by about 15% each of the commission agents and wholesalers. All processing industries complained about underutilization of their plant capacity because of inadequate availability of tomatoes for processing as the majority of farmers prefer to channel their produce into the fresh market rather than processing industries.

Table 5 Constraints faced by market intermediaries in the tomato value chain in Karnataka

Constraints	Respondents (%)
At commission agents' level	
Lack of market infrastructure (e.g. roads, toilets, drinking water facilities, etc.)	75.00
Congested and unhygienic market place	30.00
Lack of grading by farmers	15.00
High market fees	15.00
Labour shortage	10.00
Delay in receiving payments from buyers	8.33
Price fluctuations	6.67
Presence of unlicensed traders within the market yard	3.33
Lack of banking facilities at the APMC	3.33
At wholesalers' level	
Lack of market infrastructure (e.g. roads, toilets, drinking water facilities, etc.)	71.11
Congested and unhygienic market place	46.67
Lack of storage facilities (e.g. godowns, cold storages, etc.)	40.00
Lack of grading by farmers	15.56
Damage during transportation	8.89
High cost of transportation	6.67
Labour shortage	4.44
Lack of access to processing industries	4.44
Delay in receiving payments from buyers	2.22
Price fluctuations	2.22
At unorganized retailers' level	
Lack of market infrastructure (e.g. roads, toilets, drinking water facilities, etc.)	57.38
Price fluctuations	40.98
Lack of storage facilities (e.g. godowns, cold storages, etc.)	11.48
High transportation cost	8.19
Wastages	4.91
Congested and unhygienic marketplace	3.28
Unforeseen weather conditions	1.64
At organized retailers' level	
Lack of grading by farmers	60.00
Violation of contract by farmers under contract farming	40.00
Damage during transportation (e.g. transpiration, shrinkage, etc.)	40.00
At processor's level	
Underutilization of plant	100.00
Non-availability of suitable tomato varieties for processing	66.67
High cost of tomatoes	66.67

7 Financial Requirements of Value Chain Actors

This section attempts to find the financial requirement of stakeholders along the tomato value chain in Karnataka.

The pertinent areas where there is a need for financial assistance have been highlighted in Table 6. At the farmers' level, financial need for land developmental activities (Rs 1.25 lakh/household) was reported by 22% of farmers. About 3% farmers, especially in Kolar and Chikkaballapur, indicated the need for finance to create micro-irrigation facilities in their land at the rate of about Rs. 40 thousand/acre. Bore-well digging being a costly operation in these areas, there is a financial requirement of about Rs. two lakh to Rs. four lakh per borewell with depth levels from 800 to 1200 ft. About 1% farmers expressed the need of finance for purchasing tractor, solar-powered irrigation pumps, construction of greenhouses, etc., and this may require finance for about rupees five to seven lakh per household. Further, a few farmers were interested to take up activities such as poultry and dairy and needed finance for it.

About 17% of commission agents and 7% of retailers pointed out the need of financial assistance to scale up their operations with an average requirement of Rs. 4 lakh and Rs. 6.57 lakh, respectively. In addition, about 13% wholesalers reported that they need to improve their cold storage facilities, for which they would need an average of Rs. 50 lakh. However, all processing industries stated that they have credit requirement of Rs. 10 lakh in order to initiate contract farming in an average area of 200 acres. Similarly, all exporters demanded an average credit requirement of Rs. 12 lakhs mainly to purchase crates in order to improve and expand their business. This highlights the need to support the private sector by the government for their participation in tomato value chain.

8 Summary and Policy Recommendations

This study is focused on the value chain analysis of tomatoes in Karnataka, which is one of the leading states in terms of area and production of tomato. The domestic tomato value chain was mapped to identify the actors and their roles, interactions and value-addition activities. The study has revealed mainly three marketing channels: traditional APMC channel (channel I), supermarket channel (channel II) and processors-based channel (channel III). Among these channels, the quantity of tomatoes handled by the traditional channel is much higher than in the other two channels. However, farmers' gains have been found higher in channel II as compared to other channels. This has reflected higher marketing efficiency in channel II (1.46) than in Channel I (0.72). Further, the producer's share in consumers' rupee has been found lower (42.18%) in Channel I than in Channel II (59.50%), which is mainly due to the absence of intermediaries such as commission agents and wholesalers. The value-addition costs have been found higher in channel II due to

Table 6 Financial requirements of stakeholders in tomato value chain in Karnataka

Stakeholders	Purpose	Percentage of stakeholders	Average amount required (Rs. in lakhs/household)
Farmers (N = 150)	Land developmental loans	33 (22.00)	1.25
	Borewell digging with power connection	2 (1.33)	2.00
	Micro-irrigation facility creation	5 (3.33)	0.40
	Construction of green house	2 (1.33)	5.20
	Tractor buying	1 (0.66)	7.00
	Solar-powered irrigation pumps	1 (0.66)	7.00
	Poultry farming and equipment cost	2 (1.33)	5.50
	To buy milching cows and construct shed	1 (0.66)	2.50
Commission agents (N = 60)	Loans for advances	7 (11.66)	5.00
	To start wholesale business	10 (16.66)	4.00
	To purchase transport vehicles	4 (6.66)	8.00
Wholesalers (N = 45)	Improve cold storage facilities (capacity of 10 metric tonnes)	6 (13.33)	50.00
	Expand transaction quantity	2 (4.44)	3.00
Retailers (N = 60)	To expand the existing business	4 (6.67)	6.57
	Shop maintenance (repair work)	5 (8.33)	2.76
Processing industry (N = 3)	Take up contract farming	3 (100.00)	10.00
	Procure modern plant & machineries	2 (66.66)	35.00
	To create cold storage facility up to 20 metric tonnes capacity	2 (66.66)	100.00
Exporters (N = 3)	To buy crates	3 (100.00)	12.00

Note Figures in parentheses indicate percentage of total (N)

higher rejections during sorting and grading at the collection centre and distribution point at central warehouses.

The procurement cost of tomatoes has been found lowest in channel III. Among the processed products, ketchup has been found to have a higher market margin (118%) than sauce (44%) and paste (10%). The share of value-addition cost has been found higher (54%) in the production of sauce, followed by ketchup (51.6%) and paste (24.6%).

The constraint analysis in tomato value chain has revealed that high cost of inputs, high prevalence of pests and diseases, and labour shortages are the major production constraints. Low prices of tomatoes, long distance to market places, lack of processing plants and limited access to modern markets are the marketing constraints to the producers. Lack of market infrastructure, lack of sorting and grading facilities and unhygienic market yards are the major constraints for market

functionaries. With respect to the investment requirements, most of the farmers have expressed the need of a loan for land development and creation of modern farm-level infrastructure, while other value chain actors have mentioned loan for expanding their existing business, creation and upgradation of plant and machinery, and storage facilities.

The study has made the following policy recommendations to improve the tomato value chain in Karnataka:

- The major tomato-producing areas in the state, especially Kolar and Chikkaballapur districts being water-stress regions, incur high cost on pumping water for irrigation, need support of renewable energy systems at farms and access to finance. Further, the state government should organize water conservation and efficient resource utilization campaigns to educate the farmers.
- Organized retailers/supermarketers need to be strengthened and encouraged to source higher quantities of tomatoes from the farmers directly, including contract farmers.
- Most of the processing industries have reported non-availability of suitable varieties of tomatoes for processing as one of the major constraints. This issue needs to be addressed by the state agricultural universities and R&D institutions.
- Majority of intermediaries along the tomato value chain have indicated the need for finance to create infrastructural facilities (cold storages, transportation facilities, etc.) to enhance their business opportunities and hence, the banks and government should increase their access to credit.
- APMCs should take effective steps to improve the hygienic conditions and infrastructural facilities in the market area.

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Value Chain Analysis of Dry Fish in North-East Region of India

A.D. Upadhyay, D.K. Pandey and Bahni Dhar

1 Introduction

Globally, around 115 million tonnes of fish are harvested from the seas, oceans, lakes and rivers every year (FAO 2010), making it the largest extractive use of wildlife as a source of livelihood for millions of people. According to a study of the Associated Chambers of Commerce and Industry of India (ASSOCHAM 2012), the fishery sector has immense potential and fish production can grow at the annual rate of about 7% in the next five years from the current rate of 3.5%, if appropriate incentives coupled with robust investments in infrastructure are made. This study has also revealed that about 67% of the total fish produced in India is consumed as fresh, 16% is utilized for processing and drying, 6% is converted into fishmeal and only 1% is canned. In the country, Andhra Pradesh with a total fish production of 1.96 million tonnes (Mt) in 2014–15 is the leading state, followed by West Bengal (1.62 Mt) (GoI 2015). Besides meeting the domestic needs, dependence of over 14.5 million people on fisheries for their livelihood and foreign earnings from this sector to the tune of US$5511.12 million (2014–15) amply justify the importance of this sector in the country's economy and in livelihood security (FAO 2016; MPEDA 2015).

For the majority of population (90%) in North-East Region of the country, fish is the staple diet. The people of the region are habitual consumers of dry fish and several other traditional processed products like *Shidal*, *Nona Ilish*, smoked fish and canned fishes. The demand for these products is very high in the region and

A.D. Upadhyay (✉) · B. Dhar
College of Fisheries, Central Agricultural University, Lembucherra, Agartala 793105, Tripura, India
e-mail: anilupadhyay54@gmail.com

D.K. Pandey
College of Horticulture and Forestry, Central Agricultural University, Pasighat 791102, Arunachal Pradesh, India

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therefore, dry fishes are imported from the coastal states like West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and Gujarat and also from landlocked states like Uttar Pradesh. Several specific dry fish and fermented fish products like *Shidal* and Nona Ilish are also imported from Bangladesh and Myanmar. The dry fish processing and trade involve a series of activities and a number of stakeholders such as fishermen, fish processors, input suppliers, labourers, transport agencies, traders, insurance agencies and marketing agencies including wholesalers/retailers, etc. Therefore, a large network and established chains exist in the country for production and distribution of dry fish. This value chain is also important for the nutritional security of people, particularly in the rural areas.

With this backdrop, this chapter analyses the value chain of dry fish, estimates cost and margins along the value chain and examines the flow of institutional credit to value chain actors. The study on value chain will facilitate more value addition, innovation, product development, marketing, etc. for dry fish in the region.

2 Selection of Value Chain Actors

The value chain of dry fish involves many actors and business operators like fishermen, fish processors, traders, wholesalers, commission agents, retailers, labourers and consumers. Hence, for sample selection, multistage stratified random sampling was applied. This study covered three states, viz. Assam, Manipur and Tripura in North-East (NE) region and two processing centres in the coastal states of West Bengal and Gujarat. From each of the selected states in NE region, four dry fish markets (two wholesale and two retail markets) were selected considering their relative size and location (urban/rural). A major proportion of dry fish traded in NE region is produced in the coastal states of West Bengal, Odisha, Andhra Pradesh, Tamil Nadu and Gujarat. Therefore, two processing centres, viz. Digha in West Bengal and Veraval in Gujarat, were selected. Further, some products like *Shidal* and smoked fish are locally processed and traded through the same channels, therefore one processing centre from each state in the region was also selected (Table 1).

The chain actors were stratified into processors, wholesalers, retailers, labourers and consumers. Finally, a representative sample from each of these categories of chain actors was drawn using simple random sampling without replacement. A total

Table 1 State-wise list of selected dry fish markets and processing centres

State	Wholesale markets	Retail markets	Processing centre
Assam	Jagiroad, Karimganj	Tinsukia, Silchar	Kusumpur
Manipur	Ima market, Thoubal	Nambol, Moirang	Thanga
Tripura	Golbajar, Teliamura	Udaipur, Kumarghat	Gandacharra
West Bengal	–	–	Digha
Gujarat	–	–	Veraval

Table 2 Sample size of stakeholders of dry fish value chain

Chain actor	Assam	Manipur	Tripura	Digha (West Bengal)	Veraval (Gujarat)	Total
Processor	5	20	43	44	24	136 (24.50)
Wholesaler	31	11	33	–	–	75 (13.51)
Retailer	22	48	53	–	–	123 (22.16)
Labour	19	11	56	16	54	156 (28.11)
Consumer	18	12	35	–	–	65 (11.71)
Total	95 (17.12)	102 (18.38)	220 (39.64)	60 (10.81)	78 (14.05)	555 (100)

Note Figures within the parentheses indicate percentage of total respondents

of 555 respondents, consisting 136 processors, 75 wholesalers, 123 retailers, 156 labourers and 62 consumers were selected (Table 2).

For data collection, focused group discussion (FGD) and personal interview methods were adopted and information was gathered from each category of respondents using five separate semi-structured survey schedules. The survey was conducted during July to November 2015. The value chain of dry fish has been mapped using functional analysis. The functional analysis provides a complete structure of the value chain defining its boundaries, identifying core activities and economic agents, inter-relationships and linkages between the economic agents, and depicting the flow of commodities and bottlenecks.

The economic analysis has been performed for measuring the costs and margins of business operations at different stages of value chain. The economic benefits and costs of individual chain actor were analysed using formulae (1)–(4):

$$\text{Total revenue of an actor} = \sum (Qi * Pi) \tag{1}$$

where, Qi is the total quantity of *i*th dry fish products sold, and P is the price of *i*th dry fish product.

$$\text{Total cost to a chain actor (Rs./t)} = \text{Fixed cost} + \text{Variable costs} \tag{2}$$

The net income of an actor was calculated by deducting total cost from total revenue, i.e.

$$\text{Net income(Rs./t)} = \text{total revenue} - \text{total cost} \tag{3}$$

$$\text{Net margin(Rs./kg)} = \text{Net income/Quantity sold} \tag{4}$$

For effective operation and sustainable growth of dry fish trade, financing is crucial in the whole marketing system. The simple tabular analysis and descriptive statistics have been performed to assess the pattern of credit use and credit need of different business operators.

3 Mapping of Dry Fish Value Chain Activities

The value chain of dry fish comprises a large network of distributional channels, and it connects the production and processing centres that are confined in the coastal belt (marine fishes) and northern states (fresh water fishes) to the consumption points distributed across the North-East Region of the country. Therefore, the nodes of dry fish value chain are widely scattered. The core processes and activities undertaken at different stages of value chain are represented through flow diagrams in Figs. 1 and 2.

The core processes and economic agents involved in dry fish value chain were identified. The core processes were procurement of raw fish by processors at the landing centre, fish processing, assembling and trading, wholesaling and retailing. These processes are described below.

3.1 Fish Processing

For value addition of fish, different methods such as drying, smoking and fermentation are used.

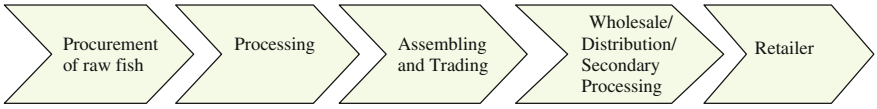

Fig. 1 Core process involved in dry fish value chain

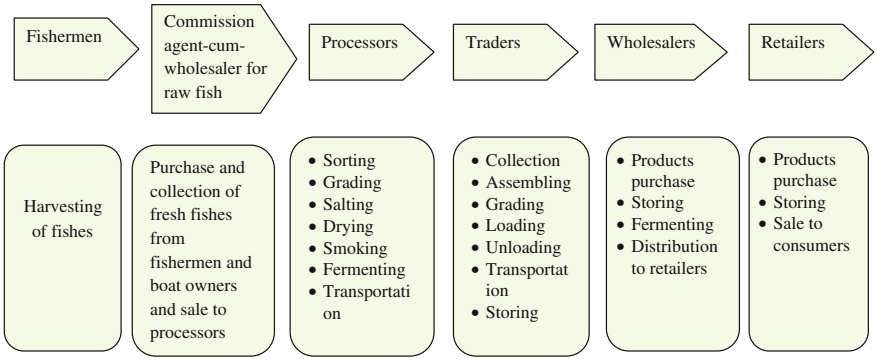

Fig. 2 Specific activities performed in the core process of dry fish value chain

Drying—The drying of fishes is an age-old practice that adds value in terms of increasing its storage life and avoids spoilage of fishes. It also reduces quantity as well as volume of fish which subsequently make the product handling easier and cost-effective. The bulk of landing of marine fishes constitutes medium- and low-value fish species which are utilized for drying.

Fermentation—It is one of the oldest and most economical curing methods for preserving food in the northeastern part of India (Tamang 1998). The fermented foods have benefits like enhanced flavour, better digestibility and higher nutritional and pharmacological values (Kakati and Goswami 2013). S*hidal* is a traditional value-added fish product prepared using indigenous fermentation technique. The processing of *Shidal* involves procurement of dry fish (*Puntius sp*), sorting, cleaning and keeping in a *matka* (earthen pot) with mustard oil for 6 months for fermentation with airtight packing. The preparation of S*hidal* is a skillful, time-consuming and labour-intensive process and mostly undertaken by the women in this region.

Smoking—Smoking of fish prolongs its shelf-life, enhances flavour, increases uses, reduces wastages and enhances protein availability to the people (Jallow 1995). A variety of smoked products of fish are popular in the tropical countries (Gopakumar 1997). Though there are several reports on smoke curing of fish in India and abroad, the smoking of fish in Manipur is unique in nature, wherein no salting is involved in the entire smoking process (Singh et al. 1990; Lilabati and Vishwanath 2001; Karthikeyan et al. 2012). In India, fish smoking is widely practised in Odisha, West Bengal, Assam, Arunachal Pradesh, Manipur, Madhya Pradesh and Andhra Pradesh. Smoked fishes are one of the popular and highly preferred products in Manipur. Several varieties of fishes are smoked by fishermen families or unemployed women. The smoked fish products are consumed after frying or roasting or as ingredients to other dishes to add taste and flavour.

3.2 Marketing of Dry Fish

Assembling and marketing are the most important processes in the dry fish value chain. The marketing involves a range of activities like supply of packaging material to the processors, procurement and storage of processed products, and transportation to distant markets. In some cases, traders finance the small-scale dry fish processors for procurement of raw fish, hiring of labour, transportation, etc. The traders are well informed about the demand and prices of dry fishes in different wholesale markets of distant places. They also provide links between processors and wholesalers and disseminate information on the required quantity and quality of processed products in different markets and about the prevailing prices for different types of processed fishes.

3.3 Distribution

The wholesaling and retailing are important activities of the dry fish value chain. At these stages of value chain, activities like transportation, sorting, grading, packaging, marking, storage, purchase and sale, etc. take place. In some cases in Tripura, the wholesalers of dry fish were found engaged in the secondary processing of dry fish for preparation of *matka Shidal*.

In addition to the above-mentioned core activities, there are a number of supporting service providers along with dry fish value chain; these include input suppliers, labourers, transporters, insurance companies, financial institutions, communication services, etc. The roles of these supporting chain actors are vital in smooth functioning of long value chain of dry fish.

4 Dry Fish Value Chain Map

A value chain map reflects inter-relationships and linkages among the chain actors. The dry fish value chain in North-East Region includes two sub-value chains, viz. outside fishes (sub-value chain-I) and local fishes produced within the region (sub-value chain-II) (Fig. 3). Both the chains begin with fishermen who catch fishes and bring them to the landing centres. In the case of sub-value chain-I, processors procure the fishes from fishermen through commission agents at the landing centres and transport them to the processing units. The outside fish value chain has two types of fishes: (i) marine fishes imported from maritime states, and (ii) inland fresh water fishes imported from landlocked states, particularly from northern region. The important states for supply of dry fishes to NE region are Gujarat, West Bengal, Andhra Pradesh, Tamil Nadu, Odisha, Uttar Pradesh and Bihar. In addition, some products like *matka Shidal* and *nona ilish* (salted hilsa) are also imported from the neighbouring countries Bangladesh and Myanmar. The local fresh water fishes are produced in small quantities in Northeastern states and most of the catch is consumed in fresh form. Only a small quantity of local fishes is processed (drying/smoking), but these products have high demand in the market because of high consumers' preference.

At the processing centre, fishes are cleaned, salted, washed and sun-dried. After processing, these fishes are packed and marketed. The traders collect the processed products from processors and transport them to their establishments located nearby the processing centre. Further, they do sorting, grading, packaging, storing, marking, etc. The traders possess big storage facilities, cemented platforms for performing different activities, some permanent and some daily-paid labourers, etc. They are specialized chain actors who have backward linkages with dry processors and forward linkages with the wholesalers of distant markets, transport agencies, insurance agencies, etc. They are responsible for the supply of dry fish produce to the wholesalers of distant markets based on demand and prevailing market price. It was revealed that traders sell the dry fish product to wholesalers of Jagiroad dry fish

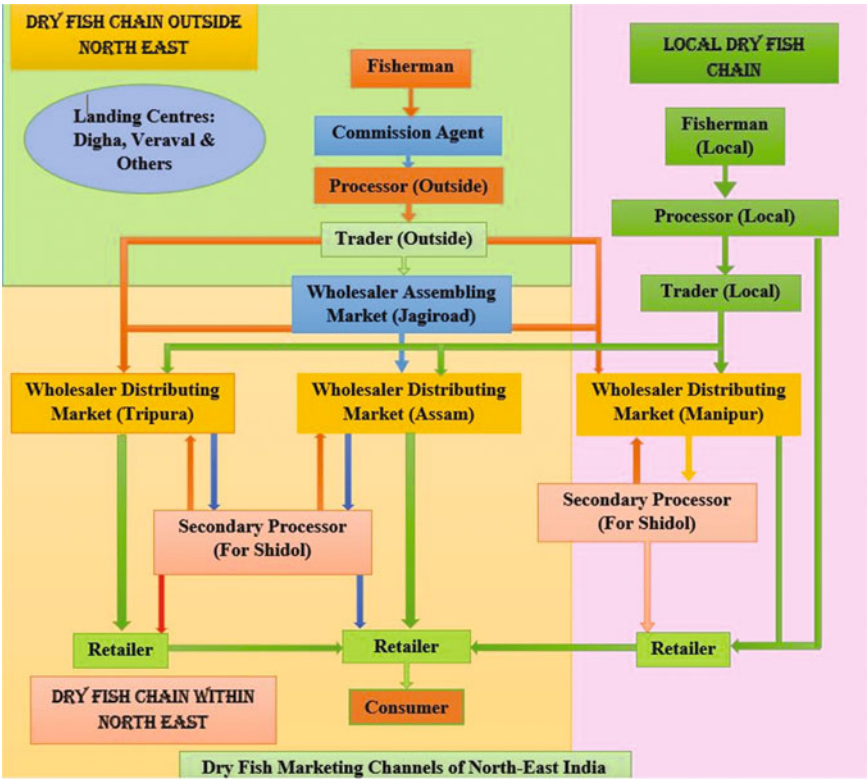

Fig. 3 The value chain map of dry fish showing relationship and linkages among different actors

market—Asia's biggest dry fish market located in Nagaon district in Assam. This market is a hub through which dry fish is supplied to wholesale markets of dry fish of all the North Eastern Hills (NEH) States. The wholesalers of different states purchase dry fishes from the Jagiroad market and sell to the retailers who cater to the need of dry fish consumers. In the sub-value chain-II, fishermen or small-scale processors process local fishes and sell them to traders, wholesalers or retailers. However, flow of a major portion of the locally produced dry fish and other processed fish products converse with wholesalers of the distributing markets of different states and moves with sub-value chain-I.

The number of marketing channels identified was five in both sub-value chain-I (Fig. 4) and sub-value chain-II (Fig. 5). In sub-value chain-I, marketing channel-I, comprising fishermen—auctioneer (commission agent)—processor—traders—wholesalers of assembling market (Jagiroad)—wholesalers of distributing market—retailers—consumers, was identified as the most dominant marketing chain and the highest proportion of dry fish produce was traded through this channel. In the case of sub-value chain-II, marketing channel-III, comprising fishermen-cum-processor—trader—wholesaler—retailer—consumer was found most dominant.

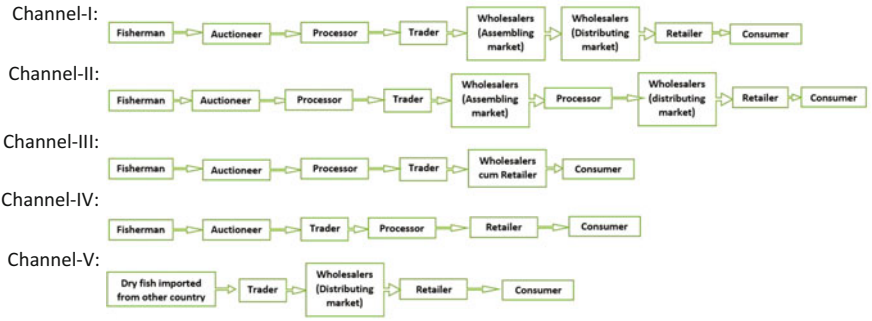

Fig. 4 Marketing channels in sub-value chain-I for fishes imported from outside the North-East Region

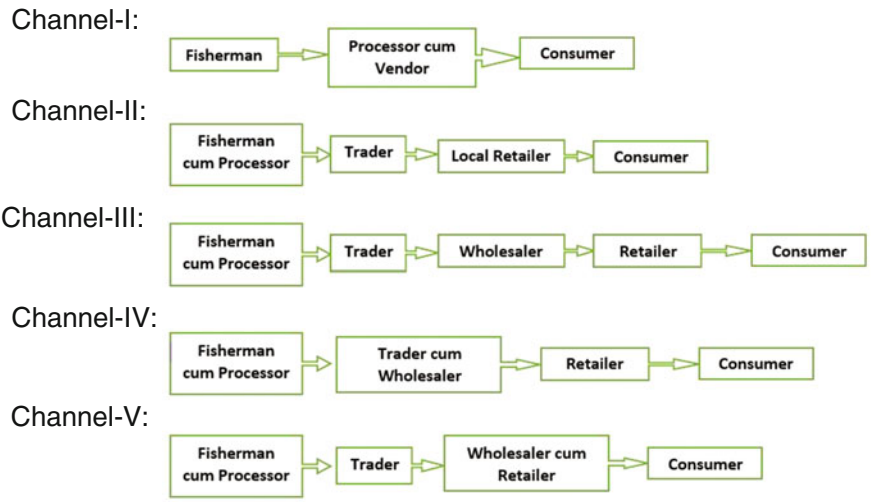

Fig. 5 Marketing channels in sub-value chain-II for local fishes in North-East Region

5 Infrastructural Facilities Along the Dry Fish Value Chains

In order to assess the status of infrastructural facilities, two processing centres in the coastal states of Gujarat and West Bengal were surveyed. It was observed that in the dry fish processing centres at Veraval, Gujarat, infrastructural facilities in terms of processing sheds, drying space, storage space, tanks for cleaning and other processing facilities, road network, transport facilities, banking services, etc. were better in comparison to those in the dry fish processing centres at Digha, West Bengal. It was also noticed that in Veraval, processing and drying of fish are

undertaken on a large scale and in a more professional way. In Digha, not only processing is done at a small scale, the infrastructure facilities, transportation facilities, road network, banking and credit facilities, etc. are also poor.

The infrastructural facilities at Asia's biggest dry fish market at Jagiroad, Assam were found poor in terms of parking space, storage facilities, auction space, etc. This wholesale market is operated by the private businessmen. The market infrastructure in some other wholesale and retail markets was also found poor. Some of the markets even operate in open space on streets without enough parking spaces, storage facilities, with poor hygiene and sanitation and poor financial services. On an average, about 7–10% of the total quantity of dry fish products traded deteriorate in quality and sometimes, turn into waste. In some of the dry fish markets, banking facilities are available but the financial services are not available as per the need of business concerns. The businessmen in the wholesale and retail dry fish markets require short-term to medium-term credit, on regular basis, with easy availability and minimum processing time.

6 Cost and Margins in Dry Fish Value Chain

6.1 Cost and Margins of Dry Fish Processors

Drying of fish is the core process and most important economic activity of dry fish value chain. The drying involves a series of activities like purchase of wet fishes, transportation, sorting, washing, cleaning, salting, drying, packaging, sale, etc. The processing includes both fixed cost and variable cost. The average cost of processing of dry fish was calculated as Rs. 84,179/t in Digha, and Rs. 84,034/t in Veraval (Table 3). The purchase of raw fish constituted about 88% of the total cost incurred by the dry fish processors. The transportation and other input costs constituted 3–4% of the total cost. The wages shared 5.3% and 6.0% in total cost in Digha and Veraval, respectively.

The net income of dry fish processors was estimated at Rs. 5,760/t in Digha and Rs. 29,009/t in Veraval. The higher returns in Veraval may be attributed to the scale of operation of dry fish processing and in being more commercialized as compared to the Digha centre. In Veraval centre, fishes are mostly salted before drying and moisture content is less, whereas in Digha centre, fishes are mostly dried without salting and moisture content is high. Hence, quality of dry fish products of Veraval was better which could provide higher prices to the processors. Further, due to the difference in the processing methods in two centres, the product quality in terms of salt-content, colour, appearance, species have all become traits for product differentiation, demand and ultimately price determination in the dry fish value chain.

Table 3 Cost and margin of processors of dry fish at Digha and Veraval centres

Particulars	Digha centre	%	Veraval centre	%
Purchase quantity of raw fish (kg/month)	99,463		90,735	
Average quantity of sale of dry fish (kg/month)	24,792		31,944	
Total revenue (Rs./tonne)	89,940		113,044	
A. Variable cost (Rs./t)				
Cost of raw fish	73,329	87	74,020	88
Transportation	2400	3	1600	2
Miscellaneous variable costs (salt, ice, rubber, medicines, etc.)	922	1	850	1
Total variable cost	76,651	91	76,470	91
B. Fixed cost (Rs./t)				
Bamboo plate form	1328	2	513	0.61
Machineries	57	0.07	692	1
Rent	530	1	346	0.41
Shed and other assets	487	1	529	1
Permanent labour	4463	5	5086	6
Miscellaneous fixed cost (Tank, bags, baskets, etc.) (Rs./t)	664	1	399	0.47
Total fixed cost (Rs./t)	7529	9	7565	9
Total cost (Rs./t)	84,180	100	84,035	100
Net income (Rs./t)	5760	6	29,009	26

6.2 *Cost and Margins of Processors in* Matka Shidal

The cost and margins of processors of *matka Shidal* of Tripura and Manipur were estimated and are presented in Table 4. Since *Shidal* is highly demanded in whole Northeastern states, it is produced on a commercial scale. The processors of *matka Shidal* purchase dry fish (*puntius species)* in bulk quantity. The economic analysis of *Shidal* processing revealed that the cost of processing was Rs. 213,647/t in Tripura and Rs. 285,129/t in Manipur. The higher production cost of *Shidal* in Manipur was due to the higher cost of raw material. The cost of raw material (dry fish) constituted the highest proportion of total cost in processing *Shidal,* 89.89% in Tripura and 92.72% in Manipur. The net returns over variables cost were Rs. 52,594/t in Tripura and Rs. 77,065/t in Manipur, which turned around 20% of total revenue generated from the sale of *matka Shidal* in both the states. It was also reported that *Shidal* is even traded from Tripura to Manipur and other states of North-East Region. The results show that *Shidal* processing is a highly profitable venture in North-East Region and it provides employment to the rural people, especially to women.

