

Full Length Research Paper

Food supply chain management in Indian Agriculture: Issues, opportunities and further research

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Received 22 November, 2013; Accepted 6 July, 2014

This paper is an attempt to explore the problems faced by Indian agriculture for food security in terms of inadequate infrastructure and highly inefficient supply chain in context of information technology. Due to lack of efficient infrastructure and food processing industry about 30-35 per cent of all foods produced in India are wasted. This paper examines the critical issues at each sub-system of agriculture supply chain, starting from the input to the consumer, with a view to integrating them in efficient and effective manner. Investments in cold chain infrastructure, applied research in post-harvest technologies, installation of food processing plants in various sectors and development of food retailing sector are mandatory for achieving gains in this sector. Paper broadly covers some of important aspects of agriculture supply chain in India- identification of issues at different levels in the supply chain; transformation in the agriculture due to various supply chain interventions; the role of ICTs in supply chain management; and this paper also covers the suggestion to improve efficiency at different levels in supply chain. There is wide research gap in this sector, having such potential and prospectus for overall growth there is not much research in this field. The paper concludes that efficient supply chain plays very important role for development and contemporary issue for agriculture therefore; government action must address the issue of infrastructure development to achieve the objective of food security for all.

Keywords: Agriculture, infrastructure, supply chain, food security, development, investment.

INTRODUCTION

Agriculture has been the backbone of Indian economy since independence and before that, right now with nearly 12 percent of the world's arable land, India is the world's third-largest producer of food grains, the second-largest producer of fruits and vegetables and the largest producer of milk; it also has the largest number of livestock. Add to that a range of agro-climatic regions

and agri-produce, extremely industrious farmers, a country that is fundamentally strong in science and technology and an economy which one of the largest in the world with one of the highest growth rate and you should have the makings of a very good harvest.

Yet the comprehensive outlook for Indian agriculture is far more complex than those statistics might suggest.

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The sector supports an estimated 70 percent of the Indian population, but is also the most sluggish, having just extricated itself from a period of negative growth of -0.1 percent in 2008-2009, to rise to an unspectacular 0.4 percent in 2009-2010 with upward revision in the production, 'agriculture, forestry and fishing' sector in 2010-11 has shown a growth rate of 6.6 per cent, as against the growth rate of 5.4 per cent in the Advance estimates. Adjusted for inflation, even this 6.6 percent growth looks unexciting when compared to the growth rates in services and manufacturing. Today, agriculture accounts for 13.8 percent of the country's gross domestic product, compared to 51 percent in the 1950s (Government of India, 2011). Worse, India is amongst the world's largest wasters of food and faces a potential challenge to provide food security to its growing population in light of increasing global food prices and the declining rate of response of crops to added fertilizers.

The reforms of 1991 have introduced Indian agriculture to the globalization which has very significant impact on agriculture and supply chain. And further analysis of secondary data says that first part of reforms brings out that there was a visible deceleration of growth in agriculture during the post reforms period. It also comes out that the growth of agriculture exports which picked up after 1991 slowed down after 1996-97 have stagnated since then and in fact it went down and fluctuating in nature as it picked up due to some policy reforms and good monsoon in 2010-11 and it raised to growth rate of 5.4 percent. The deceleration of agriculture growth was also accompanied by visible deceleration of growth in growth rate of employment. The growth rate on employment collapses to nearly zero during that period. The data on both barter and income terms of trade show that both of them had some improvement in mid-eighties up to 1996-97 but had stagnated since then. All these data and information point out that agriculture sector is a lagging sector in the Indian economy and farmers and other agricultural workers engaged in this sector have not been able to derive much benefit from the new economic policies initiated in 1991.

For strengthening agricultural production and productivity for farmers and economy, the governments had taken various initiatives, most of which were on the production side to ensure food security in the country. As a result, agricultural production in India had a remarkable growth after the mid-1960s, with adoption of the green revolution technologies. This growth certainly led the country to being food deficit country to food surplus country, but at the cost of excessive utilization of natural resources and further, raised issues of sustainability in agriculture. The other crucial problem that constraints the growth of the agricultural sector is that public investment in agriculture as a percentage of GDP has been declining gradually. A policy analysis of agricultural system shows that there is multiplicity and duplicity of rules and

regulations dealing with various components of supply chain in agriculture. Lack of coordination among these, again, leads to the poor alliance and collaboration supply chain, which in turn leads to inefficient product and information flow.

Thus, this paper broadly covers some important aspects of agriculture supply chain in India- identification of issues at different levels in the supply chain; transformation in the agriculture due to various supply chain interventions. It also tries to recommend activities to improve efficiency at different levels in supply chain. The paper explores the aspect of value supply chain as it very significant for development and contemporary issue for agriculture therefore; government must address the issue of infrastructure development to achieve the objective of food security for all.