Table 4 Cost and margin of *matka Shidal* processors in Tripura and Manipur

Particulars	Cost and returns (Rs./t)			
	Tripura	%	Manipur	%
Average quantity of sale (kg/month)	3315		10,835	
Total revenue (Rs./tonne)	266,241		362,195	
Variable cost items				
Cost of dry fish	192,053	90	264,375	93
Earthen pot	5000	2	4001	1
Mustard oil	4500	2	4285	2
Loading–unloading and transportation cost	6070	3	11,329	3
Labour cost	6024	3	1140	1
Total variable cost	213,647	100	285,130	100
Net return	52,594	20	77,065	21

6.3 Cost and Margins of Processors of Smoked Fish

The smoking of fish is a traditional practice adopted in Manipur. This technology is used in many other parts of the world, particularly in the African countries where smoked fish is produced on a large scale and exported to the US, UK and European countries. The smoked fish is highly preferred in Manipur. The fishermen or small-scale processors process the local small size fresh water fish. It was noticed that smoking of fish is mostly done by the fisherwomen or women in the family. The community smoking by women was also recorded in some places in Manipur. It is a seasonal activity performed for about five months in a year, during winter and summer seasons. On an average, a fisherman family process 391 kg of wet fishes per month and final weight of smoked fishes is 157 kg (Table 5). The total cost of processing of smoked fish was worked out to be Rs. 157,265/t and the net return over variable cost was Rs. 38,469/t. Through fish smoking, a woman could earn Rs. 6024/month. Therefore, by smoking of fishes, women can earn sufficient income for the family.

6.4 Cost and Margins of Wholesalers

The cost and margins of wholesalers at all the selected markets of three states, Assam, Manipur and Tripura, were estimated and are presented in Table 6. On an average, a wholesaler undertakes monthly transaction of dry fish of 11,762 kg in Tripura, 9038 kg in Assam and 5159 kg in Manipur. The total revenue of the wholesalers was highest (Rs. 388,057/t) in Manipur, followed by Tripura (Rs. 232,577/t) and Assam (Rs. 137,799/t), while they incurred the total marketing costs as Rs. 360,999/t, Rs. 214,660/t, Rs. 116,056/t, respectively. It is observed from Table 6 that in the total marketing cost, about 95% was spent on the purchase of dry

Table 5 Cost and margin of smoked fish in Manipur

Variables	Cost/Return (Rs./t)	
	Manipur	%
Quantity of raw fish (kg/month)	391	
Quantity of smoked fish (kg/month)	157	
Variable cost of fish smoking (Rs./t)		
Cost of raw material	80,000	51
Firewood	33,898	22
Marketing cost (transportation/fare)	11,112	7
Imputed value of family labour	31,932	20
Chulha	323	0.21
Total cost (Rs./t)	157,265	10
Returns (Rs./t)		
Total revenue (Rs./t)	195,734	100
Net return over variable cost (Rs./t)	38,469	20
Monthly net returns (Rs.)	6024	

fish and the remaining 5% on transportation, loading/unloading, market fee, electricity charges, labourers, etc. On an average, a wholesaler earned Rs. 27,058/t in Manipur, Rs. 21,742/t in Assam and the lowest in Tripura (Rs. 17,918/t). The percentage margin of wholesalers varied between 6.97 and 15.78%. These results reveal that the wholesalers handle the bulk quantity of dry fish and they earn sufficient margins from the dry fish trade.

6.5 Cost and Margins of Retailers

The analysis of costs and margins of retailers in the states of Assam, Manipur and Tripura, revealed that a dry fish retailer sold on average 1738, 365 and 1242 kg of dry fish per month, respectively (Table 7). The small scale of retail business in dry fish in Manipur may be because of less consumers' preference for dry fish and also it was observed that in Manipur, retailers sell dry fish along with other grocery items.

The total marketing cost incurred by retailers varied from Rs. 173,718/t in Assam to Rs. 391,398/t in Manipur. This variation was mainly due to the difference in the purchase cost of dry fish from the previous actor which further depends on the type of fishes they deal with as per market demand and price variations in the dry fish species. The net margin of retailers varied from Rs. 24,853/t in Tripura to Rs. 34,458/t in Manipur. The percentage margin of retailers was about 16% in Assam and about 9% each in Manipur and Tripura.

Table 6 Cost and margin of wholesalers in dry fish value chain in Assam, Manipur and Tripura

Variables	Assam (Rs./t)	%	Manipur (Rs./t)	%	Tripura (Rs./t)	%
Average quantity of sale (kg/month)	9039		5159		11,762	
Total revenue	137,799		388,058		232,578	
Variable cost						
Value of purchased fish	111,131	95.76	340,543	94.33	203,091	94.61
Packaging cost	251	0.22	–		–	
Transportation	1543	1.33	18,736	5.19	6398	2.98
Loading–unloading cost	1835	1.58	169	0.05	1990	0.93
Storing	243	0.21	–		313	0.15
Misc/Others	250	0.22	–		730	0.34
Total variable cost	115,253	99.31	359,448	99.57	212,522	99.0
Fixed cost						
Market fee	87	0.08	1038	0.29	143	0.07
Electricity	99	0.09	249	0.07	178	0.08
Permanent labour	618	0.53	265	0.07	1817	0.85
Total fixed cost	804	0.69	1552	0.43	2138	1.00
Total cost	116,057	100	361,000	100	214,660	100
Net margin	21,742		27,058		17,918	
Percentage margin		15.78		6.97		7.70

Table 7 Cost and margin of retailers in dry fish value chain in Assam, Manipur and Tripura

Particulars	Assam		Manipur		Tripura	
	(Rs./t)	(%)	(Rs./t)	(%)	(Rs./t)	(%)
Average quantity of sale (kg/month)	1738		365		1242	
Total revenue	201,313		425,857		312,470	
Variable cost						
Value of purchased fish	165,838	95.46	371,326	94.87	252,295	87.72
Packaging cost		0.00		0.00		0.00
Transportation	4703	2.71	5364	1.37	4971	1.73
Loading/unloading	301	0.17	10,729	2.74	9942	3.46
Miscellaneous	603	0.35		0.00	522	0.18
Total Variable cost	171,445	98.69	38,741	98.98	267,730	93.09
Fixed cost						
Market fee	174	0.10	3168	0.81	287	0.10
Electricity	170	0.10	811	0.21	269	0.09
Permanent labour	1929	1.11			19,331	6.72
Total fixed cost	2273	1.31	3979	102	19,886	6.91
Total cost	173,718	100	391,398	100	287,617	100
Net margin	27,595		34,458		24,853	
Percentage margin		15.88		8.80		8.64

7 Value Chain Performance of Dry Fish

The value chain performance of dry fish was analysed and quantified by computing value addition at each stage in the value chain. In this method, the 'Value' refers to the value added to the product by activities at each step in the chain, as well as the value created by the product and activities and captured by each of the actors involved. The 'added' part means the difference between the total revenue created by the product and the costs of the materials, labour and other inputs used to produce it, which was captured by the actors along the chain. The pooled value of added cost and added return are presented in Table 8, and it is observed that on an average, a dry fish consumer paid Rs. 312/kg for the purchase of dry fish. The wholesalers of the distributing market received Rs. 205/kg, the wholesalers of assembling market (Jagiroad) received Rs. 150/kg, the traders of dry fish received Rs. 125/kg and dry fish processors received Rs. 108/kg. The chain actors received different amounts while dealing with dry fish, and the value in terms of money added over the cost varied at different levels and also at different locations. The added value was found to be more in the later stages of value chains rather than in the initial stages of the value chain. It is to be mentioned that about 39 species/dry fish products were dealt under the dry fish value chain which were further differentiated based on size and other quality parameters, and due to this a lot of variation was observed in the prices of products. Therefore, price differentiation and price discrimination cause variations in the margins of chain actors dealing with different fish products. It was also observed that price differentiation and price discrimination increased at successive stages of the value chain. It was also reflected that the benefits of value chain were not distributed according to their efforts.

8 Financing Dry Fish Value Chain

The value chain of dry fish is labour-intensive as well as resource-intensive and requires a regular flow of funds for the maintenance of processing units, purchase of fish, hiring of labourers, purchase of inputs, payment of transportation charges, etc. In this section, we have examined the sources of funds for different chain actors. It was found that 56–87% of retailers, 64–92% of wholesalers and 50–100% of processors engaged in dry fish processing and trading had savings accounts in commercial banks (Fig. 6). In Manipur, 100% of processors, 82% of wholesalers and 56% of retailers had bank saving accounts. In Tripura, the highest proportion of retailers (87%), followed by wholesalers (64%) and processors (50%) had bank accounts and in Assam 42% of wholesaler, 73% of retailers and 72% of processors had saving bank accounts. It was observed that about 25% value chain actors of dry fish in the region are still not linked with banking services. However, in spite of better linkage of banks and dry fish value chain actors, the credit availed by these actors was meagre. It was found that only 20% of processors and wholesalers had

Table 8 Distribution of consumer price and value addition (overall) at different levels of dry fish value chain

Particulars	Overall values (Rs./kg)				
Price received	108	125	151	206	312
Price paid	89	108	125	177	231
Cost incurred	8	15	7	9	13
Total cost	97	123	132	186	244
Value added	11	2	19	19	68

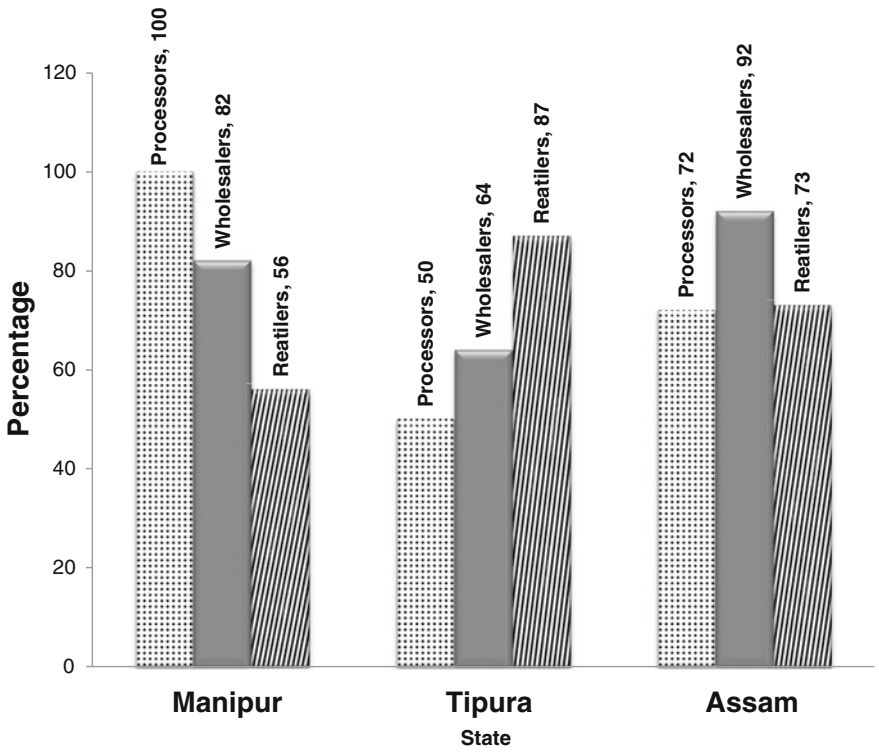

Fig. 6 Percentage of different value chain actors having savings bank account in North-East Region

availed credit in Assam and only 4% of the wholesalers in Manipur and 2.33% of processors 7.55% of the retailers in Tripura availed credit from different agencies (Fig. 7), whereas a large proportion of chain actors in North-East Region had indicated their credit requirements for the business (Fig. 8).

The analysis of sources of credit revealed that 53% had taken loans from nationalized banks, 20% from private banks, 13% from money lenders and 7% each from micro-financing agencies and SHGs (Fig. 9). It was also recorded that the amount of loan ranged from Rs. 0.5 to Rs. 5 lakh, and period of the loan was between 1 and 5 years and interest rate reported was 24–30% in case of money lenders and other non-institutional sources and 10–12% in case of nationalized banks. It indicated that financial support to dry fish value chain was weak and due to paucity of funds, the chain actors were highly dependent on credit transactions which reduced their bargaining power. Therefore, strengthening of financial services along the dry fish value chain may increase the marketing efficiencies and provide help in upgrading the value chain of dry fish.

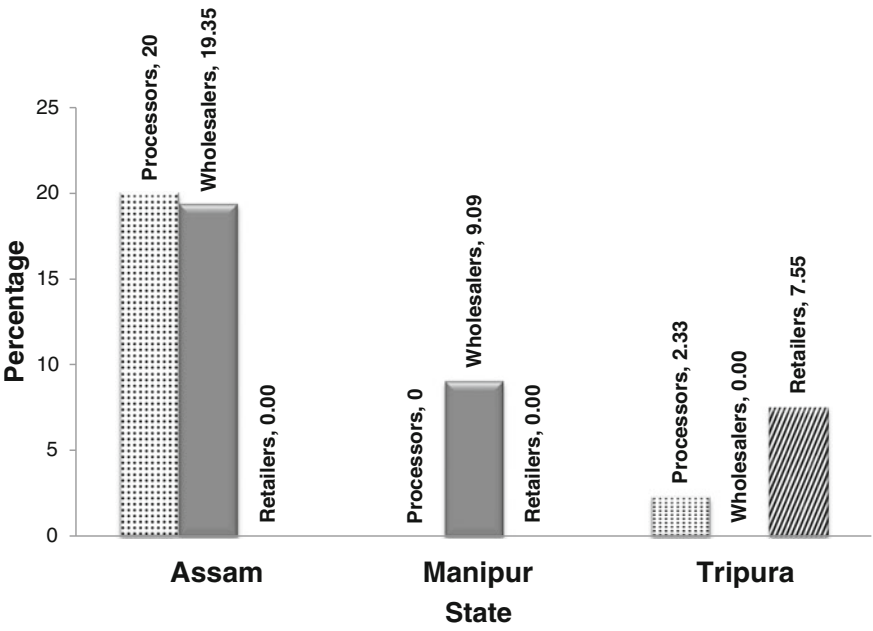

Fig. 7 Percentage of different categories of dry fish business operators who have taken loan in North-East region

9 Conclusions and Policy Implications

In North-East Region of India due to shortage of fresh fishes and habit of fish eating, the demand for dry fish is quite high. This demand is met through import of dry fish from other states. In this study, the value chain of dry fish has been analysed with emphasis on financial aspect of dry fish value chain. The study has found that the network of dry fish value chain in the country is distributed from the coastal states and other northern states to remote corners of whole North-East Region. It is a well-established value chain in which several core actors such dry fish processors, traders, wholesalers in assembling market and wholesalers (both in assembling and distributing markets) and retailers and a number of supporting actors including input suppliers, labourers, financial institutions, transport agencies, etc. function and provide support to the whole value chain. More than 39 fish species in dried form and several fermented and smoked fish products are traded through dry fish value chain which contributes to price variations. The core chain actors involved in dry fish value chain have been found earning sufficient margins. The value addition has been observed to be more in the later stages of value chains rather than in the initial stages of the value chain, whereas more efforts in terms of value addition and

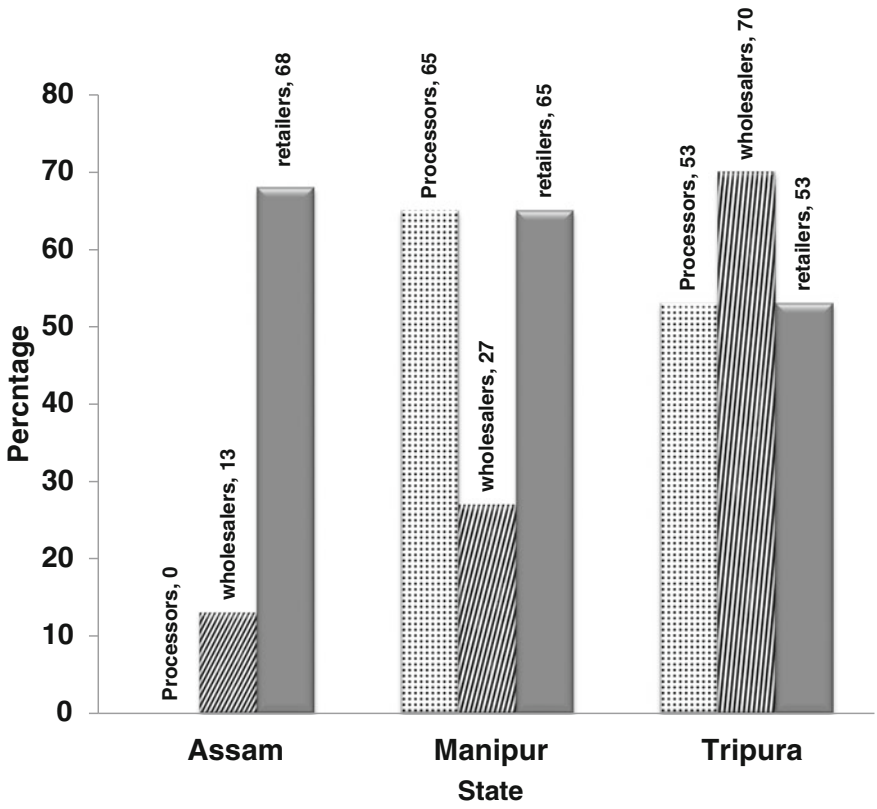

Fig. 8 Percentage of value chain operators feeling need of credit for the dry fish business in North-East Region

movement of the products are made by the actors involved in initial stages of the value chain. The poor financial services along the value chain lead to higher dependency of chain actors on credit transaction which increases inefficiencies in the value chain. Based on these findings, following measures are suggested for upgradation of the dry fish value chain:

- Micro-financing and banking services need to be strengthened at all stages of dry fish value chain.
- Technological and financial support for equipment like large solar driers would help the processors of Digha in managing housefly menace.
- Financial support for small-scale enterprises such as fermentation, smoking and other value-addition activities in North-East Region may help in enhancing income and employment opportunities, particularly for women.
- The mechanism for quality control and quality regulations for the dry fish and dry fish products should be evolved and implemented.

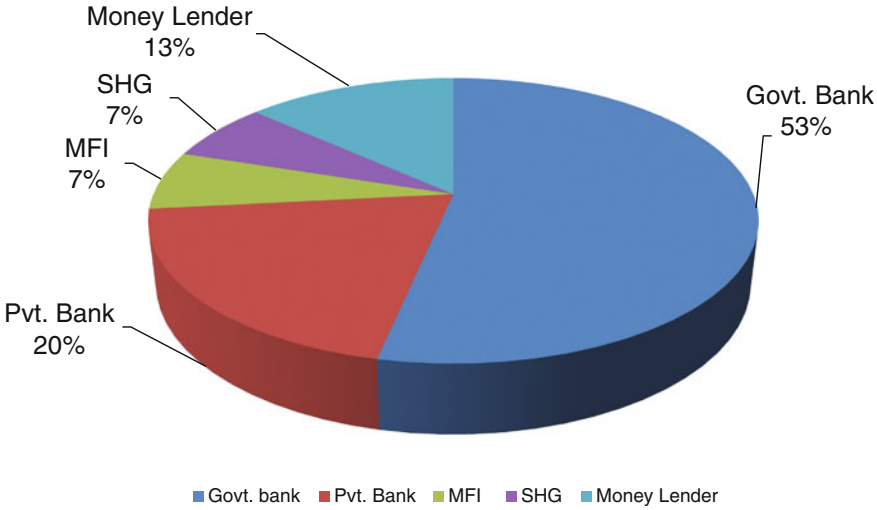

Fig. 9 Sources of credit for dry fish value chain actors of North-East Region

- The technology related to *Shidal* fish production needs to be modified, as per local needs.
- Infrastructural facilities, particularly storage facilities at market and processing sites, need to be strengthened.
- Market intelligence is needed for strengthening dry fish value chain which can help the dry fish processors.

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Broiler Value Chain Model for Empowerment of Poor Tribal Women: A Case Study in Jharkhand

M.V. Ashok

1 Introduction

Enhancing livelihood opportunities for marginalized sections of the society such as small farmers and rural women is one of the major challenges for policymakers and for those interested in agriculture and rural development in India. They lack access to capital for buying inputs, equipment and machinery necessary for farm productivity improvements. The financial institutions often hesitate in providing credit to them because of their poor creditworthiness or lack of collateral. The high cost of lending in relation to the size of the loan and poor access to the market are the other barriers in their efforts to improve farm productivity and household income. Often they are trapped in interlocked transactions where the traders advance them credit (in-kind or cash) against their commitment of sale of produce to them. Such interlocked transactions are often exploitative.

Feminization of agriculture is another problem in small holder-dominated rural economies. This is typical of some less-developed Indian states such as Jharkhand, from where men seasonally migrate to distant places in search of employment, leaving agricultural activities to the women. Note that agricultural activities are seasonal and the women have to support their families from the paltry remittances received from the menfolk.

In order to improve the economic conditions of the rural women, a national-level NGO, PRADAN (Professional Assistance for Development Action), came up with an idea of promoting broiler farming for such women households. A broiler crop is ready for harvest in about 35 days, and an entrepreneur can harvest 6–7 crops in a year, thus making a regular source of income. On the demand side, there is a growing demand for poultry meat and eggs among both rich and poor households.

M.V. Ashok (✉)
Department of Economic Analysis and Research, National Bank for Agriculture and Rural Development (NABARD), Mumbai, India
e-mail: mvashok2007@gmail.com

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Broiler farming is, thus, considered a financially and economically viable enterprise, and the financial institutions prefer financing such an activity. However, their preference has always been to finance bigger enterprises probably due to their consideration of scale economies in production and marketing. PRADAN organized women into SHGs or cooperatives so that they can benefit from the larger scale to avail production credit from the financial institutions and of an integrated value chain. PRADAN successfully incorporated these aspects in their aggregation model. In this chapter, we examine the process of development of broiler value chain by PRADAN, and its impact on the livelihood of rural women in Jharkhand.

2 Value Chain Model

In 2002, PRADAN in collaboration with poultry industry assessed the demand and supply situations of broiler meat in Jharkhand and found the demand far exceeding its supply. The daily sale of live birds was around 80 tonnes, as against daily production of 12 tonnes. The gap was being met through procurement from the neighbouring states of West Bengal, Odisha, Chhattisgarh and Madhya Pradesh.

Looking at the immense potential, PRADAN decided to take up broiler farming as a livelihood support to women from resource-poor families with low risk-taking capacity in Lohardaga district of Jharkhand state. It toyed with the idea of starting small-scale broiler units, each not exceeding 300 birds per cycle.

Further, in order to reap the benefits of scale, PRADAN made efforts to collectivize broiler women farmers, which resulted in the establishment of a District Poultry Producers' Cooperative at Lohardaga in November 2001. By 2005, each district of Jharkhand had a Poultry Cooperative Society.

Every woman farmer is a member the poultry cooperative society. The cooperative societies (with support from their Federation at the state level) procure inputs in bulk for their members and have been able to have linkages with hatcheries and feed mills. Medicines and vaccines are supplied in bulk by the Federation to the societies. Each cooperative society has a few trained veterinarians who work as production managers. They are supported by trained village-level paravets. Each farmer-member receives a one-week on-farm training under the guidance of expert veterinarians.

The state of Jharkhand being deficit in broilers, marketing is not a problem. The cooperative societies sell birds in the market. They also protect their members from market fluctuations.

These efforts were supported by the Department of Cooperation of the Government of Jharkhand by providing financial support to broiler farmers through their cooperatives. By 2012–13, this initiative expanded to cover 3969 poor rural women, producing 8409 tonnes of live birds (or 20 tonnes per day) and had a net profit of Rs. 558.7 lakh. Most importantly, the cooperatives could withstand the onslaught of bird flu without losing any of their producer-members even during the countrywide spread of bird flu disease in 2014–15.

The main factor behind the success of this initiative was the standardization of the model of smallholder poultry units befitting the resource endowments and financial requirements of the producers. The main features of the model are as follows:

- Decentralized production infrastructure to produce 300–500 birds per entrepreneur in the backyard,
- Ensuring production efficiency through rigorous training of producers and intensive production support,
- Economies of scale in procurement of inputs and sale of birds through cooperatives,
- Improved market interface to overcome volatility of market,
- Customized financial and MIS software for decentralized operations,
- Capacity building of women members and incentives for efficiency,
- Participatory assessment of business performance and internalization of best practices at the individual producer level.

A typical broiler farmer of a cooperative is a rural woman from disadvantaged communities, hitherto dependent on rainfed agriculture for wage earnings. Through systematic intervention by PRADAN at every stage, from back-end to front-end of the broiler value chain, the women have improved their skills, developed infrastructure, and meet inputs and marketing requirements of a successful home-based broiler unit. On an average, these rural women earn Rs. 15,000–20,000 a year or Rs. 75–100 a day as a regular cash flow that helps them to meet their daily expenditure or cash needs. This also helps them to strengthen their position in the family as well as society.

Individually, farmers find it costlier to purchase inputs like broiler feed, medicines and veterinary care. These problems have been addressed by PRADAN through the formation of poultry cooperatives.

Feed—Almost all cooperative societies in the state have a feed-mix plant. They procure maize, soybean and de-oiled cake in bulk from the market and 15% concentrate from the Federation to prepare the complete feed. For providing a mineral mixture, the Federation manages a feed mill at Barhi in Hazaribagh district and another is under construction at Peterwar.

Hatchery—The Federation has now one of the biggest hatcheries in eastern India. Earlier, it used to import hatchable eggs from Jabalpur, Hyderabad, Jalandhar and Bangalore for hatching. This was resulting not only in higher costs and spoilage in transportation, but the supply was also not sufficient to meet the growing demand from farmers. To overcome these problems, the cooperative society of Lohardaga district established a hatchery with a capacity to produce three lakh chicks per month. This has resulted in a saving of Rs. 2 per chick. One more such hatchery has been established by the Bokaro district cooperative with financial support from National Cooperative Development Corporation (NCDC).

Medicines and Equipment—Medicines and equipment are purchased in bulk by the cooperatives. Medicines are purchased from BGM Biologicals, managed by the National Smallholder Poultry Development Trust (NSPDT).

Capacity Building—To build the capacity of broiler farmers, the cooperative society engages qualified trainers/supervisors for every 30 farmers to train them in poultry management, and also to monitor management practices on a regular basis.

Price Management—Broiler prices are highly volatile on account of several factors such as seasonality in demand, sociocultural differences among people (e.g. high demand and therefore higher prices during Muslim festivals of Ramzan and Id, and low demand and prices during Hindu festivals of Navratri and Durga Pooja), potential threats of diseases like bird flu, etc. The cooperative societies insulate these small poultry farmers from price fluctuations using surpluses generated during peak season. The Federation also helps cooperatives to enter into supply contracts with big traders in the nearby towns, who make advance payment for the contracted quantity. The Federation plans to start its own retail chains under its own brand.

Production Risk Management—Many viral and bacterial diseases affect broiler farming. The chances of their spread are high in intensive production systems. The Poultry Cooperatives provide veterinary care through their qualified veterinarians and trained paravets. The village-level supervisors regularly monitor every farm.

These Cooperatives also tie up with some insurance companies to provide insurance for broilers against deadly diseases. The Federation also maintains a dedicated risk management fund, pooling collections from the societies, to help farmers to cope up with natural production shocks.

3 Financial and Institutional Support to Value Chain

3.1 Poultry Cooperative Federation

All the district poultry cooperative societies are now federated to form 'Jharkhand Womens' Poultry Self-Supporting Cooperative Federation Ltd'. The Department of Cooperation of Government of Jharkhand initially supported the Federation with a grant of Rs. 15 lakh to meet its administrative, overheads and infrastructural costs. The chairpersons of the poultry cooperative societies are members of the governing board of the Federation, whose main functions are as follows:

- Procure material inputs, particularly those that need to be sourced from outside the state, and supply these to member cooperatives.
- Manage the hatchery for supplying day-old chicks to members of the cooperative societies.
- Support member cooperatives in collective marketing of broilers.
- Coordinate member cooperatives to ensure higher efficiency standards.
- Set a system for management of accounts and periodic review of member cooperatives.

3.2 Central Government

The Ministry of Rural Development of the central government has financially supported the Federation through NCDC (National Cooperative Development Corporation).

3.3 State Government

The Government of Jharkhand through its Department of Cooperation has been supporting the activity through grants in the form of equity to the Federation and subsidy to broiler farmers.

3.4 National Bank for Agriculture and Rural Development (NABARD)

NABARD has supported broiler farming in Jharkhand in more than one way. Under the project on natural resource management, NABARD provided financial support for procurement of equipment, and working capital for one production cycle to 700 farmers in Dumka and 300 farmers in Godda districts. Besides, from its tribal development fund, NABARD has provided financial support to 280 tribal families in Dumka and 180 families in Godda districts.

3.5 Commercial Banks

Looking at the viability of broiler farming model, many commercial banks have started financing women entrepreneurs through a tripartite agreement involving the cooperative society that ensures repayment of the loan. The commercial banks also provide loans to cooperative societies for establishing feed mill and hatchery and for the transport vehicle.

4 Conclusions

The chapter has presented a case study of a unique cooperative institution promoted as a livelihood model exclusively for the poor tribal women of Jharkhand. The model has been conceived by a non-governmental organization, PRADAN (Professional Assistance for Development Action), to harness the benefits of scale

in the procurement of inputs and in the marketing of outputs through cooperatives of broiler women farmers. The poultry cooperatives provide day-old chicks, feed, medicines, vaccinations and training in farm management to the tribal women farmers. The cooperative society also organizes bulk sales of the birds and protects farmers from production and price risks. The study has indicated that these tribal women can earn up to Rs. 20,000/year by rearing a batch of 300–500 birds in a cycle.

The Federation, supported by backward and forward linkages, aims to establish a monopoly in the market for better price realization and better margins. The collective marketing which was restricted to wholesaling is taking a step further for branding and retailing and the product has been branded as '***Fresco Chicken***'. The Federation plans to enter into the retailing sector. This completely new phase for the Federation will provide larger benefits to the small producers in the state of Jharkhand.

The Jharkhand experience can be replicated in other states also. The marginalized disadvantaged women, who wish to adopt the enterprise, can organize themselves into a cooperative society, who would arrange loans from the bank or subsidies and grants from the government agencies for infrastructure development and working capital. The model is workable anywhere in India provided there is a strong NGO with technically qualified personnel for providing handholding and technical support. The model is a viable revenue model and is bankable.

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Strengthening Value Chain of Compound Cattle Feed

Smita Sirohi, B.S. Chandel, Bitan Mondal, Sammu Kumar, S. Chowdhury and D.K. Mahawar

1 Introduction

In India, animal feed production has considerable potential to emerge as an important agro-industry since the country, on the one hand, has huge population of livestock and poultry and, on the other hand, the shortage of feed and fodder has always been a serious constraint to increasing livestock productivity (Singh and Majumdar 1992; Jain et al. 1996; Angadi et al. 2005; GoI 2012). At the all-India level, the estimated deficits of dry fodder, green fodder and concentrates are 10, 33 and 35%, respectively, which is likely to increase to 11, 35 and 45% by 2020 (GoI 2012).

The structure of animal feed production is dualistic in nature. It is produced in both organized and unorganized sectors. The compound animal feed industry in the organized sector produces commercial feed for sale in the open market and for use in the vertically integrated enterprises, especially poultry. The production of unorganized sector includes traditional feed prepared by the farmers themselves and produced in the unregistered feed factories. Although the product of the unorganized sector suffers from many deficiencies and imbalances (Vaidya 1999; Pathak and Garg 1999) such as lack of essential vitamins, supplements, high roughage concentrate ratio, etc., it still accounts for nearly 80% of all feeds consumed in the country. As per the 2014 estimates, the production of prepared animal feed is 29.43 million tonnes in the country and it ranks fifth among 130 major feed-producing countries in the world. It produces only 3% of the world output of prepared animal feed, although it has 15% share in livestock population of the world (Alltech 2015).

S. Sirohi (✉) · B.S. Chandel · S. Kumar · S. Chowdhury · D.K. Mahawar
National Dairy Research Institute (NDRI), Karnal, Haryana 132001, India
e-mail: smitasirohi@yahoo.com

B. Mondal
Institute of Agriculture, Vishwa Bharti, Sriniketan 731236, West Bengal, India

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It is anticipated that with the growing demand for animal protein and dairy products, the demand for compound feed would increase to 35.4 million tonnes by 2019–2020 (Yadav 2014).

With this backdrop, this chapter presents value chain analysis of compound cattle feed industry in two types of dairy production environments, viz. ***Dynamic*** and ***Transient*** with the objective of identifying the main areas of intervention for strengthening the value chain in compound cattle feed. The midstream value chain analysis covers the evaluation of value addition and profitability of the manufacturing units, while the upstream analysis delineates the various value chain actors, such as suppliers of feed ingredients and other input providers, and looks into the margins involved at each level and the constraints faced by them. The downstream analysis examines the quality assurance aspects and efficacy of the compound cattle feed in enhancing production, and also attempts to capture the consumers' voice in the value chain.

2 Selection of Value Chain Actors

For the study, information was gathered through field surveys conducted in 2015 in two different dairy production environments, viz. dynamic and transient. The dynamic dairy production environment is characterized as commercially oriented, existing at well-endowed resource locations with high-yielding milch animals, and has good infrastructural facilities. The states of Punjab and Haryana were taken as sample states for this type of production environment. These states represent the buffalo-based production systems. The transient dairy production environment reflects the transitory environment from the low-input–low-output subsistence-based underdeveloped system towards the dynamic environment, and the productivity of animals is moderate in this environment. The states of West Bengal and Odisha were taken to represent this production environment. These states represent the cow-based production systems.

2.1 Selection of Feed Manufacturing Units

As per the Annual Survey of Industries (ASI), in 2012–2013, there were only 724 functional feed units in the country of which 46 were located in Punjab and Haryana and almost a similar number (47) was in West Bengal and Odisha. However, as the ASI coverage is limited to those industrial units (called factories), which are registered under the Factory Registration Act and fulfil the specified criteria, the number of units not covered by the ASI is likely to be much more, especially in the case of cattle feed manufacturing in Punjab and Haryana. No comprehensive list of the units is readily available. Even an organization like Compound Livestock Feed Manufacturers' Association (CLFMA) does not have a

list of all the firms. In the case of selected states, only 11 member firms are enlisted with CLFMA and all of them do not produce cattle feed.

In view of the limited information available from any official source, a list of more than 100 feed factories was prepared by collecting information from many sources like Internet or personal contacts with the feed factories. A sample of 20 feed factories was taken from each production environment, with the number of firms in each of the two states of a production environment depending upon the probability proportion to the number of enlisted firms. But, in the case of transient environment, seven firms had to be dropped from final analysis due to reasons like non-response, non-functional factory, no production of cattle feed and non-usable data. In this region, the feed firms were mostly involved in poultry and aqua feed production, and therefore these seven firms could not be replaced with other firms producing cattle feed. Hence, the final sample size was of 20 firms in the dynamic region and 13 firms in the transient region. But these 13 firms had 19 manufacturing units, as one firm had five manufacturing units in the state and another had three feed factories within the region.

2.2 Selection of Other Actors in Value Chain

In each production environment, primary information was also collected from various actors in the feed value chain. First, the value chain was identified in consultation with the feed manufacturing firms, and then two chain actors were selected from each link of the value chain to collect data on their role and contribution to the feed value chain. The sample size of the other actors in each region was as follows:

- Backward Chain: 6
  - Suppliers of major raw material (brokers and traders): 2.
  - Suppliers of other inputs (manufacturers): 2
  - Machinery and service providers: 2
- Forward Chain: 2
  - Wholesalers and retailers: 2

2.3 Selection of Dairy Farmers

The final player in the cattle feed value chain is the dairy farmer. For the primary survey of dairy farm households, a sample of two districts was selected from each state. From each district, one Tehsil/Community Development Block (CDB) and one village were selected. Complete enumeration of all the households in the village was done to ascertain the number of dairy farmers in the village, their land ownership pattern, herd size and usage of compound cattle feed. Thereafter, an equal

number of compound cattle feed users and nonusers were selected giving due representation to various herd-size and land-size categories. The final sample was 560 dairy farmers (after data cleaning): 80 each from Kurukshetra and Sirsa in Haryana, and Cuttack and Khurda in Odisha; and 60 each from Amritsar and S.A.S. Nagar in Punjab, and Burdwan and North 24 Parganas in West Bengal.

The data were collected from all the sample respondents using well-structured survey schedules through personal interview method.

3 Value Chain of Compound Cattle Feed

The sample feed manufacturing units were post-stratified into small and large firms on the basis of their production capacity. In the dynamic region, the small and large firms with average annual production capacity of less than 15,000 tonnes were termed as small and of greater than or equal to 15,000 tonnes as large. In the transient region, the smaller firms had capacity up to 35,000 tonnes per annum and larger sample firms had capacity of $\geq$35,000 tonnes per year. The sharp inter-regional differences in the classification of small and large firms based on the installed capacity were due to the fact that in the dynamic region most of the sample firms were producing only cattle feed, while in the transient region, the product mix comprised of poultry and aqua feed also, and hence, the installed capacity was higher.

The value chain map of cattle feed industry was almost similar in the two types of dairy production environments, though with a few exceptions (Fig. 1). There were six major stakeholders in the cattle feed value chain, viz. major feed input

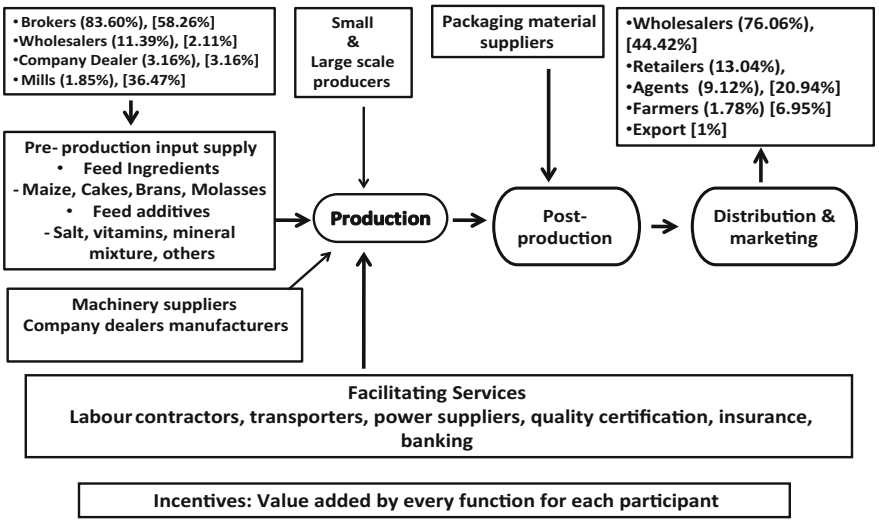

Fig. 1 General value chain of cattle feed industry in dynamic and transient production environments

suppliers, minor input suppliers, feed producers, marketers, service providers and dairy farmers. In the dynamic production environment, there were a large number of feed processing plants with small capacities (average production capacity was 20,760 tonnes/year), whereas in the transient production environment, there were a small number of feed processing plants, but their capacity was large (average production capacity was 32,000 tonnes/year). The cattle feed processing was the main manufacturing activity of the plants in the former system, while it was a secondary activity of the plants in the latter system that mainly carried out poultry and aqua feed processing. In the transient dairy production system, raw material supply was generally from outside the states through distant traders, whereas in the dynamic dairy production system, raw material was largely procured from within the state from wholesalers and brokers.

The important features of the value chain in the two types of dairy production environments are presented in Table 1.

4 Interaction of Actors and Stakeholders

This section identifies the activities and actors in the value chain, and assesses their relative importance in the chain.

4.1 Dynamic Dairy Production System

(i) **Brokers**—Brokers are the important intermediaries linking thousands of farmers and oilseed and grain millers to feed manufacturing units. They are the major suppliers of grains, oilseed cake and bran to the animal firms meeting 95–100% of their requirement.

(ii) **Wholesalers**—The wholesaler is a major agent in the supply of molasses, catering to 75.4% of the total requirement. Some supplements and feed additives are also supplied by the wholesalers. They are the minor suppliers of feed additive.

(iii) **Company/Manufacturers/Company Dealers**—Feed additives are procured either directly from the company or through their dealers. About 60% of the total requirement of feed additives is supplied by the company dealers. The packing materials, such as polythene bags, are supplied mainly by the local manufacturers/company (94.2%), after labelling as per demand of the firms.

The machinery for production of compound cattle feed which includes mixer, grinder, pelletizer, hopper, bag filler, conveyor belts, etc. is fairly simple and available locally. It is generally supplied by the manufacturers directly to the feed firms. Most of the plants have semi-automatic machinery, except for some large

Table 1 Characteristics of feed value chain in dynamic and transient dairy production system

Dynamic dairy production system	Transient dairy production system
(a) Major raw material and feed ingredients supply	
• Feed ingredients include maize, rice bran, oilcake, molasses and feed additives • Major actor in procurement of raw material is broker • Maize is procured from Uttar Pradesh, Bihar and Himachal Pradesh, and soybean from Madhya Pradesh and Maharashtra • Locally procured raw materials include rice bran, mustard oilcake and molasses • Salt, mineral mixture, vitamins and feed additives are procured directly from the company	• Maize, rice bran, oilcake, sugar molasses, feed additives and fish meal are important feed ingredients • Procurement is mainly through raw material traders • Feed ingredients are sourced from Andhra Pradesh, Madhya Pradesh, Bihar and Uttar Pradesh • Locally procured feed ingredients include rice bran, sugarcane molasses, etc. • Vitamins, salts, feed additives, etc. are purchased through local company dealers
(b) Feed production	
• Average annual production capacity of small producers is 6900 tonnes and of large producers is 34700 tonnes • Manufacturing units utilize 80% of the installed capacity • Predominance of pellet feed in the product mix. Small firms produce 55% feed in pellet form. Large firms produce even higher quantity (62%) of product as pellets and rest in the form of mash • There are very small plants which prepare customized feed for the big farmers • Average ex-factory sale price of pellet was Rs. 1310/quintal and of mash feed was Rs. 1350/quintal • Average number of employees per mill is approximately 6 in small production units and 13 in larger ones	• Average annual production capacity of small producers is 17100 and of large producers is 47000 tonnes • Only about half of the installed capacity is utilized by the manufacturing units • Mainly mash feed is produced in the area, especially by small firms. The product mix of these firms contains 4% pellet and 96% mash. Large firms have 66% of mash fed in their product mix • Firms do not provide option of customized feed preparation to the farmers • Average sale price of pellet feed was higher (Rs. 2080–2100/quintal) than of mash feed (Rs. 1780–1870/quintal) • Average number of employees per mill is 67 in small and 144 in large production units
(c) Animal feed distribution and marketing	
• About 76% of feed is sold through the output supply channel of wholesaler–retailer–dairy farmer • Second channel, retailers–dairy farmers, has 13% of share in total feed marketed • About 9% of the feed is sold through exclusive agents to dairy farmers • About 2% of sale by the manufacturing units is made directly to the farmers or dairy farms • A small proportion of the finished product is kept as stock. The stock holding is only 1.28% of production in small firms and 4.36% in large firms	• About 45% of feed is sold through wholesaler to retailer to dairy farmer channel • Manufacturing units do not make direct supply to the retailers • Exclusive agents have a sizeable presence; 21% of feed is sold to dairy farmer through exclusive agents • About 7% of feed is sold directly to dairy farmers from factory gate by the feed-producing firms and another 25% to government farms • About 1% of feed is exported to the neighbouring countries. Inventory of finished product is negligible

firms that have fully automatic plants. The local fabricators of machinery have begun to feel the heat of Chinese machinery and spare parts imported into the country. The imports of machinery for preparing animal feeding stuffs (HS 84361000) have gone up from US$ 2.52 million in 2009–2010 to an average of US $ 13.06 million per annum during 2012–2013 to 2014–2015, with the leading supplier (>60%) being China.

(iv) **Commercial Banks**—The dependence of firms on an external source of finance is low. The feed firms largely use their own funds in the establishment and management of firms, and avail credit only in small amounts from commercial banks. In small-scale firms, about 25% of funds come from the institutional sources like banks and remaining 75% are their own funds. In the case of large firms, one-third are the funds borrowed from banks and two-thirds are own funds. The funds are generally borrowed from the public sector banks. For keeping bank account of the business, the firms prefer private sector banks for their add-on services and flexibility in services.

(v) **Labour Contractors**—Nearly three-fourths (72%) of the manpower employed in the manufacturing units is of unskilled workers who are engaged in the production process and loading/unloading of raw materials as well as finished products. This labour supplied by the labour contractor is usually drawn from the migrants of other states of India like Uttar Pradesh, Bihar, etc. and not from study area of Punjab and Haryana. The skilled employees include administrative personnel and marketing agents, and are hired directly by the firm.

(vi) **Insurance Agencies**—Insurance is done for machinery, raw materials and labourers. The insurance covers theft, burglary, fire, death, etc. Insurance is done with registered insurance companies through their agents. Insurance charges are paid annually in most of the cases.

(vii) **Quality Control Labs**—The input and product quality control is very weak. Small firms do not have any in-house testing facility. They depend on private labs for testing the quality of raw materials as well as of the final product. The firms occasionally send feed samples to quality certification labs for testing. The quality analysis charges range from Rs. 400 to Rs. 600/sample. The charges also depend on the number and types of nutrients analysis. Some larger firms have their own quality control labs, while others avail the services of private labs by regularly sending two to four samples in a week for testing.

(viii) **Retailer**—The retailer is a major actor in the downstream value chain linking dairy farmers with feed manufacturing units through the product sale. The retailers also cater to the requirements of other farm inputs, such as fertilizers, pesticides, etc., and hence have good linkages with the farmers. This offers them immense opportunities to further expand their sales. A large volume of sales is, however, on credit basis, and hence the circulation of working capital of retailers is a slow process.

4.2 Transient Dairy Production System

(i) **Local Traders**—The local traders supply procured raw materials from distant traders to the feed firms in the region. The feed firms source their requirements—100% maize, 30% rice bran, 85% oilseed cake and 88% molasses—from the local traders.

(ii) **Processing Mills**—The second major actor in the supply of raw materials is the processing mills which supply 36.5% of the total raw material. The large feed manufacturing firms undertake annual purchase agreements with the rice mills for procuring their annual requirement of rice bran.

(iii) **Company/Manufacturers/Company Dealers**—About 60% of the feed additives are sourced from the company dealers. Vitamins, mineral mixture and buffers used in animal feeds are produced by the manufacturing companies located at various places in the country like Mumbai, Chennai, Kolkata, Indore, etc., and feed manufacturing units buy these materials from the local company dealers.

The raw materials and finished products are increasingly being packed in plastic bags instead of jute bags, even in the largest jute-producing state of India, viz. West Bengal, as in terms of price and durability, plastic bags are better than jute bags for the cattle feed. Customized polyethylene bags are supplied mainly by the local manufacturers/companies.

(iv) **Commercial Banks**—The debt–equity ratio is 1:2.2 for small firms and 1:1.9 for large firms, public sector commercial banks being the main source of external finance. The role of local money lenders is negligible, which shows that institutional sources of credit have gained importance in the business even in the relatively less-developed parts of the country.

(v) **Labour Contractors**—The unskilled labour migrants from other states like Bihar, Jharkhand, etc. comprise 93–94% of the manpower employed in the feed factories. Most of this workforce is predominantly male and is engaged through the local contractor.

(vi) **Insurance Agencies**—Almost all large firms opt for insurance, but only 71.43% of small firms have insurance cover for machinery, raw materials, labourers, etc. The private insurance companies have virtually no role in covering the risks faced by the feed manufacturing units.

(vii) **Quality Control Labs**—For quality feed preparation, less than half (46.15%) of surveyed firms follow the specifications laid down by the Bureau of Indians Standards (BIS). The feed firms depend on the private quality labs for testing of raw materials and finished products. The testing charges range between Rs. 500 and Rs. 650, depending on the type of analysis required.

(viii) **Government Farms**—In this system, the livestock farms managed by the government totally depend on these feed firms for the procurement of feed. Of the total feed produced, 25% is procured directly by the government farm mainly from the large-scale producers/firms.

The other major players in the chain are wholesalers and retailers, marketing 46% of the produce. The firms do not supply prepared cattle feed directly to the retailers. Also, direct sale to the farmers is negligible.

5 Production Costs and Margins

The major cost in the production of feed is the raw material expenses. In the dynamic region, feed ingredients account for 93–94% of the total cost and another 2% is accounted by the feed additives (Table 2). The large firms could reap economies of scale in the purchase of raw materials and hence, their unit cost has been found lower (Rs. 9699/tonne) for feed ingredients than the corresponding cost (Rs. 10,142/tonne)

Table 2 Cost of production and profit margin in cattle feed production in dynamic and transient regions

S. No.	Particulars	Dynamic		(Rs./tonne) Transient	
		Small (<15,000 tonnes/year)	Large ($\geq$ 15,000 tonnes/year)	Small (<35,000 tonnes/year)	Large ($\geq$ 35,000 tonnes/year)
1	Feed ingredients	10142 (92.62)	9699 (94.28)	12572 (89.89)	12974 (87.66)
2	Premixes and additives	223 (2.04)	219 (2.13)	457 (3.27)	842 (5.69)
3	Electricity and fuel	167 (1.52)	88 (0.85)	227 (1.62)	201 (1.36)
4	Packaging material	205 (1.87)	120 (1.16)	238 (1.76)	237 (1.60)
5	Salaries and wages	102 (0.93)	54 (0.52)	236 (1.69)	244 (1.65)
6	Overheads	22 (0.20)	13 (0.13)	173 (1.24)	181 (1.22)
7	Depreciation	90 (0.82)	95 (0.93)	83 (0.59)	121 (0.82)
8	Total cost	10951 (100)	10287 (100)	13986 (100)	14800 (100)
9	Average annual operating expenses (in crore Rs.)	6.01	28.89	12.80	35.27
10	Average annual sales (in crore Rs.)	7.32	36.26	16.33	45.24
11	Average value of inventory (in crore Rs.)	0.09	1.65	0.08	1.16
12	Total value of output (in crore Rs.)	7.41	37.91	16.41	46.40
13	Profit before tax (10–9) Average annual profits (in crore Rs.) Average profit per unit (Rs./tonne) Profit margin (%)	1.31 2383 17.9	7.37 2624 20.3	3.53 3855 21.61	9.97 4186 22.05

Note Figures in parentheses indicate percentage of total cost

for small firms. This cost advantage due to the larger scale of operation is also discernible in all other components of variable cost. The difference between unit cost of small and large firms has been found particularly sharp for wages and salaries and packaging material. However, in the case of fixed expenses (depreciation), as the capital outlay of the large firms is much higher, the depreciation charges are slightly higher (Rs. 95/tonne) than for the smaller firms (Rs. 90/tonne).

The relative share of various components in the total cost is observed to be more or less similar in both the regions; however, the cost of production of compound cattle feed is higher in the transient region by about Rs. 3–4 per kg in comparison with the dynamic region, mainly due to higher cost of raw materials procured from other states.

The value addition has been found to range from Rs. 2550 to Rs. 3200/tonne of compound cattle feed in the dynamic system. The profit margin realized by the sample firms is 18–20% in the dynamic region. In the transient region, despite a higher cost of production, the profit margins are higher (about 22%) due to higher sale prices and less competition in cattle feed production. The value addition is also higher in transient region than dynamic region.

In the backward chain, the percentage of margin ranges from 7.5 to 9.5% in the dynamic system, which is higher than the corresponding range of 2.5–6.5% in the transient system. Along the forward chain, the wholesalers are the most important players in the dynamic region, transacting about 1500 tonne of cattle feed and reaping a margin of 10.71% on the purchase price. In the transient region, wholesalers' margin is found much lower (5.0%) as direct supply of feed to the dairy cooperatives is prevalent, especially in Odisha where OMFED is an important player in the cattle feed market.

6 End-use Analysis: Adoption and Efficacy of Compound Cattle Feed

Dairy farmer is the most important stakeholder in the cattle feed value chain. The adoption of compound cattle feed has been more in the transient region than in dynamic region (Fig. 2), where green fodder is a good source of nutrition for the animals. Also, the use of traditional feed prepared by the farmers was more prevalent due to ready access to oil cakes, brans and broken wheat grains. In the dynamic region, the adoption rate of compound cattle feed increases with herd size as well as land size. In the state of Punjab from the dynamic region, 92% of those farmers keeping more than 10 milch animals use prepared cattle feed in animal ration.

The compound cattle feed is expected to provide a balanced source of nutrition to the animals and hence should have a substantial effect in enhancing productivity. However, in the dynamic system, the estimated milk productivity differentials between adopters and non-adopters of compound cattle feed are quite small in the case of buffaloes (6.39%) and moderately higher for the crossbreds (16.63%). The productivity differential for crossbred has been found higher (62%) in the transient

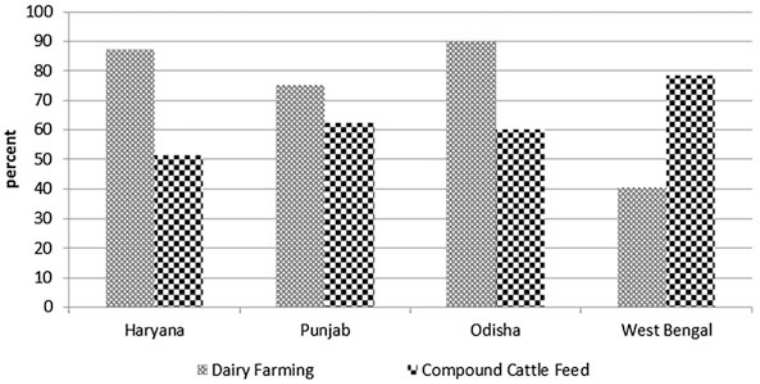

Fig. 2 Rural households in dairy and adoption of compound cattle feed by dairy farmers in selected four states

system (Table 3). The low differentials in yield among the animals fed and not fed on compound cattle feed could possibly be attributed to two important factors: one, inadequate quantity of compound cattle feed fed to dairy animals and two, limited nutritional potential of the prepared cattle feeds available in the market.

The profitability of milk production plays an important role in farmers' decision on input use. As feed inputs account for 60–70% of the cost of milk production, milk–feed ratio (in monetary terms) is a fairly good indicator of the economics of milk production. The average milk–feed ratio of the two groups brings to light a vicious circle of low profitability and low input operating in dairy farming, especially in buffalo milk production. The milk–feed ratio of buffaloes fed on compound

Table 3 Feeding pattern of lactating animals in dynamic and transient regions

Particulars	Dynamic region				Transient region	
	Buffalo		Crossbred cows		Crossbred cows	
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2
Average milk productivity (l/day)	4.97	4.65	6.83	5.86	9.78	6.04
Average quantity of dry fodder (kg/day)	7.29	8.31	5.99	6.36	8.76	7.67
Average quantity of green fodder (kg/day)	21.05	22.48	18.66	18.28	3.27	2.36
Average quantity of compound cattle feed (kg/day)	2.50	0.00	2.37	0.00	3.21	–
Average quantity of home-prepared concentrate (kg/day)	0.86	1.15	0.63	1.36	2.73	3.05
Roughage: Concentrate	76:24	91:9	75:25	87:13	61:39	73:27

Note Group 1: Animals fed with compound cattle feed
Group 2: Not fed with compound cattle feed

cattle feed was 1.37 (Group 1) as against a higher ratio of 1.78 (Group 2) for those not fed on compound cattle feed. The corresponding ratios were 1.85 and 2.30, respectively, in case of crossbreds in the dynamic system. This indicates that the productivity of group 1 animals may be little higher, but their gross returns from milk output over feed cost are lower than group 2 animals. The farmers are hesitant to increase the quantity of compound cattle feed in the diet of animals as the marginal returns from increased quantity of milk production due to compound cattle feed do not meet the marginal cost of its increased use. It is particularly true in the case of dominant dairy animal in the region, viz. buffaloes.

In the transient region also, it emerged that the milk–feed ratio is better for the group 2 animals (2.47) than the group 1 (1.73) animals, indicating that despite its technical superiority, the use of compound cattle feed was not improving the profitability of milk production at the existing level of feed and milk prices. The average costs of compound cattle feed and homemade concentrates in the region were Rs. 22/kg and Rs. 18/kg, respectively, and the milk price was only marginally higher at Rs. 24/l. So for every additional kilogramme of compound cattle feed, the milk yield does not increase by the same quantum, and hence, the economic benefits to farmers remain limited.

There is a lack of awareness among farmers about the balanced feeding of dairy animals so as to realize the maximum production potential at the least feed cost. The roughage–concentrate ratio is high compared to the standards of balanced feeding, the adoption of mineral mixture supplementation is low, and once the animal dries off, the feeding of concentrate is tapered. In fact, in the dynamic region, out of 147 dry buffaloes and 43 dry crossbred cows, in about 50% animals, no concentrate of any type was being fed, especially when the dry animal is not pregnant. In the transient region also, the situation is more or less similar with concentrate feeding largely limited to pregnant animals after they stopped lactating.

The farmers in the dynamic region resort to frequent switching-over of compound cattle feed of one firm to another, partly due to the lack of confidence in the reliability of any one brand, and partly due to their quest to try different products. About one-third of the adopters of cattle feed in the dynamic region felt that the quality of available feeds was not reliable as they did not see any perceptible benefits of feeding the same to the animals. A large proportion of non-adopters of compound cattle feed (59%) also cited this as the main reason for not adopting cattle feed preparations, and another 40% considered it expensive to adopt.

In the transient region as the options available in the prepared cattle feed segment are few, ‘brand switching’ is not common. Although a lower proportion of compound cattle feed users (20%) in the transient region compared to the dynamic region were reportedly not satisfied with the quality, interestingly, a sizeable number of users (35%) were not willing to buy compound cattle feed without the price subsidy. The two major reasons for non-adoption of compound cattle feed by the farmers were same as in the dynamic region, viz. no perceptible benefits (mentioned by 68% non-adopters) and cost considerations (54% farmers).

7 Strengthening Value Chain: Desired Interventions

The major strength of the midstream, upstream and downstream actors stems from the buoyant demand of compound cattle feed in the country; the major weaknesses/constraints of feed manufacturing units include (i) the sharp fluctuations in the prices of feed ingredients and (ii) limited storage capacity available with the firms, especially the small firms. The limitations of service providers in the value chain are erratic power supply due to old supply lines of electricity and frequent load shedding, unskilled workforce, lack of quality testing facilities and control measures, and inadequate financial services by the banks (especially, public sector banks) for quick and hassle-free working capital provisioning. The major weakness of the final stakeholder—dairy farmer—is the lack of awareness about balanced feeding of dairy animals to realize the maximum production potential at the least feed cost.

For strengthening the cattle feed value chain in the country, the key interventions are desired in four major areas: quality assurance and feed safety, maintaining profitability, capacity and skill development, and value chain financing. The important aspects where interventions are required include the following:

- Establishment of a tracking and tracing system along the feed supply chain, with provision for tough BIS standards for animal feed to ensure feed quality and safety.
- Extending the coverage of agricultural commodities within the ambit of hedging tools and providing support to the players of all sizes and scales in the feed ingredients supply to benefit from hedging primer. Presently, only feed ingredients, maize and cottonseed cake, are covered under the commodity exchange and the advantage of commodity derivatives is being taken by the corporate giants in the animal feed industry.
- Revisiting the export policy on maize, oilseeds/cakes and molasses from time to time, and rationalizing the taxes, duties and levies imposed on various feed ingredients and additives for ensuring regular supply of raw materials and supplements at reasonable prices.
- Strengthening the R&D component of cattle feed, especially through the application of biotechnology in feed compounding and the use of non-conventional feed resources in manufactured feed.
- Periodically revising milk procurement price in the cooperative sector in accordance with the changes in cost of feeding.
- Diversifying the product mix of manufacturing units for catering to the nutritional requirement of animals of different productive potentials using market segmentation and targeting techniques.
- Developing the compound cattle feed value chain as a part and parcel of the overall milk value chain to take advantage of the synergistic complementarity between milk output and feed input. Financial institutions have to support organizations like Milk Producer Companies, Farmer Producer Organisations, Dairy Cooperatives, etc. in this through value chain financing.

- Linking smallholders to feed value chain through capacity building interventions. Systematic and planned interventions are required for generating awareness among the producers and farmers about sound animal nutrition practices, quality and safety.
- Developing skill of producers, better quality control services, risk coverage mechanism and finance to strengthen service needs of the feed value chain.

8 Conclusions

There is a direct relationship between adoption of compound cattle feed and herd size or even landholding size. Either most of the animals with smallholders are less productive or farmers lack resources and knowledge to feed a balanced ration to high-productive animal. This results in a sharp reduction in productivity and animals suffer from various reproductive problems. Thus, most of the small farmers operate at low-input–low-output production, fetching 1–2 l of milk to the market/cooperative societies. Bearing the above situation in mind, the interventions encompassing three aspects have been recommended to bring smallholder dairy farmers to an advantageous position in the animal feed value chain: (i) enhancing knowledge and skill of smallholders about balanced ration; (ii) integrating feed value chain with milk value chain and (iii) maintaining profitability of smallholder dairy producers. Further, the demand for cattle feed at smallholders' level can be enhanced by addressal of financial constraints through credit and risk constraints by developing better livestock insurance products.

It is important to note that financing is just one of the several constraints that impinge on the performance of a value chain. The financing constraints have to be situated in relation to other constraints. There are a number of issues like weak quality control, inadequate infrastructure, need for new technological innovations, asymmetric information, etc., where policy advocacy is required for upgrading, scaling and strengthening of the compound cattle feed value chain in India.

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Potato Value Chain Analysis in Selected States: Tamil Nadu, Uttar Pradesh and Bihar

R. Venkatram, N. Ajjan, S.D. Sivakumar, H.P. Singh and S.P. Singh

1 Introduction

Potato is grown throughout the world and among various countries, the contribution of China is highest (24%) to the world potato production, followed by India (12%). In India, potato is the fourth most important food and cash crop, which is cultivated in a wide range of climatic conditions (Pandit and Chandran 2011). The annual potato production in India is about 44.31 million tonnes (GoI 2014). Uttar Pradesh has about 29% of the total potato area in the country, followed by West Bengal (21%) and Bihar (16%) which together contribute about 72% of the total potato production in the country. In Tamil Nadu, potato is cultivated mainly in the hilly areas (5900 ha) with an annual production of 1.22 lakh tonnes.

The potato production and the marketing pass through a set of activities involving various stakeholders. Further, supportive mechanisms like supply of agricultural inputs for production and post-harvest infrastructural facilities are also involved. Nevertheless, weak institutional arrangements, limited marketing facilities and lack of coordination among various institutions act as hindrance to the growth of potato sector in the country. The potato value chain thus aims at providing consumers with good quality and fresh produce, incorporating consumer orientation in downstream activities, finding possibility of higher efficiency through interlinked process among stakeholders, creating new value addition opportunities and achieving sustainability. Besides, upstream and downstream processes flowing

R. Venkatram (✉) · N. Ajjan · S.D. Sivakumar
Tamil Nadu Agricultural University, Coimbatore 641003, Tamil Nadu, India
e-mail: dr.venkatrengan@rediffmail.com

H.P. Singh
Banaras Hindu University, Varanasi 221005, Uttar Pradesh, India

S.P. Singh
Dr. Rajendra Prasad Central Agricultural University, Pusa 848125, Bihar, India

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along the value chain could be understood and thus enable the actors or stakeholders to develop new business models or innovate the current value system.

This chapter presents a research study conducted across three states, viz. Tamil Nadu, Uttar Pradesh and Bihar, with the following specific objectives:

- to examine the current practices of production and marketing of potato in selected states of India and to measure efficiencies at various levels,
- to assess the production and marketing credit gaps—requirement and availability—and to suggest suitable financial products for further development, and
- to identify the potentials for value addition and the investment needed to perform value chain analysis and to suggest suitable strategies for improvement.

2 Data and Analytical Framework

This study was conducted in three states. Adopting multistage random sampling technique, the primary data were collected from 90 potato growers and 40 market intermediaries (local traders, commission agents, wholesalers, retailers, processors and exporters) from each state, viz. Tamil Nadu, Uttar Pradesh and Bihar. Thus, the sample size comprised of 270 farmers and 120 market intermediaries.

The primary data were collected through personal interview method using structured interview schedules and the secondary data were collected from the published reports. The value chain mapping was done first to identify the major stakeholders in the chain and their performance was measured using different analytical tools. The technical efficiency of potato growers (one of the main stakeholders) was estimated through stochastic production function and the model specified was

$$\ln Yi = \beta_0 + \beta_1 \ln(\text{LAB}) + \beta_2 \ln(\text{QFERT}) + \beta_3 \ln(\text{QFYM}) + \beta_4 \ln(\text{MECH}) + \beta_5 \ln(\text{CPP}) + \beta_6 \ln(\text{SEED}) + v_i - u_i, \quad (1)$$

where

Y_i	Output of potato (tonnes/ha)
LAB	Labour (human days/ha)
QFERT	Quantity of fertilizer (kg/ha)
QFYM	Quantity of farmyard manure (tonnes/ha)
MECH	Machinery (hrs/ha)
CPP	Cost of plant protection (Rs./ha)
SEED	Quantity of seed (tonnes/ha), and
$\beta_1, \beta_2, \ldots, \beta_6$	Coefficients to be estimated.

The technical inefficiency component 'u_i' included

$$u_i = \delta_0 + \delta_1(\text{AGE}) + \delta_2(\text{EDU}) + \delta_3(\text{EXP}), \quad (2)$$

where AGE was age (in years); EDU was the education level (in schooling years); EXP was the farming experience (in years) of a potato farmer and δ_1, δ_2 and δ_3 were the coefficients to be estimated.

In the case of other stakeholders (marketing intermediaries), price spread analysis was done to measure the marketing efficiency. The export competitiveness of potato was assessed through estimation of nominal protection coefficient (NPC). The structural change in exports was examined by performing Markov chain analysis. The credit gaps and the potentials for investment were assessed finally.

3 Major Findings

The stakeholders involved in production and distribution of potato in the study regions were seed suppliers, farmers, commission agents, wholesaler, processor (unorganized), retailers, exporters and service providers (cold storage units). Among various inputs used in production of potato, the seed was one of the critical inputs and constituted a major component in the cost of cultivation. The type and number of agencies who had supplied seeds to sample farmers at the time of study period and the percentage of farmers who had sourced such seed materials from these sources are presented statewise in Table 1.

Table 1 Sources of purchase of seed tubers

S. No.	Source	Distribution of farmers							
		Tamil Nadu		Uttar Pradesh		Bihar		Overall	
		No.	%	No.	%	No.	%	No.	%
A. Institutional Market									
A1	Private seed producers	2	2.11	3	2.68	–	–	5	1.68
A2	Public research centre	–	–	15	13.39	37	41.11	52	17.51
A3	Cooperative	12	12.63	6	5.36	–	–	18	6.06
B. Non-institutional Market									
B1	Commission mandi	80	84.21	46	41.07	–	–	126	42.42
B2	Local market	–	–	40	35.71	52	57.78	92	30.98
B3	Own seed	–	–	2	1.79	–	–	2	0.67
B4	Others	1	1.05	–	–	1	1.11	2	0.67
Total		95[a]	100.00	112[a]	100.00	90	100.00	297	100.00

[a]denotes multiple responses since farmers sourced seeds from more than one source

Table 1 shows that farmers had sourced their seed materials from institutional markets (private seed producers, public research centres, Central Potato Research Institute and Cooperative society) and non-institutional markets like commission mandi (through commission agent) and local market. The commission mandi and local markets were the major places from where the farmers sourced their seed requirement. Institutional seed suppliers could not fully meet out the seed requirements as the quantity of seeds required during the sowing season was huge and therefore, the existing seed production capacity in the public sector has to be strengthened.

3.1 Current Practices of Production and Marketing of Potato

The producers constitute the base of potato value chain. A profile of sample potato farmers is presented in Table 2.

Table 2 indicates that the average age of sample farmers was around 50 years and they had a long farming experience of 24–30 years. The literacy rate (measured in terms of ability to read and write) was highest in Tamil Nadu (91%) followed by Uttar Pradesh (89%) and Bihar (87%), and the average number of years of school attendance ranged between 7 and 10 years. The size of household in Tamil Nadu and Bihar was five each against 10 in Uttar Pradesh. The major collateral assets owned by the farm households were land, building, machinery and livestock. The net cultivated area per farm household was highest in Bihar (6.85 ha), followed by Uttar Pradesh (4.53 ha) and Tamil Nadu (1.45 ha). The percentage of owned land to this net cultivated area was also highest in Bihar (82.81%), followed by Tamil Nadu (79.60) and Uttar Pradesh (66.82). On an average, a farmer cultivating potato owned assets worth of Rs. 1.02 lakh in Tamil Nadu, Rs. 6.54 lakh in Uttar Pradesh and Rs. 6.72 lakh in Bihar.

Table 2 Profile of sample potato farmers in selected states

Characteristics	Tamil Nadu	Uttar Pradesh	Bihar
Average age of respondent farmers (years)	46	49	50
Farming experience (years)	24	30	26
Literacy rate of sample respondents (%)	91	89	87
Years of schooling (No.)	9	10	7
Average family size of farm household (No.)	5	10	5
Net cultivated area (ha)	1.45	4.53	6.85
Share of owned land to net cultivated area (%)	79.60	66.82	82.81
Value of assets owned/farm excluding land (Rs.)	102,823	653,956	671,712

3.2 Potato Production: Cost and Returns and Efficiency

The cost of cultivation of potato crop in different states was estimated and the results are presented in Table 3 for Tamil Nadu and Table 4 for Uttar Pradesh and Bihar.

The cost of seed constituted 25–57% of total cultivation cost of potato. Next to seed, human labour and plant protection chemicals accounted for a major share in cultivation cost. Farmers, besides farmyard manure, applied chemical fertilizer also and the fertilizer cost constituted 6–14%. The total cost of cultivation/ha was Rs. 1.36 and Rs. 1.55 lakh yielding a net profit of Rs. 1.36 and Rs. 1.30 lakh, respectively, in unirrigated and irrigated farms in Tamil Nadu and Rs. 1.35 lakh (Uttar Pradesh) and Rs. 1.06 lakh (Bihar) yielding a net profit of Rs. 0.74 and Rs. 0.84 lakh in Uttar Pradesh and Bihar, respectively.

The production efficiency of these farmers was estimated through stochastic frontier production function, in which the parameters were specified to be a function of the variables associated with inputs like seed, labour, fertilizer, etc. The different factors of production involved influenced the responsiveness of the crop and the estimates together with the standard errors are presented for the three states in Tables 5 and 6.

In Tamil Nadu (Table 5), the variables associated with seed quantity, farmyard manure under unirrigated cultivation and other variables, namely labour and fertilizer (K), had a positive and significant effect on yield of potato, while fertilizer (P) had only a negative effect on yield of potato under irrigated condition. In Uttar

Table 3 Cost of potato cultivation in irrigated and unirrigated regions of Tamil Nadu

Inputs	Unirrigated regions			Irrigated regions		
	Quantity	Amount (Rs.)	%	Quantity	Amount (Rs.)	%
Seed (quintal/ha)	18.7	34,830	25.60	27.9	43,609	28.00
Machinery (h/ha)	4.0	3736	2.75	10.6	9946	6.39
Animal power (h/ha)	8.0	6108	4.49	1.8	1084	0.70
Men (human days/ha)	69.0	26,180	19.24	43.8	19,249	12.36
Women (human days/ha)	60.0	13,340	9.80	78.2	21,215	13.63
Farmyard manure (tonnes/ha)	4.0	5635	4.14	10.6	16,665	10.70
Fertilizer (kg/ha)	1243.0	19,538	14.36	728.6	10,582	6.80
Plant protection chemical (Rs./ha)	–	20,936	15.39	–	30,569	19.64
Other cost (Rs./ha)	–	5764	4.23	–	2767	1.78
Total cost (Rs./ha)		136,067	100.00		155,686	100.00
Yield (tonnes/ha)	16.7	272,576	–	26.5	285,994	–
Net profit (Rs./ha)		136,509	–		130,308	–

Table 4 Cost of potato cultivation in Uttar Pradesh and Bihar

Inputs	Uttar Pradesh			Bihar		
	Quantity	Amount (Rs.)	%	Quantity	Amount (Rs.)	%
Seed (quintal/ha)	42.1	77,811	57.38	24.0	42,649	40.13
Machinery (h/ha)	25.8	11,251	8.29	11.0	5794	5.45
Men (human days/ha)	62.1	15,548	11.47	65.0	11,737	11.04
Women (human days/ha)	21.1	4021	2.97	182.5	16,009	15.06
Farmyard manure (tonnes/ha)	4.2	3924	2.89	15.0	20,085	18.90
Fertilizer (kg/ha)	1093.8	17,779	13.11	353.1	7088	6.67
Plant protection chemical (Rs./ha)	–	4580	3.38	–	2923	2.75
Other cost (Rs./ha)	–	686	0.51	–	0.00	0.00
Total cost (Rs./ha)		135,600	100.00		106,285	100.00
Yield (tonnes/ha)	33.2	209,676	–	27.3	190,637	–
Net profit (Rs./ha)		74,076	–		84,352	–

Table 5 Estimates of stochastic frontier production function (Tamil Nadu)

Variables	Unirrigated regions (n = 52)		Irrigated regions (n = 47)	
	Coefficient	Std. error	Coefficient	Std. error
Constant	−1.76,479	1.320637	−4.56889	0.0001239
Seed	0.66551*	0.165369	0.74653*	0.0000122
Labour	0.013444	0.090823	0.033152*	0.0000119
Farmyard manure	0.022561*	0.008624	0.023174*	6.84E−07
Fertilizer (P)	−0.01258	0.017834	−0.01153*	4.08E−07
Fertilizer (K)	0.009649	0.014663	0.01153*	5.08E−07
Plant protection chemicals	−0.06954	0.048777	0.20329*	2.74E−06
Log-likelihood function	−8.8643831		11.568397	

*denotes significance at 1% level

Pradesh (Table 6), barring the seed rate, farmyard manure and fertilizers (P and K) had a negative and significant effect on yield of potato. In Bihar (Table 6), among the major inputs, the variables, viz. seed and plant protection chemicals, have positively and significantly influenced the yield of potato. Thus, the production function estimates in the three selected states although varied uniquely, they showed some common agreements such that inputs, viz. seeds, farmyard manure, chemical fertilizer and even plant protection chemicals, influenced the yield of potato. There is need to transfer appropriate production technologies based on the current input usage and its influence on the yield of crop.

Table 6 Estimates of stochastic frontier production function—Uttar Pradesh and Bihar

Variables	Uttar Pradesh		Bihar	
	Coefficient	Standard error	Coefficient	Standard error
Constant	2.7847	0.6981	3.8622	0.5348
Seed	0.3437*	0.1595	0.1398*	0.0601
Machine	−0.0117	0.0763	−0.0079	0.0386
Labour	0.0235	0.0552	−0.0701	0.0799
Farmyard manure	−0.0615*	0.0229	0.0079	0.0314
Fertilizer (N)	0.0342	0.0744	0.0230	0.0368
Fertilizer (P)	−0.1888*	0.0892		
Fertilizer (K)	−0.0269*	0.0100	−0.0457	0.0379
Plant protection chemicals	0.0416	0.0593	0.0502**	0.0276
Log-likelihood Function	34.1014		110.18036	

*,**denote significance at 1 and 5% levels, respectively

The function besides accounting the effects in the use of inputs in producing output, the variations in the inefficiency effects were estimated as a function of few other variables, viz. education, experience, net cultivated area and credit availed. The results are presented for each state in Table 7.

The results presented in Table 7 indicate that the coefficients for education of farmers and credit availed had negative signs implying that lower educational levels and poor credit availability had a significant contribution to inefficiency. Longer farming experience and net cultivated area could also lead to more inefficiency. In the case of farmers in Uttar Pradesh, experience, education of farmers, net cultivated area and credit availed had negative signs on inefficiency, implying that lower level of these variables had contributed to inefficiency. In Bihar, the education of farmers, experience and credit availed had negative signs on inefficiency implying that lower educational levels and experience had a significant contribution to inefficiency. Higher cultivated area only led to more inefficiency.

The results of frequency distribution of technical efficiency (scores) across the sample farmers are presented in Table 8 for Tamil Nadu and 9 for Uttar Pradesh and Bihar.

Table 7 Variables for inefficiency effects in selected states

Variables	Tamil Nadu		Uttar Pradesh	Bihar
	Unirrigated	Irrigated	Irrigated	Irrigated
Constant	−6.4819	−1.4736	−4.1497	−2.36998
Education	−0.02298*	−0.12189	−0.0289	−0.15673***
Experience	0.014858*	0.002775***	−0.0118	−0.335945**
Net cultivated area	0.242251	0.191113	−0.0937	0.80461**
Credit availed	−1.71E−06	6.30E−08	−1.7061	−0.771313

***, **, *denote significance at 1, 5 and 10% levels, respectively

Table 8 Frequency distribution of technical efficiency scores in Tamil Nadu

Farm size	Efficiency levels (Unirrigated)				Efficiency levels (Irrigated)			
	<60	60–80	>80	All	<60	60–80	>80	All
Yield (tonnes/ha)								
<1 ha	13.70	14.24	16.14	14.72	23.05	26.86	32.88	28.46
1–2 ha	14.27	16.62	17.19	16.30	25.52	19.76	26.38	25.69
>2 ha	12.37	18.53	41.68	19.44	11.10	26.76	31.32	23.44
Overall	13.37	16.82	20.39	16.72	18.29	26.40	29.87	26.47
Number of farmers								
<1 ha	7	6	7	20	3	12	8	23
1–2 ha	3	8	4	15	2	1	9	12
>2 ha	5	10	2	17	4	3	5	12
Overall	15	24	13	52	9	16	22	47
Percentage of farmers								
<1 ha	35.00	30.00	35.00	100	13.04	52.17	34.78	100
1–2 ha	20.00	53.33	26.67	100	16.67	8.33	75.00	100
>2 ha	29.41	58.82	11.76	100	33.33	25.00	41.67	100
Overall	28.85	46.15	25.00	100	19.15	34.04	46.81	100

Table 9 Frequency distribution of technical efficiency scores in Uttar Pradesh and Bihar

Farm size	Uttar Pradesh				Bihar			
	<80	80–90	>90	All	<80	80–90	>90	All
Yield (tonnes/ha)								
<1 ha	0.00	29.89	27.36	28.51	0.00	0.00	0.00	0.00
1–2 ha	25.73	29.40	33.25	32.49	0.00	0.00	0.00	0.00
>2 ha	22.05	27.98	36.72	34.21	20.83	23.47	27.64	27.34
Overall	23.28	28.50	35.19	33.23	20.83	23.47	27.64	27.34
Number of farmers								
<1 ha	0	5	6	11.00	0.00	0.00	0.00	0.00
1–2 ha	1	1	13	15.00	0.00	0.00	0.00	0.00
>2 ha	2	15	47	64.00	1.00	5.00	84.00	90.00
Overall	3	21	66	90.00	1.00	5.00	84.00	90.00
Percentage of farmers								
<1 ha	0	45.45	54.55	100	0.00	0.00	0.00	0.00
1–2 ha	6.67	6.67	86.67	100	0.00	0.00	0.00	0.00
>2 ha	3.13	23.44	73.44	100	1.11	5.56	93.33	100.00
Overall	3.33	23.33	73.33	100	1.11	5.56	93.33	100.00

Given the technology, in Tamil Nadu (Table 8), most of the farmers (75%) under unirrigated cultivation have achieved low technical efficiency (less than 80%) in the production of potato. However, the percentage was higher with respect to irrigated farmers as about 47% of farmers had achieved more than 80% efficiency scores,

implying that irrigation also played a major role in affecting the efficiency levels. This also suggests that a considerable amount of productivity is lost due to inefficiency. The results also indicate that there existed a perceptible gap in the yield levels achieved by the progressive and other farmers, and lower technical efficiency levels and increase in farm size had a negative impact on efficiency levels.

In Uttar Pradesh (Table 9), contrary to the observations made in Tamil Nadu, most of the farmers (73%) could achieve high technical efficiency (>80%) in production of potato. The frequency distribution revealed that a considerable amount of productivity is lost due to inefficiency. The results also indicated that there existed a perceptible gap in the yield levels achieved by the progressive farmers (>90) and other farmers and lower technical efficiency levels and increase in farm size had a negative impact on the efficiency levels.

In Bihar (Table 9), the potato growers depicted better efficiency scores as 93% of the farmers could achieve efficiency score of more than 90%. Despite this, yield difference was observed (7 tonnes/ha) which implies the scope for improvement in yield of the potato crop by considering the variables leading to inefficiency. These results indicate that potato farmers depends on the downstream activities to get quality seeds and technology support so that higher efficiency in the production could be possible.

The marketed surplus of potato (Table 10) indicated that the farmers supplied 97–99% of the harvested produce to the market, keeping only a little quantity for seed and home consumption. The economic implication is that there is a need to create adequate infrastructure to handle such huge volumes of surplus produced by these farmers and depends on new seed material every time the sowing is taken up.

The potato farmers sold their produce through different intermediaries and at different markets. The pattern of such disposal was also analysed and the results are presented in Tables 11 and 12.

Table 10 Marketable surplus of potato in selected states

Particulars	Tamil Nadu	Uttar Pradesh	Bihar
Quantity produced (tonnes)	1599	11,769	3615
Quantity retained for consumption and seed (tonnes)	11.6	262.4	36.1
Marketable surplus (%)	99.27	97.77	99.01

Table 11 Percentage share of intermediaries in marketing of potatoes in selected states

Market intermediary	Tamil Nadu	Uttar Pradesh	Bihar
Local trader	0.00	17.58	39.12
Commission agent	74.33	37.01	29.77
Wholesaler	25.67	42.46	31.11
Retailer	0.00	2.94	0.00

Table 12 Place of marketing and the share marketed in selected states

Marketing place (%)	Tamil Nadu (%)	Uttar Pradesh (%)	Bihar (%)
Village shandy	0.00	35.23	0.00
Commission mandi	74.33	0.00	0.00
Nearest wholesale market	25.67	15.75	60.88
Nearest retail market	0.00	6.28	0.00
Others (Cold storage)	0.00	42.74	39.12

Among various market intermediaries, local trader (Bihar: 39.12%), commission agent (Tamil Nadu: 74.33%, Uttar Pradesh: 37.01% and Bihar: 29.77%) and wholesaler (Tamil Nadu: 25.67%, Uttar Pradesh: 42.46% and Bihar: 31.11%) were preferred by the farmers to sell the produce. Overall, the preferred place of disposal was Commission mandi in Tamil Nadu, Village shandy in Uttar Pradesh and nearest wholesale market in Bihar. Few farmers also availed the storage facilities and disposed the produce after a brief storage, particularly in Uttar Pradesh and Bihar states.

We also estimated value addition by these stakeholders in the potato supply chain. The value added by the major intermediaries including the share of producer in the consumer's rupee would imply the overall marketing efficiency thereafter. The difference in price at farm gate (price received by farmer) and at retail level (price paid by consumer) is used to measure the value added (Acharya and Agarwal 2004). The value addition by stakeholders was estimated for the major channel, viz. Farmer–Wholesaler–Retailer–Consumer, and the results are presented in Table 13.

Table 13 reveals that value addition by different stakeholders is comparatively high in Tamil Nadu vis-à-vis Uttar Pradesh and Bihar. This was because of the need to transport the produce from hilly areas to plains for marketing. However, among the three players, the wholesalers did most of the value additions. In Uttar Pradesh and Bihar, the farmers did most of the value additions. The details of the cost incurred for performing each value-adding activity are presented in Table 14 for all the three selected states. Each stakeholder before moving/selling to next level undertook various activities like sorting, grading, transportation, weighing, loading and unloading, packaging, etc. for which certain cost was incurred. Though the change in form of the initial produce (potato) was done mostly by the processing unit, the other activities mentioned below were absolutely essential.

Table 13 Value addition in potato by stakeholders in selected states (Rs./quintal)

Value chain actor	Tamil Nadu	Uttar Pradesh	Bihar
Farmer	69.50 (6.28)	96.00 (58.18)	87.00 (65.91)
Wholesaler	657.50 (59.39)	42.00 (25.45)	34.00 (25.76)
Retailer	380.00 (34.33)	27.00 (16.36)	11.00 (8.33)
Total	1107.00	165.00	132.00

Note Figures in parentheses denote percentage to total

Table 14 Cost incurred in different stages of value addition in potato in selected states

Sl. No.	Particulars	Tamil Nadu		Uttar Pradesh		Bihar	
		Cost (Rs./quintal)	%	Cost (Rs./quintal)	%	Cost (Rs./quintal)	%
Farmers							
1	Cleaning grading/sorting	8.00	11.51	20.96	21.83	18.94	21.77
2	Packing (material and labour cost)	38.00	54.68	40.00	41.67	35.00	40.23
3	Transport	6.50	9.35	20.16	21.00	8.34	9.58
4	Loading and unloading	7.00	10.07	9.51	9.91	18.72	21.52
5	Commission	10.00	14.39	5.37	5.59	6.00	6.90
	Total	69.50	100.00	96.00	100.00	87.00	100.00
Wholesalers							
1	Packing (material and labour cost)	520.00	79.08	26.00	61.90	19.00	55.88
2	Transport	62.50	9.51	11.00	26.19	10.00	29.41
3	Loading and unloading	75.00	11.41	5.00	11.90	5.00	14.71
	Total	657.50	100.00	42.00	100.00	34.00	100.00
Retailers							
1	Loading and unloading	80.00	21.05	7.50	27.78	1.30	11.82
2	Packing (material and labour cost)	200.00	52.63	10.75	39.81	6.00	54.55
3	Transport	100.00	26.32	8.75	32.41	3.70	33.63
	Total	380.00	100.00	27.00	100.00	11.00	100.00

3.3 Producer's Share in Consumer Rupee

Among various channels, Farmer–Wholesaler–Retailer–Consumer was the predominant channel. Hence, the producer's share in consumer rupee was estimated for this channel and is shown in Table 15. The producer's share in consumer rupee was 74% in case of Bihar, 71% in Uttar Pradesh and as low as 38% in Tamil Nadu. The limited supply with high demand was exploited by the intermediaries in Tamil Nadu, causing a lower share of farmers in consumer's rupee (Table 15).

The marketing efficiency was calculated by the following three approaches, viz. Shepherd, Calkin index and Acharya (Table 16).

The first measure (Shepherd's efficiency) indicated that among the three states, marketing efficiency was relatively higher in Bihar (4.41) compared to 3.59 in Uttar Pradesh and 2.24 in Tamil Nadu, as higher the ratio more was the efficiency. The second measure (Calkin index) relates profit or margin earned with cost incurred and enables a comparison across the states even though the magnitudes of these two

Table 15 Producers' share in consumers' rupee in potato value chain in selected states

Sl. No.	Particulars	Tamil Nadu (Rs./quintal)	Uttar Pradesh (Rs./quintal)	Bihar (Rs./quintal)
1.	Gross price received by farmer	1419	631	616
2.	Marketing cost of farmer	69	96	87
3.	Net price received by farmer (1–2)	1350	535	529
4.	Purchase price of wholesaler	1419	631	616
5.	Marketing cost of wholesaler	657	42	34
6.	Marketing margin of wholesaler	400	32	37
7.	Purchase price of retailer (4 + 5 + 6)	2476	705	687
8.	Marketing cost of retailer	380	27	11
9.	Marketing margin of retailer	728	26	16
10.	Selling price of retailer (7 + 8 + 9)	3584	758	714
11.	Producer's share in consumer rupee (%)	37.66	70.58	74.09

Table 16 Marketing efficiency in potato value chain in selected states

Sl. No.	Particulars	Tamil Nadu	Uttar Pradesh	Bihar
1.	Value of goods sold (Rs./quintal)	3585	758	714
2.	Price received by the farmer (Rs./quintal)	1350	535	529
3.	Total marketing cost (Rs./quintal)	1107	165	132
4.	Total marketing margin (Rs./quintal)	1128	58	53
5.	Total cost + margin (Rs./quintal)	2235	223	185
6.	Shepherd's efficiency	2.24	3.59	4.41
7.	Calkin index	2.02	1.35	1.40
8.	Acharya's approach	0.60	2.40	2.86

factors vary. The indices were found to be 2.02, 1.35 and 1.40 in Tamil Nadu, Uttar Pradesh and Bihar, respectively, implying that market intermediaries were more exploitative in Tamil Nadu. The third approach (Acharya) links price received by the farmer with total cost and margin. Its value is less than 1 in Tamil Nadu (0.60) as against 2.40 in Uttar Pradesh and 2.86 in Bihar, confirming the exploitative nature of the market by the intermediaries.

These indices have indicated that farmers need to organize themselves to collectively market their produce so as to avoid (one or more) intermediaries who would realize more profit/margin and gain major share in consumer's payment in the potato value chain.

3.4 Value Addition by Processor

A large number of small-scale processors in the study area are undertaking value addition in terms of potato chips. The conversion ratio of raw potato into chips ranged from 3.0–3.75:1 and varied according to the varieties. The details of value addition of potato into chips (from 45 kg raw potatoes into 15 kg of chips) are presented in Fig. 1.

The processor procured potato at Rs. 60/kg (30% of consumer's price) and added value to this primary product by converting into chips by incurring a processing cost of Rs. 63/kg (31.50%) and claiming a profit margin of Rs. 27/kg (13.50%) by selling to wholesalers at Rs. 150/kg. The wholesalers further made value addition at Rs. 30/kg (15%) and sold to retailer at Rs. 180/kg. Finally, the retailer sold chips to consumer at Rs. 200/kg by adding value at Rs. 20/kg (10%).

3.5 Value Addition by Cold Storage Units

Cold storage units, pack houses and reefer vans play a crucial role in post-harvest activities related to potato in the study areas. There has been an upsurge in the establishment of cold storage units and farmers, wholesalers and retailers avail these facilities. The potato farmers in Tamil Nadu were though not directly benefitted from the storage facilities created in the vicinity of production areas, the cold storage units were targeting the potato transported from other states. However, in Uttar Pradesh and Bihar, the farmers (mainly to store seed), wholesalers and retailers were utilizing these storage facilities. The availability of cold storage facilities not only helped to stabilize the prices of potato to some extent but also to meet the demand of consumers.

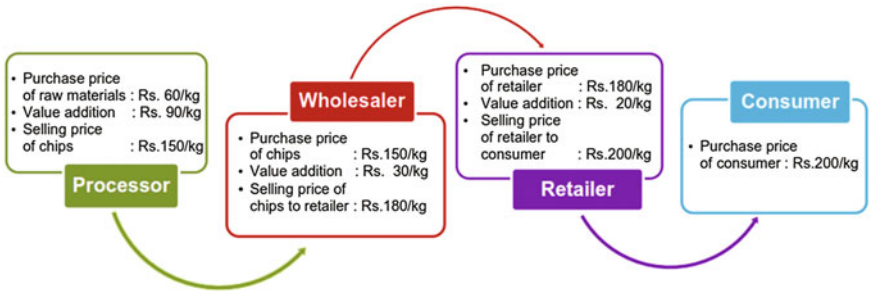

Fig. 1 Value addition in potato as chips (based on 45 kg of potatoes)

3.6 Value Addition—Export and Its Competitiveness

The export performance and export competitiveness of potato were analysed based on Coppock's instability index (to measure variation and stability in potato exports from India), Markov chain analysis (to know the structural change in exports) and NPC to analyse the competitive advantage of potato export. The growth rate and instability index were estimated for export quantity, value and unit value for the two time periods, viz. 1996–97 to 2005–06 and 2005–06 to 2014–15 and overall time period, viz. 1995–96 to 2014–15. The results are presented in Table 17.

It could be observed from Table 17 that quantity of export has grown significantly at 12.42% during 1996–1997 to 2005–2006, 12.72% during 2005–2006 to 2014–2015 and 16.92% during the entire period of 1996–1997 to 2014–2015. The corresponding export value had also grown significantly at 9.11, 29.74 and 23.27%, respectively. The growth in unit value was, however, negative (−2.94%) and significant in the first decade contributing to lower growth in value. However, during 2005–2006 to 2014–2015, the growth in value terms was significant and as high as 15.10% and contributed for the higher value in growth, keeping the growth in quantity at 12.72%. Thus, the growth in export value was influenced by both quantity and unit value and the higher growth in export price contributed to higher growth in overall export value.

To understand the stability/instability in growth of export quantity, value and unit value stability/instability indices were constructed. Despite significant growth in value and quantity and unit value, the instability was found higher in all the time horizons due to fluctuations in exports. Despite a growth rate of 16.92% (1996–1997 to 2014–2015) in export quantity, the corresponding instability index of 55.94 was of much concern.

India exports potato to more than 30 countries in the world. However, the export is more centred towards a few countries. It could be observed that about 80% of the value in export was directed towards nine countries during 2005–2006 and it reached 98% in 2014–2015. Among them, Malaysia, Mauritius, Nepal, Pakistan and Sri Lanka accounted for 94% in 2014–2015 and the export value increased to Rs. 844 crores in 2014–2015, as against Rs. 43 crores in 2005–2006. Sri Lanka,

Table 17 Growth rate and instability index for export of potato

Period	Export quantity		Export value		Unit value	
	Quantity	Instability index	CGR	Instability index	CGR	Instability index
1996–1997 to 2005–2006	12.42*	14.72	9.11*	13.35	−2.94*	13.35
2005–2006 to 2014–2015	12.72*	13.27	29.74*	24.42	15.10*	15.91
1996–1997 to 2014–2015	16.92*	55.94	23.27*	51.49	5.43*	65.32

[a, b] denote significance at 1 and 5% levels, respectively. CGR—Compound growth rate

Nepal, Malaysia, Mauritius, Maldives, Nepal, Pakistan and UAE were found to be the consistent importers of Indian potato during the past one decade. However, in recent period, the exports have increased manifold to Nepal, Pakistan, Sri Lanka, Maldives and Mauritius. Markov chain analysis was performed to identify the stable and reliable importers of Indian potato during 2005–2006 to 2014–2015. Overall, the countries like Oman followed by Bahrain, Mauritius and Nepal were the stable importers with a retention probability of more than 30%.

The cost and returns in domestic market vis-à-vis the price obtained in export market indicate the economic feasibility. Several authors have assessed the export competitiveness of India's potato based on NPC and have concluded that in some years it was competitive and vice versa in other years. Vanitha et al. (2014) had estimated the NPC for Indian potato for the period 2000–2009 and found that it was more than 1 in the years 2002 and 2007, 0.49 in 2008 and 0.79 in 2003, indicating its un-competitiveness, competitiveness and moderate competitiveness. In this study, the NPC was estimated for the period 2011–2014 and is presented in Table 18.

It was found that Indian potato was competitive only in 2011 and in the remaining years, it was only moderately competitive (0.62–0.73) in terms of export price, reflecting the need for productivity increase, better infrastructural facilities and better policy environment.

3.7 Credit Gaps

The credit requirement of farmers was estimated based on the cost of cultivation, existing credit pattern and acreage under potato. It was found (Table 19) that the potato farmers, on an average, availed credit of Rs. 66,063, Rs. 88,377 and Rs. 47,356 from institutional financial agencies in Tamil Nadu, Uttar Pradesh and Bihar, respectively. Under the current scenario, credit gap of Rs. 77,171, Rs. 4,93,347 and Rs. 1,38,644, respectively, was estimated in the selected states which could be met from these institutional agencies.

3.8 Credit Requirement of Market Intermediaries

The annual financial requirement of the market intermediaries varied depending upon the volume of produce handled. Besides, the working capital requirement to meet the wages/salaries, rent, market fees, etc. also influenced the requirement. In this study, the financial requirement of various market intermediaries was assessed by estimating the quantity and value of goods (potato) transacted, total credit availed from both institutional and non-institutional agencies, the percentage of borrowed funds to the total fund required and the credit gap if any, if the borrowed funds were to be met fully by the institutional agencies. These analyses were done

Table 18 Export competitiveness of Indian potato: 2011–2014

Year	Domestic wholesale price (Rs./tonne)	Packing, handling and transport to port (Rs./tonne)	FOB price (Rs./tonne)	International price (Rs./tonne)	Freight cost (Rs./tonne)	Freight-adjusted price (Rs./tonne)	Net protection coefficient (NPC)
2011	5590	1400	6990	24,230	3920	20,310	0.34
2012	9400	1750	11,150	19,355	4025	15,330	0.73
2013	9630	1800	11,430	23,054	4678	18,376	0.62
2014	15,110	1850	16,960	30,304	4840	25,464	0.67

Table 19 Credit requirement of potato farmers in selected states

Sl. No.	Particulars	Tamil Nadu	Uttar Pradesh	Bihar
1	Cost of cultivation (Rs./ha)	1,55,686	1,35,600	1,06,285
2	Average area under potato cultivation (ha)	0.92	4.29	1.75
3	Credit requirement—Rs./farmer (100% to be met from Financial Institutions)	1,43,234	5,81,724	1,86,000
4	Credit availed from financial institutions (Rs./farmer)	66,063	88,377	47,356
5	Gap (3–4) (Rs./farmer)	77,171	4,93,347	1,38,644

across the market intermediaries and also across the selected states. The details are presented in Table 20.

The credit requirement varied across the market intermediaries and also across the states. The commission agents offer the service of finding suitable buyers for the farmer's produce. In this process, they commit themselves to arrange for the payment to farmers and thus require adequate funds. It was observed that apart from their owned funds, they also borrowed funds from financial institutions (both institutional and non-institutional) and on average, a commission agent in Tamil Nadu depicted a credit gap (through institutional financing) of Rs. 11.03 lakh and their counterparts in Uttar Pradesh and Bihar required Rs. 80.83 and Rs. 31.00 lakh, respectively.

Similarly, the credit gaps, estimated for wholesalers and retailers, were found to be Rs. 20.25, Rs. 59.00 and Rs. 30.04 lakh in Tamil Nadu, Uttar Pradesh and Bihar in the case of wholesaler and to the tune of Rs. 1.20, Rs. 0.64 and Rs. 0.14 lakh in Tamil Nadu, Uttar Pradesh and Bihar among retailers.

The processors and exporters also demanded funds from the financial institutions. Based on the quantity handled and the financial requirement, it was found that a processor needed an amount of Rs. 0.80 lakh as credit and an exporter needed an amount of Rs. 12.50 and Rs. 21.34 lakh in Tamil Nadu and Uttar Pradesh, respectively (Table 21).

3.9 Financial Products for Further Development of Potato Value Chain

From the preceding discussions, it could be concluded that the stakeholders in potato value chain had availed loan from both institutional and non-institutional agencies. However, though the access to non-institutional financial agencies was relatively better than the institutional agencies, the high rate of interest and inadequate disbursement of fund by the non-institutional agencies indicate further potential for the institutional agencies to fill such credit gaps. Though the magnitude of such funding varied across the stakeholders in the potato value chain, the study clearly indicated that additional finance and the financial products smoothen the operations.

Table 20 Credit requirement of potato market intermediaries in selected states

Sl. No.	Particulars	Commission agents			Wholesalers			Retailers		
		Tamil Nadu	Uttar Pradesh	Bihar	Tamil Nadu	Uttar Pradesh	Bihar	Tamil Nadu	Uttar Pradesh	Bihar
1	Average quantity handled (tonnes)	607	5819	1765	238	2143	3120	15.70	46.00	10.53
2	Value (Rs. lakh)	73.56	280.67	84.41	39.94	135.64	171.60	2.86	3.13	0.64
3	Owned funds (Rs. lakh)	18.39	78.59	27.01	8.79	56.97	113.26	1.66	2.38	0.48
4	Borrowed funds (Rs. lakh)	55.17	202.08	57.40	31.15	78.67	38.51	1.20	0.75	0.15
5	% of institutional finance to borrowed funds	80	60	46	35	25	22	0	15	8
6	Gap (Rs. lakh)	11.03	80.83	31.00	20.25	59.00	30.04	1.20	0.64	0.14

Table 21 Credit requirement of processors (Chips making—Unorganized) and exporters of potato in selected states

Sl. No.	Particulars	Processor	Exporter	
		Tamil Nadu	Tamil Nadu	Uttar Pradesh
1	Average quantity handled (tonnes)	9.00	200.00	2850
2	Value (Rs. lakh)	1.80	50.00	142.30
3	Owned funds (Rs. lakh)	1.00	25.00	106.73
4	Borrowed funds (Rs. lakh)	0.80	25.00	35.57
5	% of institutional finance to borrowed funds	0.00	50	40
6	Gap (Rs. lakh)	0.80	12.50	21.34

Among various stakeholders, commission agents were the first contact persons for the majority of farmers and thus they have to take a leadership role in the value chain by tying up with wholesaler, retailer, storage service providers, processor and exporter. The major limitations, needed interventions and recommended financial products in the potato value chain are shown in Table 22.

Table 22 Financial products for potato value chain

Major limitations	Interventions	Product and delivering agencies
Inadequate quality seed supply	Quality seed production and distribution to farmers	Research institutes, organized seed producers, seed village and financial institutions to support seed production
Lack of cold storage facilities (on-farm)	Provision of on-farm storage structures to farmers	Development of low-cost storage structures and funding through venture capital schemes by financial institutions
Lack of cold storage facilities (off-farm)	Off-farm storage structures, Reefer vans and pack houses for professionalized packing and consistent supply	Storage structure through equity investment and asset finance/equipment leasing by financial institutions for pack houses and vans
Price fluctuations and lack of market intelligence and information	Price bulletins and price forecasting to all the stakeholders in value chain	SMS, Web portal, Buyers–Sellers meet, etc. through government agencies, research institutes and Farmer Producer Companies
Late payment by market intermediaries	Guaranteed lending	Seed capital by financial institutions
Inadequate processing units and non-availability of suitable varieties of potato	Establishment and making availability of varieties suitable of processing to processor	Processing units and production and distribution of seeds suitable for processing by the seed producers

4 Potential for Value Addition and Investment Needed

The value addition possibilities in potato value chain were assessed based on the volume of production and other parameters in the selected states. In Uttar Pradesh and Bihar, the entire annual production was not consumed within the state and thus, the surplus was being transported to low but high demanding long-distance southern states like Kerala, Karnataka, Andhra Pradesh and Tamil Nadu. Besides, a considerable volume of the potato is moved to Delhi, Rajasthan and Maharashtra and to northeastern states. Therefore, there is a need to have adequate transport and logistic support besides other services like storage, pack house, price information, etc. The mandies of the surplus producing states have to be adequately equipped with grading, sorting, packing and storing facilities.

The states earlier concentrated more on building storage capacity to tie over the cross-seasonal carry through the produce. Thus, an increase in cold storage capacity in the three studied states was observed. Except in Tamil Nadu, the other two states have witnessed a rise in potato production and surplus was being stored in these cold storages. However, the market-led intervention or input (seed) and credit flow to the farmers directly by the cold storage houses were very little. The farmers availed these facilities at minimum and the situation was thus exploited by the middlemen who also offered low prices to farmers at periods of glut and enjoyed high price from consumers in other periods. Hence, there is a need to link and integrate various opportunities in the potato value chain.

Based on the infrastructure requirement and created so far, it is estimated that to develop a full-fledged cold chain infrastructure for perishable fruits and vegetables in the whole country, additionally about 70,000 numbers of pack houses, 3.28 million of cold storage space and about 53,000 reefer vehicles are to be established (NCCD 2015). The requirement of various cold chain infrastructures in the select state based on the data available is furnished in Table 23.

Table 23 reveals that additional storage facilities would have to be created, particularly in Bihar, as there is a gap of about 37.12 lakh tonnes in cold storage

Table 23 Existing gap in infrastructure (cold storage) in selected states

State	Number of cold stores created	Capacity (tonnes)	Requirement (tonnes)	Gap (tonnes)
Tamil Nadu	165	3,04,771 (1847)	1,94,640	–
Uttar Pradesh	2215	138,35,743 (6246)	106,75,137	–
Bihar	304	14,11,395 (4643)	51,23,982	37,12,587
All India	7129	328,67,458 (4610)	351,00,664	22,33,206

Source NCCD (2015)
Note Figures in parentheses denote average capacity per cold storage unit

capacity. In the other two states, though there were no such gaps, the existing created capacities have to be effectively linked with the production points. During the survey also, the sample farmers in all the study areas indicated that cold storages have to be created considering the production centres and have to be linked with transport and other infrastructure.

In case of pack houses, at all-India level, only 249 pack houses have so far been established and no details about the availability of such pack houses in individual select states are available. However, it is estimated that at all-India level, about 70,080 units are to be established and have to be concentrated near production centres so as to create and support appropriate supply chain operations in the cold chain. Besides, the requirement of reefer vehicles is estimated to be about 61,830 for the country.

5 Information Exchange/Sharing for Value Addition

Besides creation of infrastructure facilities, market intelligence and information sharing could add value in the potato chain. In the study area, the farmers and other stakeholders informed that market intelligence covering product intelligence, place intelligence, price intelligence and time intelligence is needed to be developed and disseminated to farmers. Price intelligence includes price forecasts for potato crops for the season concerned and selection of sowing the crop based on the same. To achieve the expected high prices, the product characteristics are to be provided through product intelligence. The information regarding high-price markets for the potato can be disseminated through place intelligence. Time intelligence suggests the farmers to sell the produce immediately on harvest or store for sometime to get the maximum prices. These ICT-based platforms need to be strengthened. Establishment of information kiosks, regular SMS-based market information dissemination, pre-sowing and storage/sell advises, through PPP initiatives, could facilitate informed decision-makings at various levels and among the stakeholders. Besides, empowering the farmers through market intelligence and making them into agri-preneurs are the approaches to help improve the value chain activities over a period of time. This could be achieved through promotion of Commodity Growers' Association and also through Producer Companies in the study regions.

6 Conclusions

Organization of agriculture along the value chain framework has been conceived as one of the strategies to bring more efficiency in the agricultural sector (Kumar et al. 2011). Identification of stakeholders and subsequently value chain analysis would help to ensure demand-led activities and their sustainability. This study has highlighted different actors in the potato value chain, their economic roles and

possibilities of increasing the efficiencies. In the case of potato value chain strengthening of the value chain through seed and other input supply, integrating all secondary functions like grading, storage, processing, etc. would avoid duplication of many unwarranted handling and effect minimization of cost. At various levels of production and marketing, the potentials for growth in the potato sector have been observed constrained. The farmers in the study area have reported the existing storage facilities to be inadequate and the potentials for processing though existed were found to be highly unorganized. The value addition through potato export would imply that our crop is moderately competitive and fluctuations in imports to traditional markets were found. Oman, Bahrain, Mauritius and Nepal were the major importing destinations for potato with more retention probabilities.

Thus, for an effective potato value chain, there is a need to strengthen seed supply chain in all the three states selected for the study. Besides, the potato value chain requires more dominant players and such leadership has to emerge. Farmers producer organizations (FPO), organized processors, exporters and retail chain stores need to push the chain based on the demand from consumers. Funding opportunities for storage and processing are prevalent in all the states. Commercialization of potato seed production and distribution; development of alternative market channels to achieve more value addition by providing finance and developing niche markets and also encouraging professionalism in sorting, grading, storage, processing, etc.; creation of cold storage facilities at production centres and development of integrated value chains linking farm gate and consumption points and the capacity building for the chain actors for an increased professionalism and entrepreneurship are the specific recommendations that have emerged from the study.

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Part III
Institutional Framework for Agriculture Value Chain Financing

Elements of a National Agricultural Market in India

Devesh Roy, P.K. Joshi and Raj Chandra

1 Introduction

The proposed National Agricultural Market in India is conceived as a nationwide electronic trading portal that would create a network of wholesale markets (*mandis*) and market yards. Structured as a virtual market place, to a large extent like the existing models of e-commerce, it identically requires the backend support that takes the form of both infrastructure (for example, warehousing, grading, packaging and standards) and institutions (formal changes in laws and its implementation protocols). In the conceptualized model, the nodal point in the backend comprises the existing *mandis* which currently are mostly under state government regulations. In its vision, NAM expects the private sector to open markets and get involved at both front end and back end.

A common market for agricultural products means a market within which there are no institutional or legal barriers to the free circulation of such products, so that producers or traders can sell them with the same freedom across state borders as they can within their own state. According to FAO (2004), the analogous concept in the EU is a single market (because the EU used the term 'common market' to refer to the stage in its development when there were no custom duties or quantitative restrictions on internal trade, but still there were fiscal charges and non-tariff barriers).

What is planned under the National Agricultural Market (NAM) in India, based on the proposal cleared by the Cabinet Committee on Economic Affairs, is an online trading portal where farmers can offer their produce to buyers in any part of the country. This virtual marketplace will allow a farmer with subscription to NAM

D. Roy (✉) · P.K. Joshi
International Food Policy Research Institute (IFPRI), NASC Complex,
New Delhi 110 012, India
e-mail: d.roy@cgiar.org

R. Chandra
Iowa State University, Ames, Iowa, USA

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portal to sell his produce to the destination with the best price (net of the marketing costs). Any buyer, for example a food processor, can benefit from not having to be physically present or having to depend on traders in the relevant Agriculture Produce Marketing Committee (APMC) area. Since taxes and charges still apply, in essence, it is a common market not a single market.

The Small Farmers' Agribusiness Consortium (SFAC), a Society under the Department of Agriculture and Cooperation (DAC), Ministry of Agriculture, Government of India, has been designated as the lead agency for developing the NAM e-platform. While buyers can log into the platform from anywhere in India including off-market, the transactions will still be recorded as having been conducted through the *mandi* where the seller would have sold the produce from otherwise. The APMC of the area in which the transaction originates will continue to earn the mandi fee on the transaction even if it does not happen in that particular market yard.

The Government of India has allocated over 30 million dollars, i.e. Rs. 200 crores, for 3 years to set up the online NAM by integrating 585 wholesale markets across the country. Initially, the common electronic platform will be deployable in the selected regulated markets across the country. In its proposed form, the NAM envisions that there will be one licence for the entire state and there will be a single-point levy. Further, it envisages electronic auctions for price discovery. With these provisions, it is expected that seamless transfer of agricultural commodities within the state and beyond can take place, thus expanding the market for farmers and traders.

Operationally, NAM involves the potential buyers and sellers who are not physically proximate to be engaged in transactions at the local level. By virtue of being a common national market, in some respects at least, the NAM would have to supersede the structure of the existing APMC. Under the current system of APMC that are under the jurisdiction of the state governments, different licenses are needed to trade in each market. Similarly, there are market-specific fees that need to be incurred.

With regulated markets at the first point of sale, farmers are currently restricted to sell their produce locally. Even within a state, there does not exist a common market (the recent exceptions being Gujarat and Karnataka), implying that mandis in general are not connected and price differentials usually do not get equalized across the markets. If price differentials stimulate trade across the markets, it would likely improve the outcomes of both farmers and consumers.

As for the traders, they can benefit from the volume expansion that can take place through the integration of the markets. Even within a state, since there is no unified market, there often are significant costs involved in moving agricultural products. The end result is highly fragmented and high-cost agricultural economy, which prevents economies of scale and seamless movement of agricultural goods across district and state borders. The NAM seeks to address the issue of fragmentation of markets, ultimately lowering intermediation costs, wastage and prices for the final consumers (SFAC 2015a, b).

With this background, this chapter addresses the following research questions with regard to NAM. How far do indicators suggest a basis for NAM? Does the current state of market exhibit lack of an effective integration and in which

commodities? What are the elements of the NAM on the back end? To what extent are the attributes of the existing marketing infrastructure such as backend support suited for the NAM? What changes in the back end (infrastructure and institutions) would be needed to make the NAM effective?

These questions are pertinent in the context of NAM since the existing network of wholesale markets is supposed to provide the backend support for the electronic platform at the state or national level. Also, there exist several rules and regulations that can militate against the formation of NAM. Note that as perceived in NAM, all the wholesale markets (both public and private) would be linked to the electronic hub and thereby would allow sale of produce at the national level.

2 Elements of a Functional Marketing Platform

It is straightforward to see that a portal once created can bring up the offers and bids from different parts of the country. However, to be functional, NAM would also need actual transactions to take place. With buyers and sellers, anonymous and not proximate, NAM will need commensurate development at the back end (infrastructure and institutions) for the actual transactions to take place in a reasonably frictionless way. Based on a simple analysis of the marketing infrastructure and institutions, we believe that a lot needs to be done in order to make an arrangement like NAM to function.

In India, the agricultural markets are regulated under the APMC Act which is under the jurisdiction of the state governments. The APMC is an old Act that was formulated in 1952. The conditions such as majority of small farmers with individually small marketable surplus produce and inadequate infrastructure for storage and marketing perhaps necessitated the development of government markets, leading to the adoption of APMC Act. Further, information asymmetry that can cause severe inefficiencies in the system was also typical in the context of Indian agricultural markets.

Barring a few first mover states in the development of local markets, we find that market density for what would make the back end is strikingly small. According to the Economic Survey 2014, there are nearly 2500 regulated markets and over 4800 sub-market yards regulated by the APMCs under respective states. This number by itself might seem large, but normalizing by the number of farmers or geographical area, the density of government-regulated wholesale markets turns out to be quite small across the country.

According to the Economic Survey 2014, even the model APMC Act treats the APMC as an arm of the state, and the market fee, as the tax levied by the state, rather than a fee charged for providing services. This is a crucial provision which acts as a major impediment to creating a common market in agricultural commodities.

Two features of APMC have a possible bearing on the proposed NAM. First, agriculture is a state subject, and second, the APMC Act covers a wide array of

commodities, including cereals, oilseeds and high-value items such as fruits and vegetables and meat products. In that sense, commodities that have diverse marketing requirements are more or less treated in the same manner. There is a strong evidence that consumption patterns are getting diversified in India towards high-value perishable commodities. However, *mandis* at the back end seem not to have developed in line to take care of the changing food habits.

Even with market liberalization, allowing private trade and removing marketing parastatals are necessary but not sufficient for efficient markets to evolve. In the absence of proper infrastructure and institutions, spatially dispersed markets may continue to lack integration. For instance, in Mexico, the 'railroad' contributed significantly not only to the overall economic growth of the country but also played a key role in the integration of corn market (Dobado and Marrero 2005).

Before getting into the details about the state of markets in the back end to support a system like NAM, we first look at the extent of integration across markets by taking a core–periphery approach where the principal market is defined based on comparatively high market arrivals. Towards this, we use prices data from the wholesale markets at high frequency and use time series techniques to assess spatial integration. We find that there are several commodities that are characterized by the lack of spatial integration, which implies that there are frictions in the markets. The NAM is expected to bring down the level of frictions that would lead to spatial integration. With spatial integration, prices will tend to equalize and there will be a co-movement of prices across the markets in the country.

The minimization of frictions in transactions characterized by disaffiliate buyers and sellers would require changes that go beyond merely creating an online platform. To analyse this issue, we employ a sparsely available data to map out the state of wholesale markets in the country and try to assess their readiness for the NAM. In the context of food commodities, several physical and institutional infrastructures are necessitated by design. The examples of these requirements include weighing, grading and transport infrastructure, food safety certification systems, cold storage and quality standards, among others. Mapping out the wholesale markets, we find that markets currently lack in terms of these credentials to support an initiative like NAM.

The NAM, in fact, is expected to facilitate the growth of integrated value chains in the major agricultural commodities across the country and promote scientific storage and movement of agricultural goods. From this perspective, the emergence of integrated value chains and the development of facilities such as scientific storage are conceived more as an effect rather than a prerequisite of NAM. We consider that scientific storage, transportation and similar amenities as precursor to the NAM rather than just an expected result from it.

In terms of organizational structure, the NAM envisions about conforming to the regulations of each state's APMC Act. Moreover, all transactions that actually take place would be considered a throughput of the local mandi which would continue to earn the transaction fee (SFAC 2015a, b). Hence, the transformation of the system could be revenue neutral for the states and may even be revenue expanding, depending on the elasticity of transactions with respect to the base expansion that would likely follow from NAM.

Within a state, since NAM requires a single license for trading and a single-point levy of transaction fee, apart from the revenue implications, political economy would also play a critical role in the adoption of system by the state governments. The idea of integrating the existing APMC markets through a common e-platform has come from Karnataka. The state government has established Rashtriya e-Market Services Private Limited, a 50:50 joint venture with NCDEX Spot Exchange, to offer an automated auction platform for connecting all the mandis in Karnataka. Already, 55 of the 155 main marketyards in the state have been integrated into a single licensing system through this platform.

Note that there is important backend support embedded in functioning of the new common market platform in Karnataka. First, there is a single licensing system. Second, the Rashtriya e-Market Services Limited (ReMS) offers automated auction and post-auction facilities (weighing, invoicing, market fee collection and accounting), assaying facilities in the markets, facilitates warehouse-based sale of produce, facilitates commodity funding and disseminates price by leveraging technology. Under the NAM, these amenities would be needed on a many times larger scale.

3 Agricultural Markets in India: Common or Single? NAM from Market Integration Perspective

In principle, a common agricultural market like NAM can provide several benefits to the participants in the value chain. The farmers can benefit from having a wider choice of buyers and can choose to sell the best possible option in terms of net returns. The Small Farmers' Agribusiness Consortium 2015 emphasizes that under NAM, the bulk buyers like processors and exporters will be able to participate directly in the mandis and can thereby cut their intermediation costs. Hence, the extent to which the returns of intermediaries change would depend on the degree of consolidation on the buyer side. Also, there can be a variation in direct purchasing by bulk buyers based on the market- and state-specific differences in regulation and its implementation.

Finally, the consumers are expected to benefit from a wider set of choices and spatial arbitrage in response to price differences. In this context, it is not yet clear whether there would be size requirements of buyers and sellers in the proposed NAM as well as what would be the threshold for direct purchases. These factors would determine the outcomes for the final consumers, farmers and other agents in the value chain.

Technically, the NAM implies spatial market integration and it can have significant implications on price discovery, overall income of producers, market liberalization and other policy reforms. According to the law of one price (LOP), the prices of homogeneous goods at different locations should differ only by the transaction cost of those goods between different locations. Or else, the traders can

engage in spatial arbitrage, which would increase the price of a good in low-price location and reduce the price in high-price location until the LOP is restored. The lack of common market generates possibilities of arbitrage also for the traders over time. At the end, both farmers and consumers can be better off if markets are integrated.

In economics, the spatial integration is examined by analysing the price transmission between markets (Fackler and Goodwin 2001). The manner in which the price shocks get transmitted between two locations depends on the magnitude of price difference between them (Goodwin and Piggott 2001; Stephens et al. 2012), and also the extent to which markets are integrated based on the costs of transacting across the markets. The shocks that increase the price difference so that it exceeds the costs of trade between the two locations lead to arbitrage and ultimately, to price transmission. However, when the difference is less than the transaction cost, there is generally no arbitrage and hence, there is no price transmission.

The agricultural market liberalization leads to a better price transmission as has been evidenced from different cases. Jha and Srinivasan (2000) argue that market liberalization is required for achieving allocative efficiency and long-term growth in agriculture. Reduced government intervention in agricultural markets can then yield positive welfare benefits. Awokuse (2007) shows that market liberalization policies that remove internal trade barriers and lower transaction costs enhance integration and efficiency of the domestic market. Similarly, the market liberalization has been found to increase market integration for maize markets in Malawi (Goletti and Babu 1994).

Several studies have analysed the issue of spatial market integration to assess the impact of liberalization policies in developing economies (Goodwin et al. 1999; Park et al. 2002; Laping 2004). These studies have found mixed evidence regarding the effects on production, farmer's income, prices as well as the overall income. Empirical studies show that rapid liberalization resulted in output reduction in many developing and transition economies (Brooks 1995; Eicher 1999; Kherallah et al. 2002). One possible explanation for this unanticipated outcome could be the fact that emergence of healthy systems of market exchange takes time, as traders need to learn the arbitrage skills (McMillan 1995; Blanchard 1997).

By studying the Uganda maize market, Rashid (2004) finds that the extent of integration improved in the early years of liberalization and also the markets which were not integrated before liberalization got integrated by the end of the decade during 1999–2000, showing that markets take time to emerge. But at the same time, northern districts of Uganda which were in the state of insurgency since 1986 did not show any improvement in integration.

Elsewhere, studies investigating the impact of market reforms on China's grain market find mixed evidence for market integration (Rozelle et al. 1997; Park et al. 2002; Wu 1994; Zhou et al. 2000). Examining the impact of transition policies on China's grain market, Park et al. (2002) find the markets to be integrated even in the presence of trade restrictions and different forms of government interventions.

Looking specifically at rice, soybean and maize markets, Rozelle et al. (1997) conclude significant improvement in China's grain market integration, except for a few cases where market pairs were not cointegrated. Wu (1994) using the average rice prices finds no evidence of market integration in China. Similarly, Zhou et al. (2000) test for pairwise cointegration between China's major rice markets and find the general absence of cointegration between markets.

In the case of India, Ghosh (2011) analysing the impact of agricultural policy reforms of 1990s for food grain markets finds that the extent of integration improved in the post-reform period. The regional markets which were segmented or poorly integrated in the pre-reform period were found integrated in the post-reform period.

Thompson et al. (2002) investigating the degree of spatial integration between EU's three different wheat markets (France, Germany and UK) find increased domestic-world wheat price co-movement and price convergence during the period of market liberalization. In addition, the study finds statistically significant price transmission elasticity subsequent to MacSharry reforms in 1992, which was double than what was obtained in the old 'Common Agricultural Policy (CAP)' policy regime. Overall, the study finds that reforms contributed to more rapid convergence of domestic and international prices.

Bailey and Brorsen (1989) emphasize that spatial price transmission could be asymmetric due to four reasons: asymmetric adjustment costs, asymmetric information, market power and asymmetric price reporting. The adjustment cost can include transportation cost. Goodwin and Piggott (2001) examined the daily prices of corn and soybean across spatially separated markets in North Carolina in the United States and report that bi-variate pairings of prices were threshold cointegrated. Corn prices differed significantly across the Mexican regional markets before 1885, but between 1885 and 1908, the dispersion of corn prices decreased significantly due to market integration (Dobado and Marrero 2005). Overall, the evidence suggests that spatial integration is closely related to infrastructure and liberalization policies.

In India, the proposed policies relating to NAM relate to market liberalization and possibly better infrastructure over time where restrictions on trading across space would be diluted either directly (allowing for sales outside a designated area as of now) or through changes that would as an end product imply liberalization (such as a system of single levies in the market). One should expect greater spatial integration with NAM.

4 Spatial Integration in Indian Agricultural Markets

As Sexton et al. (1991) discuss, two or more regions could fail to adhere to the LOP because of one or more of the following reasons: (i) regions could represent autarkic markets and are not linked by arbitrage (Spiller and Huang 1986); (ii) there are impediments to efficient arbitrage such as imperfect information, trade barriers or risk aversion (Buccola 1985; Ravallion 1986); and (iii) there is imperfect

competition between one or more of the markets (Stigler and Sherwin 1985; Faminbow and Benson 1990).

The geography plays a major role in trade. Trade declines with geographic distance, and per-capita income varies with climatic conditions (Anderson and Van Wincoop 2004; Sachs 2003). Geography has a significant role to play in the agricultural commodity market as well. Since agricultural commodities are bulky and/or perishable and centres of production and consumption are separated, transportation is generally costly. The geography not only affects the cost of inter-regional trade but also the autarky price in different regions. According to the factor proportion theory, the relative price of any commodity under autarky is determined by the relative abundance of factor of production, which in the case of agricultural commodity could be arable land and other inputs such as water (Heckscher 1919; Ohlin 1924) and then trade tend to equalize prices and factor returns across regions (O'Rourke et al. 1996).

In the eighteenth-century China, access to relatively low-cost ship transport was the important determinant of inter-regional trade (Perkins 1969; Chuan and Kraus 1975; Wang 1989; Shiue 2002). Keller and Shiue (2007) on examining the integration in China's rice market find that spatial features shaped the expansion of inter-regional trade of rice in China. In the following section, we check for spatial integration in the case of different agricultural commodities in the context of Indian markets.

5 Data and Market Selection

We have considered geographic area/states for different agricultural commodities to study spatial integration. These areas were selected based on the level of production of that commodity as a major crop. From the perspective of spatial integration as discussed above, we adopted a core–periphery framework by characterizing markets as central and local. The central market for each commodity was decided based on the highest market arrival and the other markets were termed as local markets. We selected one market from each region (that is east, west, north and south) as local market. However, the selection of local market was also based on the availability of data.

The data for price and market arrivals were collected from Agriwatch and National Horticultural Research and Development Foundation (NHRDF) database. The commodities selected for this study included wheat, rice, maize, potato, onion and soybean. The daily price and market arrivals of maize, wheat, soybean, potato and rice across different markets were collected from the Agriwatch, whereas the price and market arrivals in different markets for onion were collected from the NHRDF database. Since there were many dates missing in the NHRDF data, we generated the average price at weekly frequency for our analysis. Thus, the cointegration analysis was done on the daily frequency data for wheat, rice, maize, soybean and potato and on the weekly frequency data for onion. Table 1 lists

Table 1 Central and local markets selected for different agricultural commodities

Agricultural commodity	Central market	Local market	Time period considered
Wheat	Ludhiana	Lawrence road, Delhi; Kota, Kanpur, Indore, Visakhapatnam, Vadodara	2007–2015
Maize	Nizamabad	Naugachia, Ahmedabad, Gulabbagh, Karimnagar	2007–2015
Potato	Agra	Burdman	2010–2015
Onion	Delhi, Bhavnagar, Pune	Kurnool, Ludhiana, Lucknow, Nasik, Patna, Pune	2005–2015
Soybean	Nagpur	Indore, Kota	2006–2015
Rice	Vadodara	Visakhapatnam	2011–2012

different central and local markets selected for different commodities under analysis and the time period covered.

For each agricultural commodity, one market was taken as the central market. However, for onion, we selected three markets as central. As Maharashtra and Gujarat are the top onion-producing states, Pune and Bhavnagar registered higher market arrivals and hence were selected from these states. We also selected Delhi as one of the central markets as it also had higher market arrivals. It is possible that onion from different regions could be coming to Delhi market and then getting distributed to other local markets, especially in north India. The time period for analysis varied across commodities but we have tried to keep the longest span possible for each commodity, depending upon data availability.

The price differences between local and central markets are plotted in Figs. 1, 2 and 3. To illustrate, we have plotted the case of onion markets. These plots are the price differentials of log prices (Local market price–Central market price). Figure 1 shows that in most of the years, the prices of onions in Lucknow and Patna have been higher than the price in Delhi market. This pattern of spatial price difference is quite generic and not specific to some set of markets. Figure 2 shows that the price differences have been plotted in Coimbatore and Kurnool markets with Delhi markets. Figure 2 shows that prices in Coimbatore were higher than the price in Delhi market, but the prices in Kurnool were lower than in Delhi market. This could be because of the following two reasons:

(a) Kurnool itself is a major onion-producing area;
(b) Most of the onion to Coimbatore market could be coming from Kurnool rather than Delhi market. If it were to come from Delhi market, then the transaction/marketing costs could explain some part of the price difference.

There also were cases of markets where no consistent pattern could be observed across markets in terms of price difference. We considered the two big markets of Delhi and Ludhiana as shown in Fig. 3. No consistent pattern was observed. In some year, prices in Ludhiana were higher than in Delhi and in some years it was the other way.

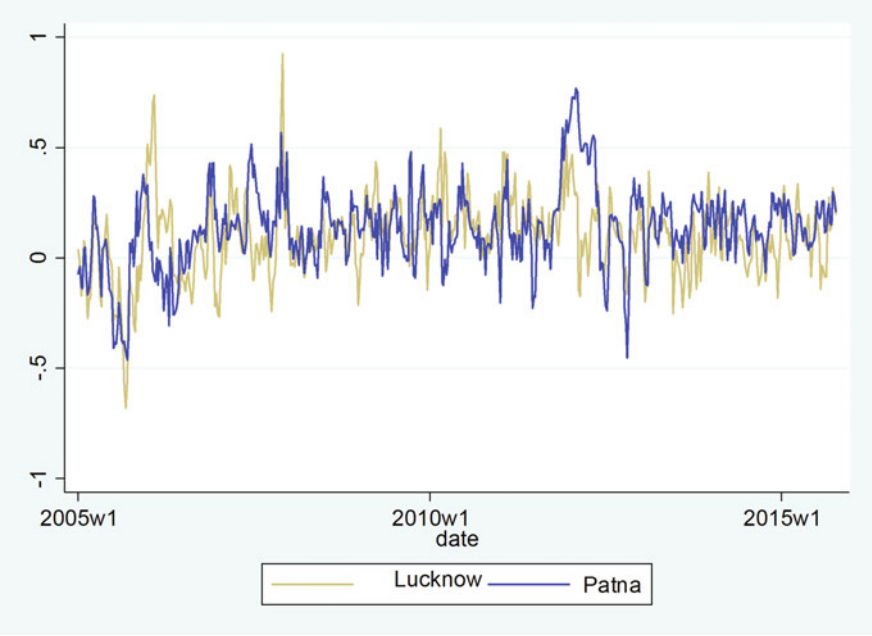


Fig. 1 Wholesale price difference—Delhi with Lucknow and Patna markets

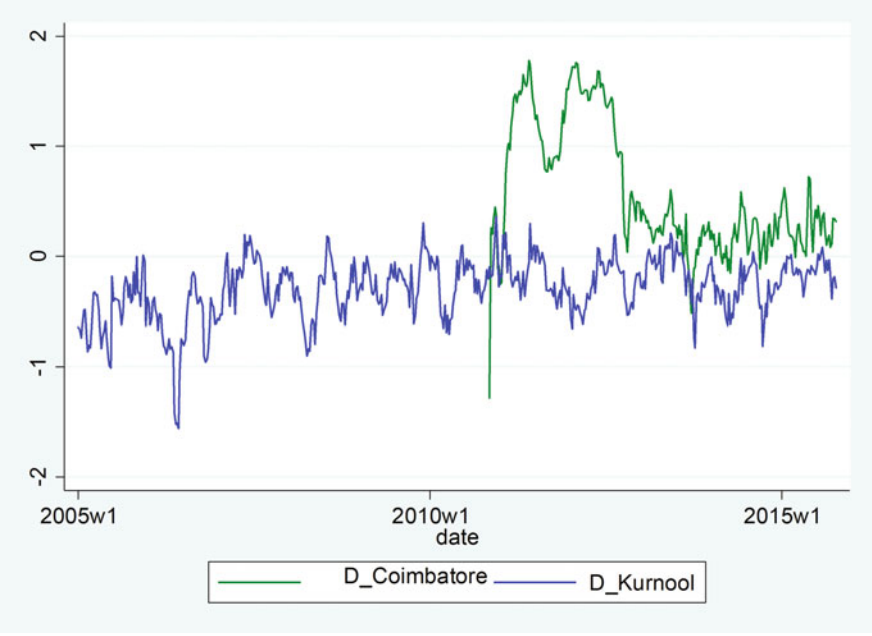


Fig. 2 Price difference between Delhi and southern India markets

5.1 Time Series Analysis of Market Integration

The starting point of time series analysis is a test for stationarity. If the time series is not stationary, then standard linear regressions can produce spurious results. Tables 2, 3, 4, 5, 6 and 7 present the unit root tests for prices in different markets for different agricultural commodities. If unit roots are found, then there is no mean reversion of the series.

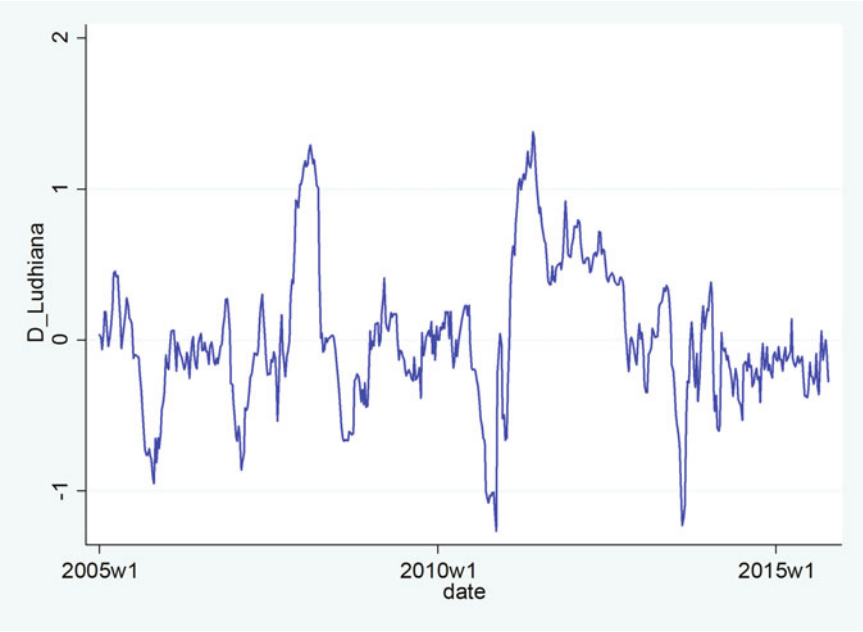


Fig. 3 Price differences between Ludhiana and Delhi markets

Table 2 Unit root test for onion markets

Onion market	First difference		Level	
	Optimal lag	Test statistics	Optimal lag	Test statistics
Ahmednagar	7	−3.79***	7	−2.58
Bhavnagar	2	−10.52***	13	−2.49
Delhi	1	−11.37***	2	−2.53
Kurnool	11	−6.82***	12	−1.91
Ludhiana	11	−6.03***	12	−2.19
Lucknow	9	−4.91***	10	−2.33
Patna	13	−5.40***	14	−1.89
Pune	2	−7.06***	3	−2.91
Nasik	5	−4.16***	6	−2.41

***, ** and * denote significance at 1, 5 and 10% levels of significance
Optimal lag is selected based on Ng-Perron seq t/min SIC information criteria

Table 3 Unit root test for wheat markets

Wheat market	First difference		Level	
	Optimal lag	Test statistics	Optimal lag	Test statistics
Ludhiana	2	−28.153***	1	−2.514
Lawrence	3	−39.297***	5	−3.157
Kota	1	−39.919***	4	−2.592
Kanpur	1	−34.995***	5	−0.744
Indore	15	−7.806***	4	−2.945
Visakhapatnam	15	−4.175***	24	−3.041

***, ** and * denote significance at 1, 5 and 10% levels of significance
Optimal lag is selected based on min SIC information criteria

Table 4 Unit root test for maize markets

Maize market	First difference		Level	
	Optimal lag	Test statistics	Optimal lag	Test statistics
Nizamabad	3	−30.657***	6	−2.443
Naugachia	1	−38.722***	12	−2.816
Ahmedabad	7	−12.924***	2	−1.900
Gulabbagh	6	−5.476***	7	−2.811
Karimnagar	5	−8.816***	6	−2.841

***, ** and * denote significance at 1, 5 and 10% levels of significance
Optimal lag is selected based on min SIC information criteria

Table 5 Unit root test for soybean markets

Soybean market	First difference		Level	
	Optimal lag	Test statistics	Optimal lag	Test statistics
Nagpur	3	−23.784***	1	−2.784
Indore	17	−6.234***	6	−2.486
Kota	1	−42.036***	1	−2.493

***, ** and * denotes significance at 1, 5 and 10% level of significance
Optimal lag is selected based on min SIC information criteria

Table 6 Unit root tests for potato markets

	First difference		Level	
Potato market	Optimal lag	Test statistics	Optimal lag	Test statistics
Agra	17	−4.381***	4	−2.976
Burdman	4	−4.604***	1	−2.665

***, ** and * denotes significance at 1, 5 and 10% levels of significance
Optimal lag is selected based on min SIC information criteria

Table 7 Unit root tests for rice markets

	First difference		Level	
Rice market	Optimal lag	Test statistics	Optimal lag	Test statistics
Vadodara	1	−14.379***	1	−2.230
Visakhapatnam	6	−21.555***	7	−2.003

***, ** and * denotes significance at 1, 5 and 10% levels of significance
Optimal lag is selected based on min SIC information criteria

Following the modified Dickey–Fuller (Elliott et al. 1996, DFGLS) unit root test, the log value of price series for different commodities across markets has been found to be non-stationary. However, the first difference of different price series is stationary, i.e. integrated of order one. Based on these results, we could check for cointegration between prices in different markets which is used as a measure of spatial integration, i.e. when prices moved in tandem.

5.2 Market Integration: Johansen's Cointegration Approach

With prices first difference stationary, we next tested for bi-variate cointegration. Suppose a homogeneous commodity is traded in 'n' spatially separated locations with a corresponding price vector of $\{P_{1t}, P_{2t}, \ldots, P_{nt}\}$. These locations are said to be integrated if

(1) $\{P_{1t}, P_{2t}, \ldots, P_{nt}\}$ can be decomposed as $P_{it} = a_i f_t + \underbrace{P}_{it}, \quad i = 1, 2, \ldots n$
where f_t is the integrating vector that characterizes the permanent, i.e. long-run component and $\underbrace{P}_{it}$ is the transitory (short-run deviation) component for each market.
(2) For all $i, a_i \neq 0$.
(3) $P_i s$ are cointegrated with exactly $n - 1$ cointegrating vectors.

The standard model of price transmission is based on price correlation between two markets. A bi-variate cointegration model for price transmission can be represented by Eq. (1):

$$P_t^1 = \pi_0 + \pi_1 P_t^2 + \varepsilon_t, \tag{1}$$

where P_t^1 and P_t^2 are the prices of commodities in two spatially distinct markets 1 and 2. Cointegration between the two markets can be tested if the prices (P_t^1 and P_t^2) display the same order of integration (Engle and Granger 1987). In the two-step Engle and Granger test, the price transmission between the two markets is measured

through the ordinary least squares (OLS) approach where unit root tests are applied to the residuals.

Hence, the two market prices are said to be cointegrated if the residuals are stationary which suggests that there is a price adjustment mechanism between the two series and it converges to their long-term equilibrium relationship. The extent of integration defined as a set of markets that share common long-run price information has been tested within Johansen's cointegration framework.

In Engle and Granger formalization (1987), the two non-stationary series are said to be cointegrated if the following conditions are satisfied: (a) both the series are integrated of the same order, and (b) there exists a linear combination of these series which is I(0), i.e. stationary. Thus, while conducting cointegration analysis across different markets (as done above), the first step is to examine the integration properties of the relevant variable included in the model. The relevant variables here are the prices of commodities in spatially separated market. Here, since we are checking the spatial integration between central and different local markets across different agricultural commodities, we check for pairwise cointegration.

5.3 *Johansen Cointegration Test: Pairwise Cointegration Test Between the Local and Central Markets*

Since the logs of different price series were found integrated of order one, we checked for pairwise cointegration across central and local markets. For maize, we chose Nizamabad as central and Naugachia, Gulabbagh and Karimnagar as the local markets. Among four local markets, only two of them (Naugachia and Gulabbagh) were found cointegrated with the central market (Table 8). Though the distance between Nizamabad and Naugachia or Nizamabad and Gulabbagh is longer than the distance between Nizamabad and Ahmedabad or Karimnagar, still these markets were not integrated. This could be because of no trade happening between Karimnagar and Nizamabad (as they both are in the same state), but there could be substantial trade between Nizamabad, Naugachia (Bihar) and Gulabbagh (Rajasthan).

For wheat, Ludhiana was selected as the central market and others as local market. In wheat, all the local markets were found cointegrated with the central market at 5% level of significance. In wheat, since there is no major demand–supply

Table 8 Spatial integration in maize markets

Market pair	Trace statistics	Critical value
Nizamabad–Ahmedabad	4.47	3.76
Nizamabad–Naugachia	3.29*	3.76
Nizamabad–Gulabbagh	2.86*	3.76
Nizamabad–Karimnagar	5.17	3.76

*critical value at 5% level of significance
Markets with * sign are cointegrated

Table 9 Cointegration in wheat markets

Market pair	Trace statistics	Critical value
Ludhiana–Lawrence	2.18*	3.76
Ludhiana–Kota	2.01*	3.76
Ludhiana–Rajkot	3.52*	3.76
Ludhiana–Kanpur	1.41*	3.76
Ludhiana–Indore	2.26*	3.76
Ludhiana–Visakhapatnam	1.36*	3.76

*critical value at 5% level of significance
Markets with * sign are cointegrated

Table 10 Cointegration among soybean markets

Market pair	Trace statistics	Critical value
Nagpur–Indore	3.89	3.76
Nagpur–Kota	2.54*	3.76

*critical value at 5% level of significance
Markets with * sign are cointegrated

shortfall and with minimum support price and other government policies, there has been stability in prices across regions. Thus, almost all the markets in case of wheat have been found cointegrated (Table 9).

In the case of soybean, Nagpur and Kota markets have been found cointegrated, but no spatial cointegration has been observed between Nagpur and Indore markets. Again, the geographical distance between Nagpur and Indore is lower than the geographical distance between Nagpur and Kota. But the integration between Nagpur and Kota could explain the direction of trade between these locations (Table 10).

In two commodities, viz. potato and rice, we could get data only for two markets. In potato, the data were for Agra in Uttar Pradesh and Burdwan in West Bengal. In rice, the two markets comprised of Visakhapatnam in Andhra Pradesh and Vadodara in Gujarat. The checking for pairwise cointegration revealed that in neither potato nor rice, there is evidence for spatial integration.

Finally, we look, at one commodity where repeated price spikes and spatial variation in prices have been a first-order issue, it was onion. Given the historical behaviour of onion prices, we suspected the markets to be not integrated spatially. We considered three central onion markets, viz. Delhi, Bhavnagar and Pune and three local markets. Indeed, the results presented in Table 11 show that none of the combinations of central and local markets in onions is cointegrated. The price spirals in the onion markets highlight the impact of lack of spatial integration.

The tests for market integration have brought out a stark reality about Indian agricultural markets. Barring cereals, particularly of comparatively low-value and homogenous wheat and to some extent soybean, there is a robust evidence of lack of spatial integration in most markets. Even among cereals, the rice markets lack integration. Perishable products like onion do not have market integration leading to localized shortages aggravating price spikes. With the evidence of clear lack of spatial

Table 11 Spatial integration among onion markets

Onion markets	Trace statistics	Critical value
Delhi–Bhavnagar–Pune–Ahmednagar	137.42	47.21
	89.25	29.68
	46.38	15.41
	15.71	3.76
Delhi–Bhavnagar–Pune–Kurnool	151.72	47.21
	94.25	29.68
	47.18	15.41
	15.28	3.76
Delhi–Bhavnagar–Pune–Ludhiana	117.21	47.21
	69.41	29.68
	36.66	15.41
	16.37	3.76
Delhi–Bhavnagar–Pune–Lucknow	211.07	47.21
	96.07	29.68
	47.40	15.41
	17.50	3.76
Delhi–Bhavnagar–Pune–Patna	154.44	47.21
	95.41	29.68
	44.23	15.41
	15.81	3.76
Delhi–Bhavnagar–Pune–Nasik	115.39	47.21
	63.26	29.68
	30.91	15.41
	10.87	3.76

integration and hence limited price transmission, there certainly is a case for trying to get market integration along the lines that NAM proposes to do. Having made a case for fostering market integration through a national platform and seamless movement of goods, next we assessed the extent of readiness for the NAM.

We basically looked at the state of markets in the back end. Primarily, we looked at the mandis in terms of some basic infrastructure indicators such as area covered, density and age of the markets. The most basic indicator of the extent of market development is market density. We were also interested in assessing the age of markets.

6 State of Wholesale Markets in India

The data were collected from the Ministry of Agriculture, Government of India (http://agmarknet.dac.gov.in) where the market profiles are posted. We have collected the market profiles and compiled the entire market information into one

cross-sectional data set. The market profiles have information on the year of establishment, APMC regulation, some infrastructural and financial information and some information on products and diversification.

The first indicator that we looked at in the context of mandis in India was the age of market. In assessing the age of markets, we started with the question: what is the average age of the agricultural wholesale markets in India? This is important since the outreach of the markets and development of infrastructure takes time. Hence, other things equal if there is path dependence, the age of market could turn out to be an important indicator for market development. Those markets that started early could have a greater chance to develop. At the same time, newer markets can have better facilities because of being able to start from scratch and also because new technologies and marketing methods emerged over time.

Our findings show that the average age of markets across districts is more than 30 years for more than three-quarters of the districts in the country. In general, only a few markets have been established in the past three decades. The markets are comparatively old in parts of Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu, while they are somewhat newer in the northeast region. One issue with the data is that there are missing observations for the year of establishment of the markets for several districts and sometimes state as a whole. With the non-missing data, the Mungwali market in Ashok Nagar district is the oldest market in the country. Several markets seem to have emerged around 40 years ago in the northwest region of the country. One of the plausible reasons could be the green revolution in the late 1960s that raised the produce surplus available with the farmers to market.

If fewer new markets have been coming up, the market density has the resulting path dependence. The markets that exist are on average comparatively old (>31 years old); if the emergence of new markets is uniformly uncommon, the areas that have older markets also tend to have relatively higher market density. The most basic measure of market density that we started with was the number of agricultural wholesale markets in the district, i.e. irrespective of the size measure (in terms of area, population or cultivators). Findings show that Punjab and Maharashtra have relatively older markets (Fig. 4) and also have a higher market density.

Parts of Rajasthan and Gujarat also have older markets, but those markets are comparatively sparse (relative to coverage area) than in Maharashtra and Punjab. The southern states like Karnataka have a greater mix of markets of different vintages. Typically among southern states, the density lies between 4 and 8 markets in each district. Andhra Pradesh does not have very old markets (>45 years) or very new markets (<31 years). The markets in Andhra Pradesh are comparatively of middle age. Still, the density of markets in Andhra Pradesh has been found quite high in some districts.

6.1 Market Density

What is important from the NAM perspective is that the number of markets in each district, i.e. market density, is really low for most parts of other Indian states such as Rajasthan, Uttar Pradesh, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Odisha and northeastern states. The thinning of market density has a gradient where moving eastward the number of markets per district tends to fall (see Fig. 4). There is rough correspondence between the age of markets and the basic measure of market density. Yet, there are exceptions like the backward regions in Maharashtra. In the Vidarbha belt, there are comparatively old markets but the density is small. It is puzzling that the markets seem sparse in Gujarat. It needs to be validated whether this is a function of missing data or markets are actually missing. Indeed like the Vidarbha belt in Maharashtra, the marginal Saurashtra region in Gujarat and the desert belts would tend to have fewer agricultural markets. Overall, Amritsar in Punjab emerges as the district with the highest number of markets (20) in the country.

While NAM would provide an online platform for nationwide sale, the back end that relies on mandis would likely be affected because of extremely low density of markets in some areas. At the state level, Maharashtra leads in the number of markets, followed by Tamil Nadu, Madhya Pradesh, Andhra Pradesh, Punjab and Karnataka. Punjab has 163 markets while undivided Andhra Pradesh with a land

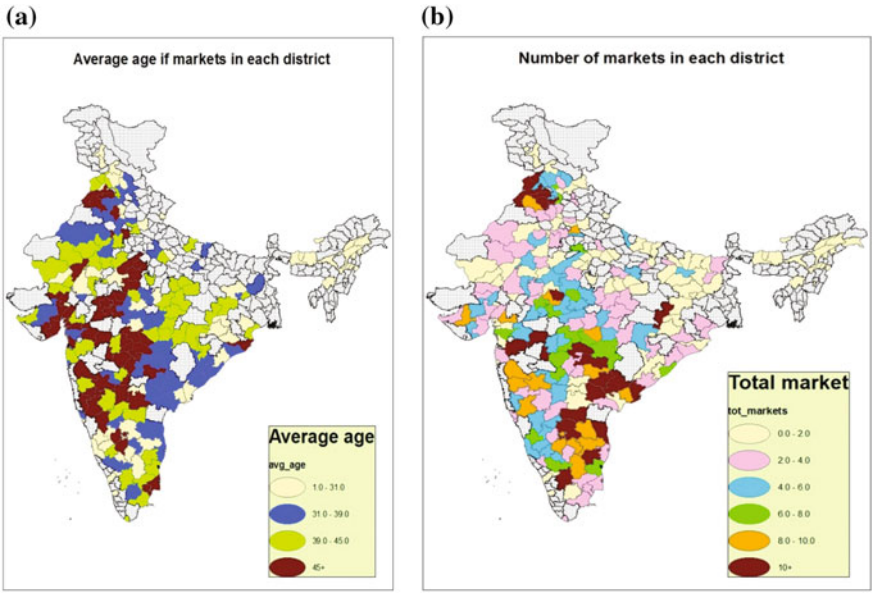


Fig. 4 The age of markets and market density in India: **a** Average age of markets in each district, and **b** Number of markets in each district

area of about four times more than Punjab has 169 markets. These differences in the number of markets in the form of basic measure of market density can easily overestimate or underestimate the effective coverage of the markets. To get a more accurate picture, the measure of number of markets needs to control for size. Different normalizations are possible based on measures of size such as land area, population or the number of farmers/cultivators.

6.2 Market Density Mapping

Using the data on the number of markets and the area of districts, we mapped market density normalized by different size measures pertaining to the district. Strikingly, density of markets per 2500 km^2 is mainly concentrated in the range 0–2 (conditional on available data). The interpretation is that in an area of 2500 km^2, on average there are just 0–2 markets for a vast majority of districts in the country. Punjab stands out with a density of >3 per 2500 km^2, which means that the districts in Punjab given their sizes have more than three markets in each 2500 km^2.

India has diverse geography and unevenly distributed population and density of markets in a region. Rajasthan is more than 2.5 times larger than Tamil Nadu in area; however, the population of Tamil Nadu is more than that of Rajasthan. Also, the number of markets in Tamil Nadu is 193, while it is just 84 in Rajasthan.

It would make better sense if we normalize the count of markets with the number of consumers that a market usually caters to. The district-level population data reflects that the distribution of population mostly lies in the range of less than 5 million (Fig. 5). We then normalized the market density per 2 lakh people. When normalized by population, the distribution of markets got dispersed and unlike the case of normalization by area, the mass of distribution was concentrated to less than 1 market per 2 lakh (0.2 million) people.

Most of the density is accumulated in the range of 0–5 markets per 0.2 million people (Fig. 5). The 75 percentile of the distribution of a number of markets by population lies at 0.67. Alternatively, it means that 75% of the districts do not have even 1 market for every 0.2 million consumers. This is also evident from map shown in Fig. 5b. Only exceptions are some districts in Punjab and some in Vidarbha region of Maharashtra.

The normalization with respect to the number of cultivators in a district shows that maximum mass is located in the range 0–5 markets per fifty thousand cultivators. The median of the distribution lies at 1.05, which means that there are zero to just about one market in the region with 50,000 cultivators. Spatially, the markets are dense in Punjab, Vidarbha and parts of Tamil Nadu, Karnataka and Andhra and Madhya Pradesh (Fig. 6).

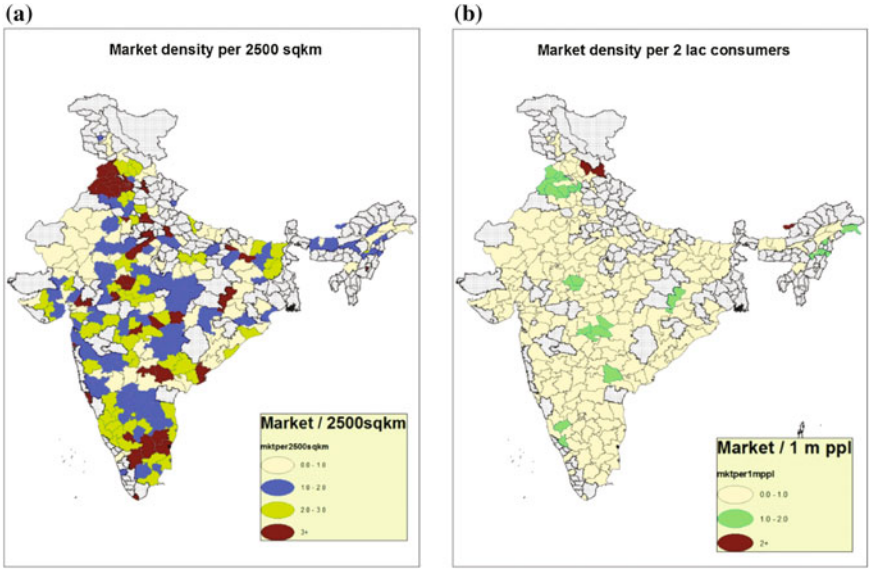
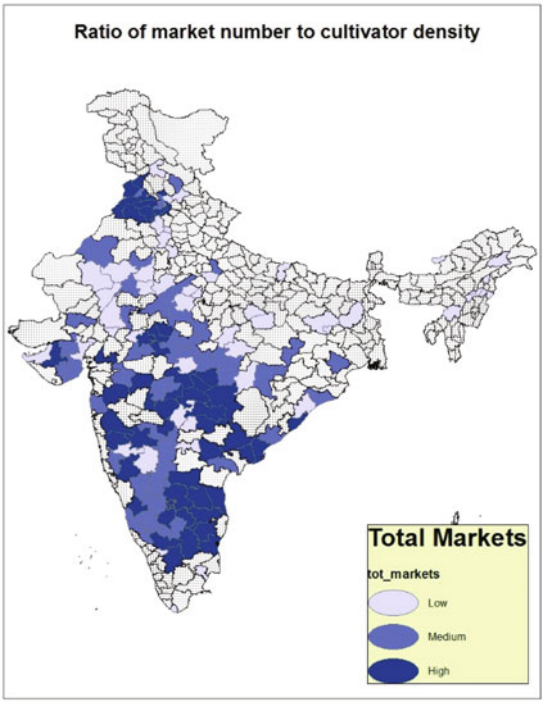


Fig. 5 Market density in India: **a** Market density per 2500 km^2 and **b** Market density per 2 lakh consumers

Fig. 6 Market density normalized by number of cultivators



7 Basic Indicators of Backend Infrastructure

Next, we look at the basic indicators of market development in the back end as part of the support for the proposed NAM. There are several markers of market development. For illustration, we have presented the most basic ones. Figure 7

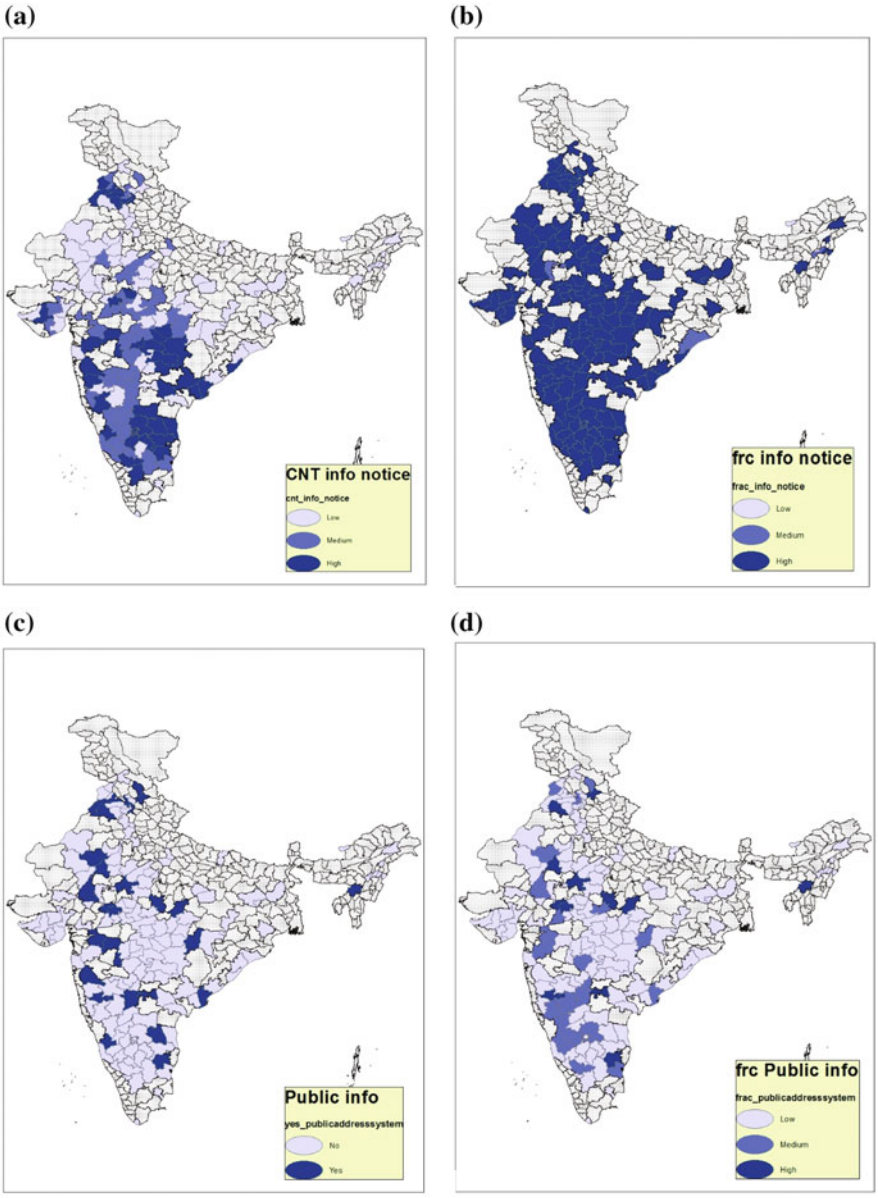


Fig. 7 Indicators of backend infrastructure in the wholesale markets of India

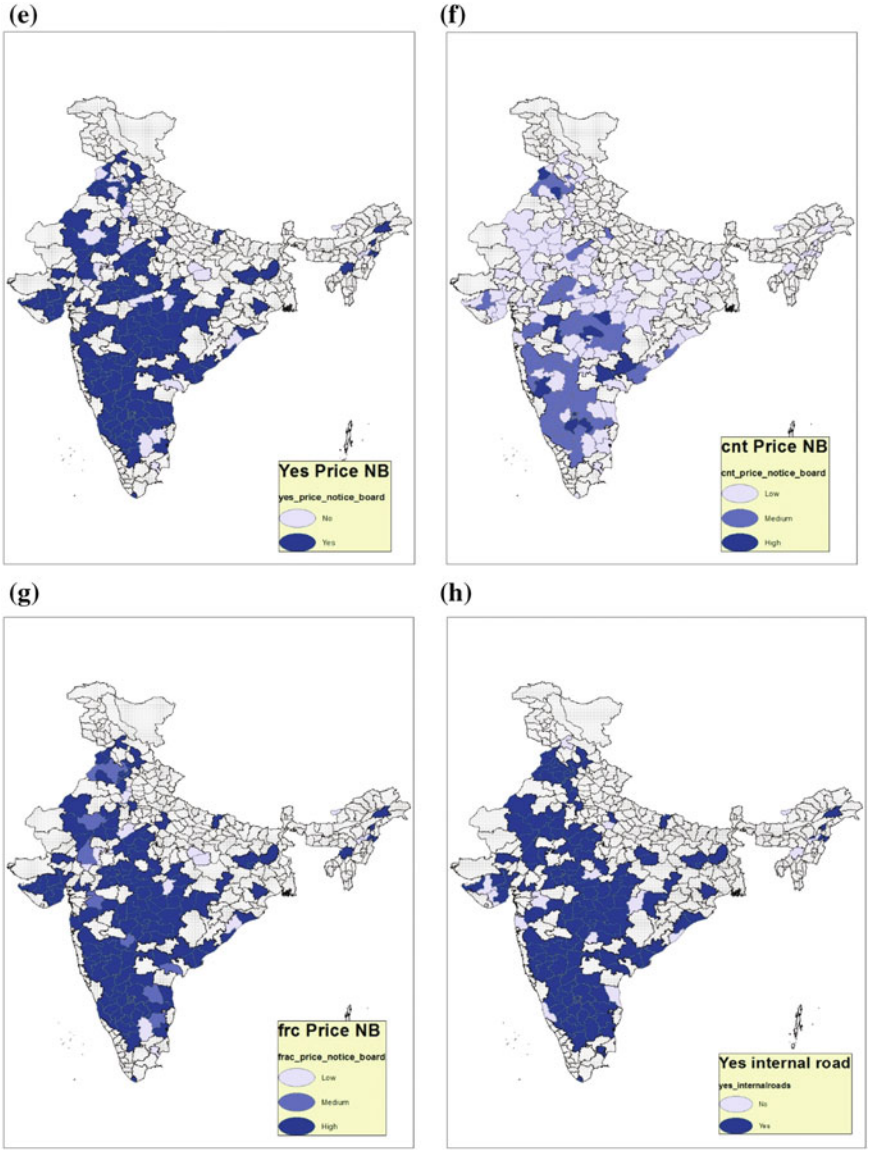


Fig. 7 (continued)

presents the markers for basic infrastructure like price notice boards, internal roads, information dissemination systems, parking spaces, etc. to highlight the lack of amenities at the back end to handle a big platform such as NAM.

According to the Economic Survey 2014, the typical amenities available in or around the APMCs are auction halls, weighbridges, godowns, shops for retailers,

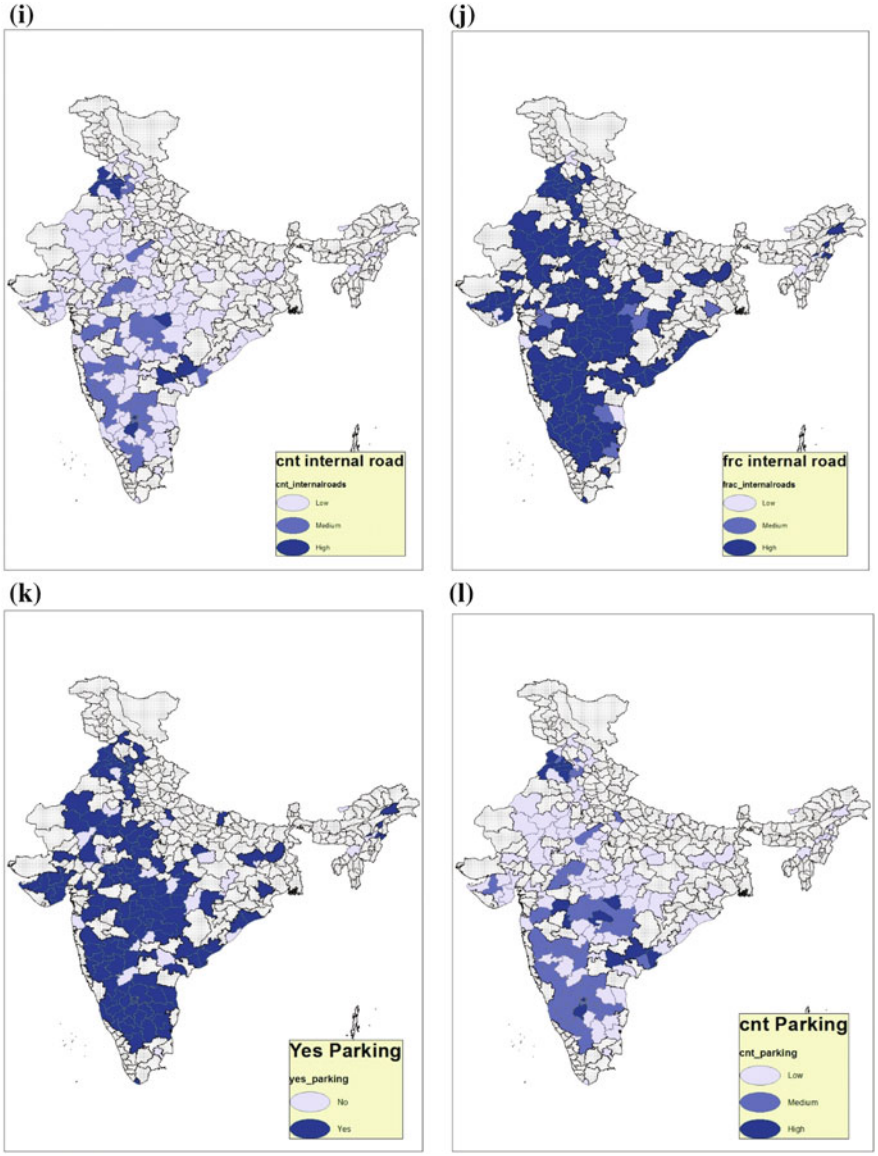


Fig. 7 (continued)

canteens, roads, lights, drinking water, police station, post office, borewells, warehouse, farmers amenity centre, tanks, water treatment plant, soil-testing laboratory, toilet blocks, etc. Various taxes, fees/charges and cess levied on the trades conducted in the mandis are also notified under the Act. The basic figures presented above show the overall lack of amenities and wide spatial variations.

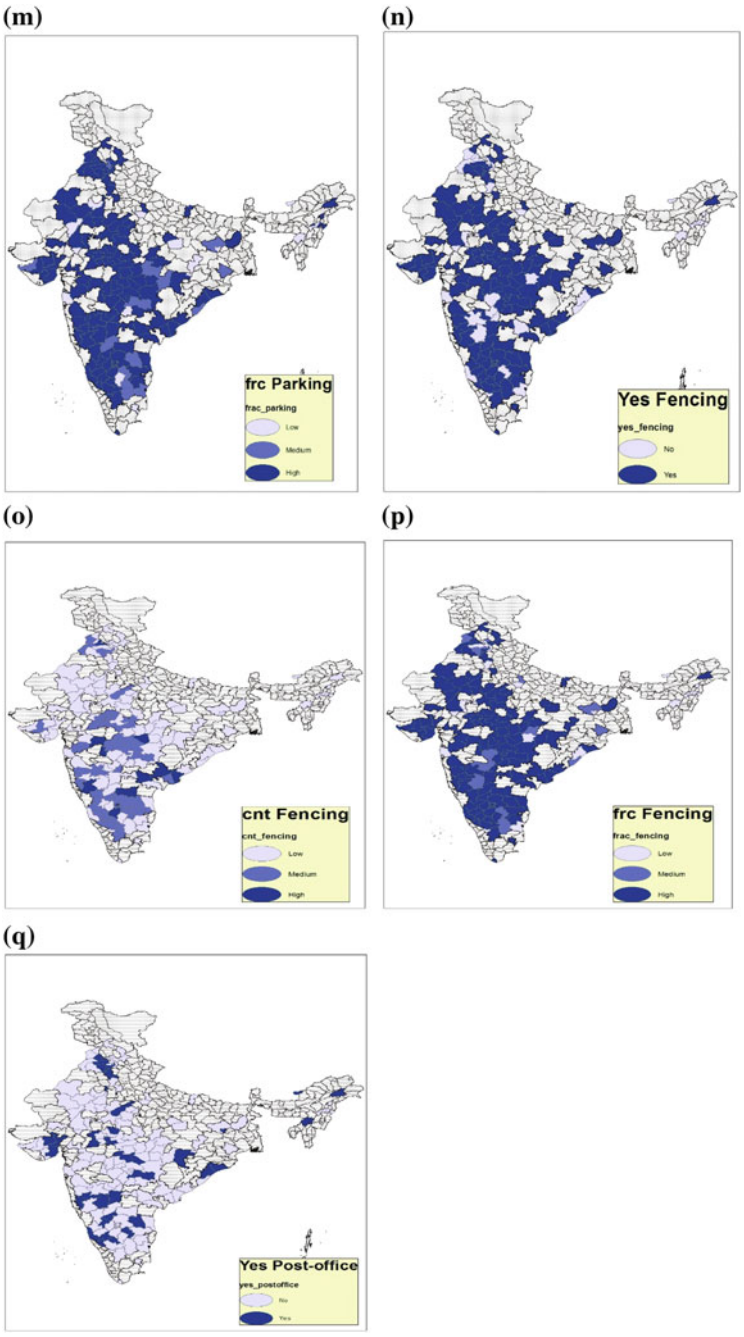


Fig. 7 (continued)

The functioning of NAM is highly dependent on proper information management. Towards this, even basic infrastructures like public notice board and price information systems are not in place in the mandis. If something like NAM were to function, the information on price not only in that mandi but also nationwide should be available in real time. Given their present status, as shown in Fig. 7a–q, they need to be strengthened for the NAM to be functional.

Prior to that, since NAM is a nationwide platform, the differential market density across regions can be a binding constraint. To operate on a large scale in the country as a whole, new markets will need to be opened if transactions are to be still mediated through mandis at the back end. If the level of transactions handled by individual mandis increases significantly post-NAM, the basic infrastructure like roads and parking will have to be improved from the uniformly very low level shown in the maps in Fig. 7a–q.

8 Conclusions

The Union Budget 2015 as well as 2016 has recognized the need for setting up a national market and stated that the central government will work closely with the state governments to reorient their respective APMC Acts to provide for the establishment of private market yards/private markets. The budget also announced that the state governments will be encouraged to develop farmers' markets in towns to enable the farmers to sell their produce directly.

The lack of integration across markets as revealed in this chapter undoubtedly makes a case for the establishment of an institution like National Agricultural Market (NAM). The analysis clearly shows that barring some low-value cereals, markets for most agricultural commodities lack integration. The subsequent analysis in the chapter shows that the preparedness for a platform like NAM is quite low on the back end.

Additionally, more steps may have to be taken to get the states on board. Steps might be needed for altering the product mix covered under APMC and since back end needs significant strengthening, state governments could also be specifically persuaded to provide policy support for setting up infrastructure, making land available, etc. The Government of India has liberal policy towards investment in the backend sector in terms of wholesale markets but has not been able to attract much private investment. Parallel to the setting up of NAM, the government could analyse the reasons for low private sector involvement and should take steps to increase the private investment in the wholesale market segment. The back end would require serious large-scale investment for the functioning of NAM comprising warehousing, cold storages, refrigerated vans, laboratories, grading facilities and certification mechanisms among others.

At some level, the NAM should dovetail with the other important similar policy, say Good and Services Tax (GST) which envisages a single unified market at the national level for goods and services, while ensuring that there is no negative

revenue impact on the states. The NAM has been launched to ensure efficiency in agricultural marketing. The GST proposes to introduce a single tax on supply of goods and services or both, by amalgamating all the central indirect taxes (excise duty, countervailing duty and service tax) and state indirect taxes (examples: VAT, luxury tax, entry tax and octroi). The GST seems to be more comprehensive, compilable, simple, harmonized and development-oriented tax system. The GST has so far faced significant political difficulty in being passed.

The establishment of NAM is likely to face similar problems of consensus building among states on various aspects dealing with revenue and implementation systems. The lesson learned in GST could easily be extended to NAM. The concept though does not propose to change the basic state-supported marketing structure but is aimed at integration to the national marketing system. The NAM would require amending of state regulations [such as Essential Commodities Act (ECA) and taxes)] that control the agricultural trade and harmonizing them across the states. If NAM results in scaling up of the operations, then the GST implementation will become relevant for agricultural traders.

Ultimately, the existing marketing structure under APMC can be incorporated into the NAM, but significant modifications will be required. For effectiveness and sustainability of NAM, the government has to provide several public goods in the back end such as roads, banking and communication facilities, etc.

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Optimal Institutional Architecture of Farmer Producer Organizations for Sustainable Value Creation for Small and Marginal Farmers

Amar K.J.R. Nayak

1 Introduction

Agricultural produce is largely perishable, but value addition can enhance its shelf life and can make it convenient to transport the processed products to far-off markets. The price realization for the agricultural produce can be accordingly enhanced. While the retail prices of agricultural produce have been rising, the price realization by small farmers has not risen commensurately (Nayak 2012; 2014a; Nayak et al. 2016). This trend has a significant impact on farmers, consumers and the overall economy.

There are several areas in which small farmers can be provided support to increase their farm income. In this chapter, we look at the nature and extent of institutional support for value addition in the agricultural produce, such that it enhances the net income of smallholder farmers.

The net income is a function of several variables, viz. production (*landholding, resource capabilities, productivity, agroclimatic conditions*), value addition and marketing of small surpluses. A small farmer may produce a few of the many possible agricultural commodities depending on his resource endowments and requirements for household consumption and market. Given the limited land, the surplus quantity of each item produced by the individual small farmers is relatively small. This situation favours the operations of local traders and local sahukars (shopkeepers) as intermediaries between small farmers and large traders or specialized food processors. In addition to lending money, local sahukars serve as single-window service providers, extending all types of credit, agricultural inputs and consumables facilities and procuring all types of produce from the smallholder farmers. Historically, the net income earned by small farmers in such market arrangements has not been favourable to them.

A.K.J.R. Nayak (✉)
XIMB, Xavier University, Bhubaneswar, Odisha, India
e-mail: amar@ximb.ac.in

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In the above context, the role of well-designed farmer producer organizations (FPOs) and their institutional architecture at the district level is visualized for higher value addition or income enhancement for the smallholder farmers. The producer organizations in the form of cooperatives exist for over a hundred years in India. The Primary Agricultural Cooperative Society (PACS) is one of the oldest forms of producer organizations in the country. In addition to the cooperatives, there are many other forms of producer organizations that cater to some specific or multiple function(s) such as Self-Help Groups (SHGs), Federation of SHGs, Common Interest Groups (CIGs), Joint Liability Groups (JLGs), Farmers Clubs and Producer Companies.

In recent years, the focus of the Government of India (NABARD), Small Farmers Agriculture Consortium (SFAC), state governments and various developmental agencies has been towards the producer companies. International development agencies including World Bank, UNDP and IFAD, have also been showing interest in investing in these organizations. NABARD alone has formed over 2000 FPOs during the past 2–3 years. Similarly, SFAC and other developmental agencies have also formed a couple of thousands of FPOs since Producer Companies Act was initiated in 2002.

Despite the considerable emphasis on different forms of farmer producer organizations, the plight of farmers across the country has not improved. In fact, the problems of farmers are rather increasing. Empirical evidence show that the overall performance of producer companies, the new generation of FPOs in India, does not seem to have significantly increased the net incomes of smallholder farmers yet.

We are aware that well-established value chains exist in the industrial production sectors, viz. Maruti Suzuki supply chain, Toyoto supply chain, Hindustan Unilever distribution chain, Global delivery model in IT industry, etc. The idea of developing value chains for agricultural commodities to improve the well-being of small farmers presumes an industrial model of value addition. But, will adoption of such value chains be suitable for agriculture? In other words, is there a need to reconstruct an appropriate value-creating network that fits the characteristics of small farmers, agricultural produce and technology-capital lock-in effect?

Given the experiences, constraints of industrial value chains, empirical evidence and action research on FPOs of small farmers, this chapter presents an alternate perspective to value addition mechanism for higher income generation for small famers. The chapter first discusses the inherent limitations of industrial model of value chain in subsistence agriculture, and then suggests an institutional architecture of FPOs at the grass-root level for higher value generation for all stakeholders in the chain. The chapter argues that the assumptions for industrial model of value addition on size, scope, technology, management, ownership, market landscape and governance structure are different from agricultural model for sustainability of small and marginal farmers. Based on a survey of over 250 FPOs and in-depth analysis of 21 of these FPOs during 2011–2014 and also study of one FPO for over 8 years (2008–2015), the chapter suggests an optimal institutional architecture for value addition and marketing that enhances value creation for producers and consumers at

a lower transaction cost, and connects small producers to global markets without disrupting their capabilities of diversity.

2 Industrial Model of Value Chain in Agriculture

The industrial model of value creation has been popularly explained and understood through a value chain analysis (Porter 1985). It is a systematic analysis of all components of a value creation process by an organization or company. It includes the external supply system to obtain raw materials, key internal processes within the company and the distribution system of products manufactured by a company. As the focus of analysis in this model is the company, it simplifies the analytical framework. The raw material or component procurement is studied through a supply chain analysis. The internal processes include the coordination among various support functions of the company, viz. manpower, physical infrastructure, finance and accounting, inbound and outbound logistics, production operations, research and development, advertisement and marketing, etc. The distribution of the manufactured products to different markets is facilitated by the outbound logistics and external transport systems, wholesalers, distributors and retailers.

The industrial production process is a closed system and the products need to be standardized. The 'economies of scale' is the technical basis through which industrial production becomes efficient. For achieving economies of scale, the production unit has to specialize in producing any one item. To specialize and produce in large volumes, the organization or company needs to provide high-end technology, which could consist of both process technology and product technology. Both in-house development of product technology and purchase of process technology are expensive and require large capital. The cost of management also rises due to the complex management hierarchy that would evolve with the increased size of operations. When an organization or company seeks more capital, its ownership structure gradually changes; and a few private capital investors take over the control of the company. Industrial production gives rise to large national and global corporations, which subsequently could be the eye of the storm in an economy and society and be the cause for greater inequity (Vernon 1972; 1998; Stiglitz 2002).

An industry with a large production base requires an appropriate institutional architecture of an industrial market economy to flourish. The physical infrastructure, social infrastructure, educational institutions, banking, capital markets, regulations, policies, etc., all gradually get aligned to facilitate industrial production. The monoculture of industrial production fights to replace the small-scale production by masses and gradually destroys the diversity of agricultural production. This agricultural production gets modelled on the basis of industrial production design and agricultural value chains.

The prime objective of this industrial value creation process is to increase the economic gains of the financial investors or shareholders of the company, where the

bulk of shares is held by a few resourceful shareholders. The rest of the population in this scale-based industrial production system constitutes workers or professionals working as employees in these large hierarchical organizations. The wages and salaries less taxes become their source of income for material well-being.

Would the industrial value chain model fit the agriculture sector, especially to the small and marginal farmers in India? It appears that the characteristics of agriculture and small farmers are inconsistent with the design of industrial value addition and value distribution method. Let us now look at the basic characteristics of agriculture and small farmers in India.

3 Characteristic of Agriculture and Small Farmers in India

While the efficiency of production in industrial system is '*economies of scale*', the efficiency of production in agriculture is '*economies of scope*'. The diversified agriculture with multiple commodities that stays closer to ecology is now being established as the sustainable agriculture. This is being reiterated now by the agricultural scientists, research institutions, policy-makers and international development agencies by advocating for sustainable agriculture. Agriculture by nature is an open system of production vis-à-vis the closed system of industrial production. Agricultural produce is perishable, much faster than industrial products. In short, agricultural production is inherently different from industrial production. Given this core difference between agriculture and industrial manufacturing, value addition methods and institutional architecture adopted in the present industrial production may not fit to agriculture.

In India, a small farmer in agricultural context could be characterized as someone who holds or owns very little private property in terms of land, assets and resources. She/he is one with minimal education and has limited access to information, knowledge, capital and technology. The individual family health as well as the community health is poor. The primary education available for children in a village or the community is usually weak. These characteristics of small farmers in Indian agriculture are clearly different from the entrepreneurs in an industrial production system.

Given the land and resource base of a small farmer and the need to meet the basic food security and nutritional security of her/his family, the small farmer practises subsistence farming. This type of farming leads to multiple cropping and may generate small surpluses in different agricultural produce. Aggregation of these surpluses by a community-based FPO can possibly provide better value to producer based on economies of scope. This is contrary to the purpose and method of industrial production. The objective of an entrepreneur in industrial production is to rotate capital and the method of production is economies of scale. The factors of production including employees, suppliers and products in industrial production are usually driven by contracts and not long-term relationships.

4 Value Chain, Technology, Capital and Ownership Lock-Ups

The product-specific value chain has its own dynamics and complexities. An organization operating on a single product uses the 'economies of scale' principle for its efficiency. The product-specific value chain in agriculture would lead to sourcing of raw produce from a very large geographical base of farming communities to build volumes. The large volume of collection would accordingly require large processing units and facilities. In order to increase the shelf life of perishable agricultural produce and to be able to sell it in large volumes in distant markets, there is a need for technology for processing, storing and transportation. The procurement of technology requires large capital that necessitates the ownership of such operations to be held by large capitalists.

Path dependency (Leibowitz and Margolis 1995) is one of the key characteristics of any technology, whether it is product technology or process technology in any sector or industry. Path dependency is the tendency of an individual or organization to be gradually locked into any particular product or process technology. Several studies argue for less capital-intensive production technology in agriculture that is appropriate for smallholder farmers (Howard 1940; Alvares 2009; Rupela 2011; Nayak 2014b).

It is also observed that farmer organizations that work on a linear value chain model lead to complex technological processes and they do not tend to perform well. Masuta PC, Vanilco PC, Vasundhara PC and Samagri PC are a few examples that focussed on single product and adopted a typical industrial value chain model (Nayak 2014a). The net incomes of farmer members in these well-known FPOs have not been sustainable. While there is clearly a need for aggregation and value addition of agricultural produce and farmers including small farmers, the current framework of value creation tends to defeat the purpose of making the farmers better off. Given the logical lock-up of value chain-technology-capital-ownership structure and the inability of small farmers to contribute large capital to buy expensive processing, packaging and transportation technology, how do we design greater value-creating system for farmers?

5 Value Addition as Value Destruction of Agricultural Produce

Different forms of value addition are being undertaken in different agricultural commodities. Amongst cereals, rice is polished of its brown shell, and the roughage of both wheat and maize is also polished out. Amongst pulses, pigeon pea (arhar) is first polished of its husk and then treated with tetrazine to give it smoothness and consistent yellow colour. This chemical is considered to kill appetite and is carcinogenic. Most of the pulses are stored with boric powder to keep them away from

insects and pests. Obviously, these chemicals being harmful to human beings, actually reduce value of the commodity. Interestingly, knowing the loss of value and harmfulness of these processes, the new wave of consumerism has been for whole grains.

Vegetables are sprayed with pesticides and injected with chemicals to make them fresh and healthy and to increase shelf-life. Fruits like apples, grapes, pear, etc., that travel to far-off markets are polished and sprayed with wax and chemicals. The use of these chemicals is rather poisonous to human health and drastically reduces the value of food. Therefore, unlike in industrial products, high value addition in agricultural produce can lead to value destruction.

6 Income for Small Farmers or Gross Turnover of FPO

While the intent of aggregation of small surpluses of small farmers has been to enhance their net income, often this has been difficult to achieve. Increase in gross income at producer organization level is generally perceived to be an indicator of net income to the farmer. Instead, accounting for transaction costs of aggregation, value addition and marketing in distant markets could provide a fair understanding of the value created (net income per unit of produce) for small farmers.

An estimation of transaction cost of an FPO in markets at different locations and distances from an FPO (Table 1) shows the dynamics of transaction costs and net incomes for different products. Connecting small farmers through existing value chain does not seem to offer a good deal to farmers owing to high hidden costs of transactions. Instead selling produce in local market by an FPO gives better net income to farmer members. For instance, Nava Jyoti Producer Company, formed by tribal farmers of Nuagada and Gulluguda panchayats of Rayagada district, ensures a better net price to farmers. Nava Jyoti PC deals with all types of produces; such as pulses, cereals, cashew, hill broom, leasing farm machinery, production, consumption and emergency credit services as well as preventive health care, sanitation and other services needed by farmer members. FPOs that have adopted industrial model of value chain do not seem to create much value for the small producers. Table 2 provides evidence on the relatively low average income earned by individual farmer members, even if the gross turnover achieved by respective producer organizations has been large.

7 Value Chain or Value Network for Agricultural Produce

Empirical evidence of producer companies that have been in operation for nearly 10 years, as shown in Table 2, does not seem to show sustainable returns to small farmers. Further, gross monthly income per farmer member of a small cooperative

Table 1 In-season; selling price, transaction cost and net price of different products to Nava Jyoti PC farmers in different markets, 2011–2014 (in Rs/kg)

Product	Local community market			District capital market			State capital market		
	Selling price	Transaction cost (15%)[a]	Net selling price	Selling price	Transaction cost (35%)[a]	Net selling price	Selling price	Transaction cost (60%)[a]	Net selling price
Pigeon pea/Arhar (whole)	60	9	51.00	62	21.70	40.30	55	33	22
Pigeon pea/Arhar (dal)	80	12	68.00	70	24.50	45.50	88	52.8	35.20
Cow pea/Jhudungo (whole)	70	10.50	59.50	60	21.00	39.00	80	48	32
Black gram (whole)	60	9	51.00	60	21.00	39.00	80	48	32
Black gram (dal)	80	12	68.00	75	26.30	48.80	84	50.4	33.60
Turmeric powder	120	18	102.00	90	31.50	58.50	190	114	76
Vegetables (beans, bottle gourd, bitter gourd, lady finger and brinjal)	30	4.50	25.50	15	5.25	9.80	18	10.80	7.20
Cashew seed	90	13.50	76.50	90	31.50	58.50	PNT	–	–
Hill broom	50	7.50	42.50	50	17.50	32.50	35	21	14
Mahua dry flower	22	3.30	18.70	22	7.70	14.30	PNT	–	–

PNT Product Not Traded in this market

[a]The margins are based on overall marketing experience of Nava Jyoti PC in these markets over a 5-year period

Source Nayak (2014c)

Table 2 Farmer Producer Organizations (FPOs), gross turnover and average gross income for farmers

FPO/PC name	Year of registration	No. of members (Farmers)	Market landscape and distance from FPO	Gross annual turnover of FPO (in crore rupees, 2012–2013)	Gross income per farmer per month (rupees)
Amalsad Vibhag Vividh Karyakari Sahakari Mandali, Gujarat	1941	7934	Local markets in the first 20 years and later export markets were added later	44.58	4683
Kaira District Cooperative Milk Producers' Union (AMUL), Gujarat	1946	3.18 million	National markets through outlets and retailers	25,990	6810
Karnataka Milk Federation, Karnataka	1984	2.23 million	Markets within the state	7332	2740
Mulukanoor Women's Cooperative, Telangion	2000	21,000	Markets within the district and nearby districts	70.50	2780
Masuta Producer Company Ltd., Jharkhand	2005	1937	National market and exports	3.23	1390
Rangasutra Producer Company, New Delhi	2004	1025	National market	3.07	2500
Vanilla Producer Company Ltd., Kerala	2004	3000	National market and exports	1.0	280
Indian Organic Farmers Producer Company Ltd., Kerala	2004	1404	Exports on order	1.4	833
Vasundhara Agri-Horti Producers Company Ltd., Maharashtra	2004	54 PCs (50,000 farmers)	1300 km	4.4	74
Krushi Dhan Producer Company Ltd., Gujarat	2005	200	Outlets for supplying agricultural inputs	0.065	270

Source Nayak (2014a). *PC* Producer Company

such a Amalsad Cooperative, appears to be higher than the state level or district-level dairy cooperative such as Nandini or Mulukanoor. These empirical observations throw a question of how we need to look at value creation for small farmers.

Could the industrial product value chain framework could be used for the agricultural products? Further, given the pattern of production and consumption of agricultural produce, can we adopt the value chain framework of industrial products for agricultural produce? Agricultural production is widespread to meet the consumption needs of population. The location of food production is also the location of consumption, and habitations around it are also the location for consumption. More than a ***value chain system***, as in the production and consumption of industrial products, a ***value network system*** may best describe the production and consumption of agricultural commodities.

The following section proposes an institutional architecture for FPOs that has potential to overcome the limitations of previous models of intervention. It discusses the FPO architecture at the block and district levels for the sustainability of farmers and agriculture in India.

8 Optimal Institutional Architecture of FPOs

The optimal size of an FPO consists of no more than 1000 farm families in a cluster of villages and hamlets with a natural resource base of about four contiguous microwatersheds. For easier understanding and appreciation of geographic boundary of the cluster of villages and hamlets by the stakeholders as well as effective implementation, Gram Panchayat appears to be the optimal boundary for an FPO. The FPO at this level has the '*economies of scope*' to undertake primary value addition activities such as aggregation, drying, grading, basic processing, packing, storage, transportation and marketing in the nearby markets. These value addition activities can help farmers to capture nearly 80% of the value of most of their agricultural produce. Further, the architecture of forward and backward linkages is such that the total distance travelled by the bulk of any agricultural produce from the point of production to the point of consumption is significantly reduced.

Further value addition to agricultural produce can be undertaken better at the block level. Each block in a district could specialize in value addition of a single product category such as pulses, cereals, minor millets, spices, vegetables, fruits, etc. Value-added agricultural products at the block level can be sold back to the villages in the district and the balance surpluses of value-added items could be collated at the district level for marketing at state, national and global levels. The big food retail chains can place their demand at the district level to get their supplies. An optimal architecture of FPOs at various levels (village, block and district) is shown in Fig. 1.

The overall district-level map of the architecture of FPOs is shown in Fig. 2, which suggests the upper boundary limit of the value network, that is the district.

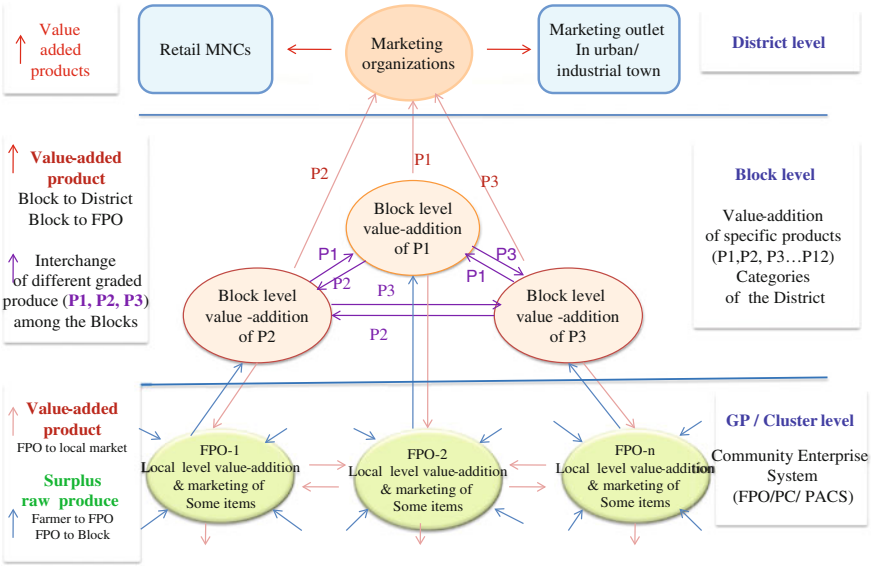

Fig. 1 Optimal institutional architecture of FPOs in GP–Block–District ecosystem. *Source* Nayak (2013)

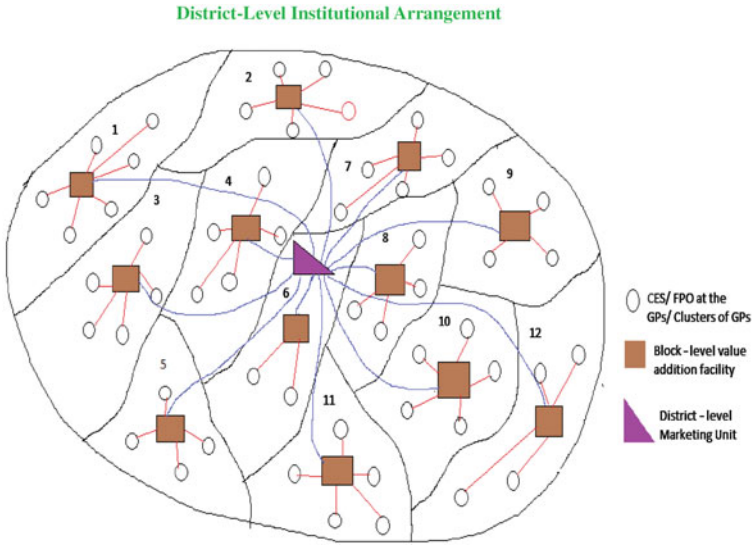

Fig. 2 Institutional arrangement of FPO. Number *1–12* refer to the blocks in a district; *CES*–Community Enterprise System that is equivalence of an optimal FPO; *GP*–Gram Panchayat that may consist of a cluster of villages and hamlets

A network larger than this is dysfunctional as has been observed in the case of SHG federation in Andhra Pradesh, sugar cooperatives in Maharashtra and dairy cooperatives in several states of India such as Gujarat. Given the constitutional provisions for local planning and governance at village and district levels, the proposed structure fits well to the existing administrative structure. Decentralization of decision-making on tax utilization by people and convergence of external resources into the village-level FPOs can greatly help in sustained value creation.

In addition to optimality in size of membership and geographic spread, a sustainable FPO adopts economies of scope in its list of produce and engages in multiple service needs of the community; such as health, education and infrastructure. The issues like technology, management and ownership are also to be simultaneously optimized at individual FPO level. Market landscape of the FPO also needs to be optimized within a market distance of about 200 km to fit with other design features such as product and service basket of the FPO (Nayak 2014c).

9 Conclusions

Summing up, given that diversity is the basis of agricultural productivity, that food and nutritional security is the prime concern of small farmers, that small farmers with small surpluses when transacting individually with large traders or processors have a disadvantage in price negotiations, we need to develop a value network of FPOs from GP level to block level and to district level.

The optimal architecture of FPOs in a district can become the core competence of agriculture and small farmers in terms of diversity or economies of scope at the village-level FPO, facilitates specialization and economies of scale at the block-level network of FPOs and economies of scale at the district level for marketing surplus value-added agri-products to traders or processors in the state, national and global commodity markets. Accordingly, agricultural policy and rural development policy need to provide financial support for developing optimally designed FPOs at Gram Panchayat (GP) level, specialized value addition facility at the block level that is jointly owned by the FPOs of respective block and scale-based marketing of processed and packaged food products at the respective district level, jointly owned and managed by the FPOs of the district and the district administration.

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Impact of Market Reforms on Integration of Food Markets in India

Madhusudan Ghosh

1 Introduction

During the past two decades, agricultural marketing system has witnessed significant changes worldwide due to the liberalization of trade in agricultural commodities in line with the provisions under the Agreement on Agriculture (AoA) of the World Trade Organization (WTO). Under the changed situation with immense global market access opportunities, the agricultural marketing system needs to be strengthened, integrated and made efficient for the benefit of farming community. An efficient agricultural marketing system is considered essential for the development of the agricultural sector, since it provides outlets and incentives for production and contributes greatly to the commercialization of agriculture. Recognizing the importance of liberalized agricultural markets, India, like many other countries, has embarked on liberalizing the agricultural commodity markets in the context of implementing comprehensive economic reforms involving structural adjustment and liberalization programmes since the early 1990s. It has been argued that liberalization of agricultural commodity markets can lead to allocative efficiency and long-term growth in agriculture. Economic liberalization, involving increasing withdrawal of government interventions from the agricultural commodity sector, made agricultural prices dependent on the market forces. The government interventions are likely to distort price signals in the spatially separated markets because of which agricultural prices may not converge efficiently, and regional markets may remain segmented. Such interventions may insulate regional markets from one another and act as barriers to spatial market integration, defined as a situation in which the prices of a commodity in spatially separated markets move together and price signals and information are transmitted smoothly. On the

M. Ghosh (✉)
Department of Economics and Politics, Visva-Bharati, Santiniketan 731235, West Bengal, India
e-mail: msghosh123@rediffmail.com

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other hand, liberalization of agricultural commodity markets can strengthen spatial market integration by removing the barriers to the movement of commodities across markets and allowing price signals and information to be transmitted smoothly and the market forces to determine agricultural prices.

A series of domestic market reforms have been introduced to improve the efficiency of marketing system and to attract private investment. The Agricultural Produce Marketing Committee (APMC) Act was revised, and a Model APMC Act entitled 'State Agricultural Produce Marketing (Development and Regulation) Act, 2003' was introduced by the Ministry of Agriculture, Government of India, in September 2003. The Model APMC Act 2003 (hereafter, the Model Act) has the provisions for setting up of private markets/yards, consumers/farmers market centres for direct purchase/sale, contract farming and for promoting public–private partnership in the development and management of agricultural commodity markets. As agricultural marketing is a state subject, the Ministry of Agriculture has been persuading the state governments for more than a decade to modify their respective APMC Acts along the lines proposed in the Model Act.

A number of policy reforms, liberalizing domestic trade in agricultural commodities, have been adopted. Some of these include (a) relaxation of restraints on inter-state movement of food grains, (b) restructuring of the public distribution system, (c) liberalization of licensing requirements and stocking limits for wholesale and retail trade, and of selective credit controls used to regulate institutional credit to traders, (d) curtailment of state trading activities, (e) relaxation of restrictions under the Essential Commodities Act, 1955, (f) permission to the corporate sector to enter the agricultural markets through contract farming, (g) permission to many domestic and multinational firms to participate in the marketing and processing of agricultural products, (h) introduction of forward trading in many agricultural commodities and (i) removal of marketing restrictions on some crops.

The extent to which agricultural commodity markets are spatially integrated (efficient) has important implications for market liberalization and other reform programmes. From a policy standpoint, it is also important to know how these reforms alter the convergence of prices across geographically dispersed market centres. Do the liberalization policies indeed affect the degree to which price signals are transmitted to different markets and, if so, what is the nature of this relationship? The importance of these and other questions for agricultural development has led to a number of empirical studies investigating the spatial integration of agricultural commodity markets. For example, Dercon (1995) argued that since the extent of spatial market integration determines the transmission speed of price changes due to any policy reforms across regional markets, the effects of market liberalization should be evaluated on the basis of what happens to the prices for producers and consumers and also on the basis of functioning of agricultural markets. He found that liberalization had a positive impact on the functioning of Ethiopian grain markets through increased short-run integration. Based on the performance of Indonesian rice markets, Ismet et al. (1998) argued for limiting government interventions in the integrated markets by rationalizing its price stabilization and buffer stock activities, and allowing the private sector to contribute as much as possible.

In the Indian context, a few studies (e.g. Ghosh 2000, 2003, 2010; Ghoshray and Ghosh 2011; Jha et al. 1997, 2005; Palaskas and Harriss-White 1993) have evaluated the spatial integration of agricultural commodity markets. However, no study seems to have evaluated the impact of reforms along the lines of Model Act on spatial integration (efficiency) of agricultural commodity markets. A few studies have examined the impact of general economic reforms initiated in India since 1991 on spatial market integration in agriculture (see, for example, Ghosh 2011, 2013). Needless to say, this type of study is important because of its obvious policy implications. The success of policy reforms along the lines of Model Act in improving the spatial efficiency of agricultural markets may be evaluated in terms of their impact on the degree of spatial integration of these markets.

Using the maximum likelihood method of co-integration, this chapter examines the impact of reforms in the APMC Act on spatial integration of Indian wheat markets. In particular, we examine whether Indian wheat markets are in spatial equilibrium, and whether the reforms along the lines of Model Act have improved spatial integration of the markets by strengthening the relationship among the wheat prices quoted at various market centres in four selected states of India. Some of the ideas contained in this chapter are drawn from my works (Ghosh 2011, 2013).

2 The Model APMC Act and the Reforms

The agricultural marketing system in India was highly regulated with various restrictions. This type of marketing mechanism has yielded ineffective and inefficient farm–market linkages, leading to high transaction costs, post-harvest losses and lower income to farmers. Many regulations were in existence, controlling the storage, transportation, exports, imports and direct marketing of agricultural produce by farmers. The APMC Act was passed in 1963 with the intentions to regulate agricultural commodity markets and to protect the farmers from market shocks and help them to get the justified price for their produce. It has, however, been argued that this Act has yielded inefficiencies in the agricultural markets over the past several years. A competitive marketing system could not emerge in the country largely due to the monopoly of regulated agricultural markets. While exercising monopoly power in the functioning of the markets, the APMC markets have not provided any assistance to farmers in direct marketing, organizing retailing, adopting innovative marketing system and technologies and supplying raw material to agro-processing industries. By mandating the selling of agricultural commodities through regulated markets, the farmers are prohibited from direct selling of commodities to consumers. The bureaucrats exercise absolute power in the management of APMCs, and market fees are charged for each transaction, raising the transaction costs. The statutory levies and other charges have been a major source of market distortion with cascading effects on commodity prices passing through the supply chain. For wheat, the taxes/levies were 14.5% of the minimum support price

(MSP) in Punjab, 11.5% in Haryana, 8.5% in UP and 3.6% in Rajasthan in January 2014 (Government of India 2015).

The regulated marketing system suffers from ineffective laws, lack of information flows and quality check, high transaction costs for farmers, lack of options other than broker system, dual role of broker and wholesaler, etc. Due to the deficiencies in the traditional supply chain, the farm–market linkages have become weak and imperfect (Pachouri 2012). This leads to lower marketing margins to farmers, but high prices for retailers and consumers. The margin in transactions between buyers and sellers at the wholesale markets varied between 13 and 26% (Minten et al. 2009). Banerji and Meenakshi (2004) have argued that the regulated marketing system lacks integration and efficiency, causing a high level of wastage of produce. Similarly, Chand (2012) has argued that the marketing system has been suffering from inefficiency, policy distortion, poor infrastructure and fragmented marketing channels with no connection between prices paid by consumers and those received by producers. Thus, the APMC Act, introduced to promote fair trade in agricultural commodities, has become the major impediment to the development of agricultural markets.

Recognizing these problems, the Indian government has initiated some fundamental reforms in the agricultural marketing system to remove the inefficiencies in the traditional supply chain. As a step towards liberalization of agricultural markets, a government order was issued on 15 February 2002, removing the licensing requirements and all restrictions on buying, stocking and transporting select commodities, including wheat, rice, oilseeds and sugar, which were further decontrolled thereafter. The Model Act was introduced by the Ministry of Agriculture, Government of India, on 9 September 2003 in order to protect the interests of farmers and to promote private sector's participation in agricultural marketing, removing the monopoly of brokers and barriers in the prevailing marketing system. The Act provides for improved regulation in marketing of agricultural produce, development of efficient marketing system, promotion of agri-processing and agricultural export, establishment and proper administration of markets, and effective infrastructure for marketing. It provides for direct marketing of agricultural produce, contract farming, establishment of markets in the private and cooperative sectors and development of infrastructure by the private sector. The key features of the Act, as reported in Government of India (2015), are the following. The Model Act

(i) provides for the direct sale of farm produce to contract farming sponsors;
(ii) allows contract farming under written agreement recorded in the market committee and enables e-trading;
(iii) provides for setting up 'special markets' for 'specified agricultural commodities', mostly perishables;
(iv) permits private persons, farmers and consumers to establish new markets for agricultural produce in any area to facilitate direct sale of agricultural produce to consumers;
(v) proposes a single levy instead of multiple levies of market fee on the sale of notified agricultural commodities in any market;

(vi) requires registration in place of licensing of market functionaries, allowing them to operate in a single or multiple markets;
(vii) allows spending of the revenue earned by the APMC for the development of marketing infrastructure;
(viii) allows the establishment of private market yards and purchase of agricultural produce directly from farmers;
(ix) provides freedom to the farmers to sell their produce directly to the contract-sponsors or in the market set up by private individuals, consumers or producers;
(x) allows common registration of market intermediaries with a view to increasing the competitiveness of the markets for agricultural produce.

The state governments have been advised to implement the marketing reforms along the lines suggested in the Model Act. Table 1, reporting the status of reforms in the APMC Act, shows wide variations in the extent of marketing reforms across the states; while some are reform-oriented, others are either intermediate reformers or lagging reformers.

In order to reduce the multiple layers of intermediaries and to provide the farmers the opportunity for direct selling of agricultural produce through alternative marketing channels, some states have taken initiatives in this regard by establishing farmers' markets like *Apni Mandi* (Punjab, Haryana), *Kisan Mandi* (Rajasthan), *Safal* (Karnataka), *Shetkari Bazars* (Maharashtra), *Hadaspur Vegetable Market* (Pune), *Rythu Bazaars* (Andhra Pradesh), *Uzhawar Santhai* (Tamil Nadu) and *Krushak Bazaars* (Odisha). Since market information is very important for the agricultural marketing system, the Ministry of Agriculture (GoI) introduced the ICT-based Central Sector Scheme of Marketing Research and Information Network (MRIN) in 2000 to provide regular and timely information regarding prices of

Table 1 Status of reforms in the APMC Act across different states/union territories in India

Status of reforms	States/union territories (UTs)
States/UTs where reforms to APMC Act have been implemented	Andhra Pradesh, Arunachal Pradesh, Assam, Goa, Gujarat, Himachal Pradesh, Jharkhand, Karnataka, Maharashtra, Mizoram, Nagaland, Odisha, Rajasthan, Sikkim, Tripura and Uttarakhand
States/UTs where reforms to APMC Act have been implemented partially	(a) *Direct Marketing*: Chhattisgarh, Madhya Pradesh and NCT of Delhi (b) *Contract Farming*: Chhattisgarh, Haryana, Madhya Pradesh, Punjab and Chandigarh
States/UTs where there is no APMC Act and hence do not require reforms	Bihar (repealed in 1.9.2006), Kerala, Manipur, Andaman and Nicobar Islands, Dadra and Nagar Haveli, Daman and Diu and Lakshadweep
States/UTs where APMC Act already provides for the reforms	Tamil Nadu
States/UTs where administrative action is initiated for the reforms	Haryana, Jammu and Kashmir, Meghalaya, NCT of Delhi, Uttar Pradesh, West Bengal and Puducherry

Source Government of India (2013)

agricultural products prevailing in the markets. As marketing infrastructure is crucial for the growth of integrated marketing system, the *Grameen Bhandaran Yojana* (Rural Godown Scheme) was launched in 2001 to provide assistance for creating scientific storage capacities with allied facilities. In 2004, the Ministry of Agriculture (GoI) introduced a scheme called 'Development/Strengthening of Agricultural Marketing Infrastructure, Grading and Standardization'. The scheme provides for investment subsidy on the capital cost of building general and commodity-specific marketing infrastructure, and for strengthening and modernization of the existing rural, wholesale and periodic agricultural markets. Since the scheme is linked to reforms, such facilities are extended to those states, which have amended the APMC Act by allowing setting up of agricultural markets in the private and cooperative sectors (Government of India 2013).

Some of the recent initiatives, taken by the Government of India in agricultural marketing, include: (i) Recognizing the need for setting up a 'common national market' for agricultural commodities, the Union Budget 2014–2015 stated that the Centre would work closely with the states so that necessary amendments are made in their respective APMC Acts for establishing private market yards/markets; (ii) The Department of Agriculture (GoI) has approved Rs. 200 crore to be spent through Agri-Tech Infrastructure Fund (ATIF) during 2014/2015–2016/2017 for the promotion of National Agricultural Market as a 'common national market' through e-platforms; (iii) The states were advised to declare their respective entire state a 'single market' with one license valid across the entire state, and to remove all restrictions on movement of agricultural commodities within the state (Government of India 2015).

3 Analytical Approach

3.1 Co-integration

Two markets are considered to be spatially integrated if, in the presence of trade between them, the price in importing market (P_{it}) is equal to the price in exporting market (P_{jt}) plus the transport and other transfer costs involved in moving goods between them (T_t). This happens because of the spatial arbitrage condition given by $P_{it} = P_{jt} + T_t$. If the prices are stationary, market integration and the Law of One Price (LOP) can be examined by estimating the regression Eq. (1):

$$\ln P_{it} = a + b \ln P_{jt} + \varepsilon_t \tag{1}$$

where ε_t is a random error term; ln is natural logarithm. The absolute LOP, saying that the prices of a commodity in two different markets are equal and their co-movement is perfect and price changes in the exporting market are transmitted to the importing market on a one-for-one basis, holds when $a = 0$ and $b = 1$. The relative LOP, saying that the prices have a proportional relationship and their levels differ due to factors like transportation and other transfer costs, holds when $a \neq 0$ and $b = 1$.

However, when prices are non-stationary, co-integration is considered to be an appropriate method for testing the market integration and the LOP. This method can be used even in a situation when the co-movement of prices is less than perfect, prices are simultaneously determined and there are seasonal variations in transfer costs. As co-integration implies that there exists a linear long-run relationship between non-stationary variables in question, the co-integration test for market integration evaluates whether there is a statistically significant linear long-run relationship between different price series. If this relationship exists, then the markets are said to be spatially efficient (integrated) in general.

The maximum likelihood (ML) method of co-integration (Johansen 1988; Johansen and Juselius 1990) has been applied to test for market integration. This method, besides providing tests for the general notion of market integration, allows testing for the relative LOP in bivariate as well as multivariate settings. As the relative LOP holds for a group of commodity prices when each pair of the prices moves proportionally to each other, the multivariate test for it requires that there is only one common stochastic trend in the system, obtained when the prices are pair-wise co-integrated. With n prices in the system, the pair-wise co-integration requires that there must be $n - 1$ co-integrating vectors and hence, only one common stochastic trend. In general, with n prices and r co-integrating vectors, there will be $n - r$ different stochastic trends (Stock and Watson 1988). Hence, the relative LOP as implied by pair-wise co-integration (i.e. when all the prices share a common stochastic trend) is a stronger proposition than the general notion of market integration, as implied by the presence of at least one co-integrating vector (and multiple stochastic trends) in a multivariate system. While the relative LOP necessarily implies that markets are integrated, integration of markets does not necessarily satisfy the LOP. This signifies that the number of co-integrating vectors is an important indicator of the extent of co-movement of prices. An increase in the number of co-integrating vectors implies an increase in the strength of market integration.

For assessing the impact of reforms in agricultural marketing system along the lines of Model Act on spatial market integration applying the co-integration method, we need to examine the extent of market integration during the post-reform period vis-à-vis the pre-reform period. Since spatial market integration, essentially based on trade flows, is viewed as a situation where price signals and information are transmitted to different markets so that the prices in spatially separated markets move together over time, any policy that improves the process of trade flows and the mechanism through which price signals and information are transmitted smoothly across spatially separated markets, would strengthen spatial integration of markets. Naturally, the reforms in agricultural commodity markets would make trade flows smoother and allow the market forces to play a greater role in price determination, increasing thereby the extent of market integration. From an econometric point of view, this would mean that the number of statistically significant co-integrating vectors should be larger in the post-reform period than in the pre-reform period. A pre-requisite to setting up of a 'common national market' for agricultural commodities is that the prices of a commodity quoted at various market centres across the country follow a common trend, satisfying the relative LOP.

3.2 Data

The data set used in this study consists of monthly wholesale prices of wheat for the period March 1984–December 2012. In order to compare the extent of wheat market integration between the pre- and post-reform periods, we have divided the entire period into two sub-periods. Since the Model Act was introduced in September 2003 and the reform process in agricultural marketing system along the lines of the Act was initiated since then, we have considered March 1984–September 2003 (1984: 3–2003: 9) as the pre-reform period, and October 2003–December 2012 (2003: 10–2012: 12) as the post-reform period. It may be noted that some liberalization policies in internal and external trade in agricultural commodities have been initiated from the mid-1990s, and hence their effects would be felt in the agricultural commodity prices and markets. However, since the reform process has been continuous, the effects of these policies would be reflected in the extent of spatial market efficiency during the post-reform period as defined here.

The data on wheat prices quoted at different market centres of the selected states were compiled from various issues of *Agricultural Situation in India* (a monthly journal published by the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India), *Agricultural Prices in India* (Ministry of Agriculture, Government of India), and *Indiastat*. The choice of states and the market centres from each state was constrained by the availability of consistent data for the period. Four major wheat-producing states, viz. Haryana, Punjab, Rajasthan and Uttar Pradesh were selected, and the market centres chosen from each state were: Ambala, Karnal, Rohtak and Sonepat from Haryana; Amritsar, Barnala, Jalandhar and Ludhiana from Punjab; Alwar, Bharatpur, Jaipur, Jodhpur, Kota and Sriganganagar from Rajasthan; Bahraich, Gorakhpur, Jhansi and Kalpi from Uttar Pradesh. The prices of the *Mexican* variety of wheat reported in Ambala, Karnal, Rohtak and Sonepat have been used for Haryana. For Punjab, the prices of *WL-711/Kalyan* variety quoted in Amritsar, Barnala, Jalandhar and Ludhiana have been used. For Rajasthan, we have used the prices of the *Mexican* variety collected from six market centres, viz. Alwar, Bharatpur, Jaipur, Jodhpur, Kota and Sriganganagar. Finally, for Uttar Pradesh, the prices of the *Mexican/FAQ* variety quoted in Bahraich, Gorakhpur, Jhansi and Kalpi have been used. By choosing the comparable varieties of wheat across market centres and states, we assume that price variability would be due to spatial and seasonal effects and not so much due to various differences. However, as Table 1 shows, there has been a significant variation in the extent of reforms done in the APMC Act across the selected states. Rajasthan is the most reform-oriented state, where reforms to APMC Act have been implemented; Punjab and Haryana are the intermediate reformers with partial reforms; and Uttar Pradesh is the lagging reformer, where administrative action has been initiated for the reforms. This allows us to see whether the degree of market integration depends on the extent of reforms.

4 Impact of Agricultural Policy Reforms

Before conducting the co-integration test, we need to evaluate the univariate time-series properties of the data to see whether all the prices are non-stationary and integrated of the same order. We have applied the augmented Dickey–Fuller (ADF) test (Dickey and Fuller 1979, 1981) to all the prices of wheat for the pre- and post-reform periods. The ADF test statistics for the wheat prices in levels and first-differences are reported in Table 2. The results reveal that the null hypothesis of non-stationarity (unit root) cannot be rejected for the prices in levels, but it can be rejected in their first-differences for both the pre- and post-reform periods. The prices are, therefore, non-stationary in levels but stationary in first-differences. This

Table 2 The ADF test for stationarity in wheat prices

Market centre	Pre-reforms period (1984: 3–2003: 9) $N = 235$		Post-reforms period (2003: 10–2012: 12) $N = 111$	
	Level (τ_τ)	First-difference (τ_μ)	Level (τ_τ)	First-difference (τ_μ)
Haryana: Mexican variety				
Ambala	−1.713 (10)	−9.850 (3)*	−2.693 (5)	−6.337 (3)*
Karnal	−1.528 (10)	−8.190 (5)*	−2.725 (5)	−6.400 (2)*
Rohtak	−1.378 (10)	−7.510 (5)*	−2.209 (6)	−6.560 (3)*
Sonepat	−2.053 (10)	−8.370 (4)*	−2.909 (5)	−5.920 (4)*
Punjab: WL-711/Kalyan variety				
Amritsar	−2.596 (8)	−8.599 (4)*	−2.916 (2)	−6.055 (3)*
Barnala	−2.720 (7)	−8.457 (4)*	−2.816 (5)	−6.456 (2)*
Jalandhar	−2.865 (7)	−8.669 (4)*	−2.685 (7)	−6.368 (3)*
Ludhiana	−2.271 (8)	−9.994 (2)*	−1.984 (2)	−5.646 (4)*
Rajasthan: Mexican variety				
Alwar	−2.868 (8)	−8.640 (3)*	−2.441 (5)	−5.758 (4)*
Bharatpur	−2.561 (8)	−7.999 (4)*	−2.783 (6)	−6.910 (4)*
Jaipur	−2.194 (8)	−7.997 (4)*	−2.304 (4)	−5.305 (3)*
Jodhpur	−2.792 (7)	−8.797 (4)*	−2.189 (4)	−6.268 (2)*
Kota	−2.812 (9)	−7.612 (4)*	−2.481 (6)	−5.722 (3)*
Sriganganagar	−2.560 (7)	−9.782 (2)*	−2.224 (4)	−5.169 (3)*
Uttar Pradesh: Mexican/FAQ variety				
Bahraich	−2.724 (8)	−7.709 (5)*	−2.762 (4)	−5.771 (3)*
Gorakhpur	−2.728 (8)	−9.005 (4)*	−2.530 (9)	−6.730 (2)*
Jhansi	−2.919 (7)	−9.640 (3)*	−2.426 (6)	−7.305 (4)*
Kalpi	−2.911 (8)	−7.654 (4)*	−2.907 (4)	−6.442 (3)*

*Denotes significance at the 1% level. Figures in parentheses are the optimal numbers of augmenting lags selected by the Akaike Information Criterion (AIC). For $N = 235$, the 1 and 5% critical values for τ_τ are: −3.999 and −3.433, and for τ_μ: −3.467 and −2.881. For $N = 111$, the 1 and 5% critical values for τ_τ are: −4.04 and −3.45, and for τ_μ: −3.507 and −2.889. N is the number of observations. The results were estimated using STATA 8.2

Source Author's estimates

implies that all the series of wheat prices contain a single unit root and are integrated of order one, I(1) for both the periods.

For investigating the impact of agricultural policy reforms on spatial integration of wheat markets, we have evaluated the long-run relationship between the prices of state-specific variety of wheat quoted at spatially separated locations in each state. The maximum likelihood trace statistics, reported in Table 3, reveal two significant co-integrating vectors for the *Mexican* variety of wheat traded at the market centres in Haryana and Rajasthan during the pre-reform period. However, there is only one statistically significant co-integrating vector for the *WL-711/Kalyan/Mexican/FAQ*

Table 3 Results of co-integration for spatial integration of selected wheat markets

Pre-reforms period (1984: 3–2003: 9)				Post-reforms period (2003: 10–2012: 12)			
Eigen value	Trace test			Eigen value	Trace test		
	Null	Trace statistics	5% critical value		Null	Trace statistics	5% critical value
Haryana (*k = 10 for the pre-reform period and k = 2 for post-reform period*)							
0.129	r = 0	61.85*	47.21	0.416	r = 0	120.81*	47.21
0.067	r ≤ 1	30.82*	29.68	0.294	r ≤ 1	62.19*	29.68
0.061	r ≤ 2	15.11	15.41	0.195	r ≤ 2	24.14*	15.41
0.004	r ≤ 3	0.97	3.76	0.005	r ≤ 3	0.516	3.76
Punjab (*k = 10 for the pre-reform period and k = 1 for the post-reform period*)							
0.137	r = 0	73.86*	62.99	0.318	r = 0	78.94*	54.64
0.120	r ≤ 1	40.61	42.44	0.183	r ≤ 1	36.80*	34.55
0.078	r ≤ 2	21.78	25.32	0.102	r ≤ 2	14.55	18.17
0.016	r ≤ 3	3.56	12.25	0.024	r ≤ 3	2.68	3.74
Rajasthan (*k = 7 for the pre-reform period and k = 2 for the post-reform period*)							
0.170	r = 0	118.17*	94.15	0.316	r = 0	134.36*	104.94
0.130	r ≤ 1	75.61*	68.52	0.276	r ≤ 1	92.93*	77.74
0.086	r ≤ 2	43.81	47.21	0.186	r ≤ 2	57.76*	54.64
0.057	r ≤ 3	23.22	29.68	0.166	r ≤ 3	35.38*	34.55
0.035	r ≤ 4	9.79	15.41	0.087	r ≤ 4	15.52	18.17
0.007	r ≤ 5	1.57	3.76	0.049	r ≤ 5	5.54	3.74
Uttar Pradesh (*k = 10 for the pre-reform period and k = 2 for the post-reform period*)							
0.115	r = 0	63.46*	62.99	0.208	r = 0	55.83*	47.21
0.081	r ≤ 1	35.88	42.44	0.169	r ≤ 1	30.46*	29.68
0.050	r ≤ 2	16.88	25.32	0.086	r ≤ 2	10.29	15.41
0.023	r ≤ 3	5.32	12.25	0.004	r ≤ 3	0.41	3.76

*Indicates significance at the 5% or lower level

k = Optimal number of lags selected by the Akaike Information Criterion (AIC). The estimated VAR includes a constant and a trend for the pre-reform period in Punjab and Uttar Pradesh; it includes a trend for the post-reform period in Punjab and Rajasthan; it includes a constant for the pre-reform period in Haryana and Rajasthan, and for the post-reform period in Haryana and Uttar Pradesh. The results were estimated using STATA 8.2

Source Author's estimate

variety of wheat traded at the market centres in Punjab and Uttar Pradesh during the pre-reform period. Thus, the regional wheat markets in all the states were spatially integrated to an extent during the pre-reform period.

The extent of spatial integration of the markets has unambiguously improved in all the states post-reforms, as the number of significant co-integrating vectors has increased, *albeit* with some variations across the states, during post-reform period vis-a-vis pre-reform period. The number of co-integrating vectors has increased from two to four in Rajasthan, from two to three in Haryana and from one to two in Punjab and Uttar Pradesh. The biggest increase is observed in Rajasthan, the state where the reforms to the APMC Act have been implemented extensively. The number of co-integrating vectors has increased in Haryana (where the reforms to the APMC Act have been made partially) to the extent that the wheat prices quoted at the regional markets in the state have followed a common stochastic trend and therefore, are co-integrated pair-wise, satisfying the relative LOP. As intermediate reformers, Punjab and Uttar Pradesh have also experienced an improvement in the extent of spatial integration of wheat markets post reforms. Thus, the regional wheat markets, which were integrated to some extent during the pre-reform period, become integrated to a greater extent during the post-reform period.

The extent of market integration appears to be positively related to the extent of reforms in the marketing system, suggesting that further reforms in the APMC Act and minimization of government interventions in agricultural commodity markets would further improve spatial efficiency in the markets. It may be noted that infrastructural development policies for storage and transport and communication networks would also strengthen spatial integration of the markets by reducing transaction costs. Hence, the reforms in the marketing system in the presence of good physical and institutional infrastructures would strengthen market integration greatly by helping the movement of agricultural commodities and the transmission of price signals and information smoothly across spatially separated markets. The finding of an increase in the extent of integration of the wheat markets after the reforms and the tendency of the wheat prices to move towards a common stochastic trend extend support to the proposal of declaring each state a ‘single market’ and the idea of setting up a ‘common national market’ for agricultural commodities in the country.

5 Summary and Conclusions

Using the maximum likelihood method of co-integration, the study has examined the impact of marketing reforms along the lines of the Model APMC Act on spatial integration of wheat markets in India. Reforms in the APMC Act have been undertaken in the states *albeit* with significant variations in the extent of reforms across the states. Against this background, the study has investigated whether the reforms have improved the spatial efficiency of the markets by strengthening the relationship among the wheat prices quoted at various market centres in four

selected states, viz. Haryana, Punjab, Rajasthan and Uttar Pradesh. The results reveal that the regional wheat markets, which were integrated relatively weakly during the pre-reform period, have become integrated to a greater extent during the post-reform period. By and large, the extent of market integration has been associated positively with the magnitude of reforms in the marketing system, suggesting that further reforms in the APMC Act and minimization of government interventions in agricultural commodity markets would further improve spatial efficiency in the markets. The government could promote the development of agricultural markets by limiting its direct intervention in the markets, but increasing its role in improving the physical and institutional infrastructures, including storage facilities, transport and communication networks and short- and long-term finances to the private traders. The finding of an improvement in the degree of integration of wheat markets after the reforms and the tendency of the wheat prices to move towards a common stochastic trend lend support to the proposal of declaring each state a 'single market' and the idea of setting up of National Agricultural Market as a 'common national market' for agricultural commodities in the country.

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