Objectives of the study

There is basically two most important objective of the study:

1. To assess the importance of supply chain in Indian Agriculture.
2. To explore the issues, importance and scope of further research in Indian Agriculture.

Literature Review

Literature review is the base of understanding of subject. The literature review covers many areas related to the nature of the research questions put forward, and thus includes: agriculture, food management, supply chain approaches, information technology and supply chain interfaces. The references were traced by looking at the reference list and relevant papers found in journals have been tackled as well. The literature sources are mainly books, scientific journals, conference proceedings, dissertations, projects documentations, and management-oriented publications. These sources are of particular importance and engender all research process development, especially the early phase for initial exploration of the food supply chain management.

METHOD

The focal point of this paper has been supply chain mechanism in Indian agriculture. It has been assessed through primary and secondary data and information obtained through application of scientific research method by formulating research design. The research was conducted by utilization of diverse kind of methods to assess the objective which includes research methods such as case study, in-depth interview content analysis, triangulation method, observation method for primary data and information in Jharkhand (India), from June-July 2013 with farmers and officials of

Reliance Fresh. Secondary data are taken from reliable sources such as annual reports of ministry of agriculture, ministry of food processing, Food Corporation of India, research papers of authors with reputation, article and book review from reputed national and international journals, Economic survey etc.

Limitations of the study

The major limitations of the study are as follows:

1. The paper has been prepared based on the data collected from the published and unpublished secondary sources.
2. The study findings are based on the limited coverage of selected literature and data available.
3. Poor availability of secondary sources of data, especially on agricultural infrastructure.

An assessment of agricultural supply chain

The paper mainly focuses on supply chain management in Indian agriculture. One can say that it is an integral part of the organisation drive and direction. SCM represents the way to customer retention and growth, competitive advantage and profitability. But enough attention has not been given to possible ex-ante measures to reduce, mitigate or share risks, although in some circumstances assessments will be conducted during/after adverse 'shocks' and attention will certainly be needed on workable coping strategies. There is also lack of emphasis on both formal and informal risk management options available to the different parties, although in practice, most analytical attention will likely focus on the scope for improving or supplementing formal mechanisms, including institutional and financial arrangements, technological changes, adoption of improved management practices, and/or investments in infrastructure. If the overall assessment is focused on the position and welfare of poorer farmers, then greater attention would need to be given to alternative informal mechanisms and improving their efficacy. The study also suggests that no attention has been paid to areas categorized as 'high vulnerability', either for individual chain participants or the chain as a whole. This high vulnerability may already be evident from recent/past experience or be expected due to unfolding changes in market conditions, regulations, or other circumstances.

Assessment of food supply chain management has not been given its due attention and that should be undertaken on the needs/options for policy and regulatory reforms that affect farmer/agro-enterprise risk management as well as the possible revision/reform of governmental risk management instruments. Aspects like cold chain need to be given more consideration as it has contributed tremendously to trade in fruits, vegetables

and flowers in developed countries and it could be game changer in India. Besides, cold chain results in the reduction of losses and retention of the quality of horticultural produce. While the introduction of a cold chain facility nationwide due to some institutional, structural and financial constraints may not be immediately possible in India, attempts must be made to develop a cool chain. Food loss reduction is less costly than an equivalent increase in food production. If efforts are not made to modernize the harvest handling system for horticultural crops, then postharvest losses will continue to have a negative economic and environmental impact. There is no doubt that postharvest food loss reduction significantly increases food availability.

Collaboration between supply chain partners has been reducing and will reduce risk and greatly improve the efficiency of overall pipeline. Supply chain efficiency therefore relies heavily on the successful long-term relationships/partnerships where information sharing, joint problem solving and trust are key success factors. Supplier development and the evaluation of the supplier's performance is the first issue of managing the supplier relationship. If the supplier's performance is perceived as inadequate, it should be assisted to enhance its performance by means of training and continuous improvement teams and this area also requires more research work and assessment for overall development.

After exploring important issues such as post-harvest losses and its impact and ways to reduce it and to achieve that, one can understand that there is need of educating farmers in selecting the correct inputs and in postharvest handling, including cleaning, food safety, drying, sorting, and packaging at the farm gate. There has been gradual improvement in the accuracy of demand forecast by dynamic adjustments to reflect changes in demand, lead times, transit time, capacity, and transportation and distribution routes, as well as events outside the organization due to advancement in information and communication technology. It has done a good job as per reducing the post-harvest losses and it means that variance of lead-time can be reduced by removing non value-added steps and activities, improve the reliability and robustness of manufacturing, administrative and logistics processes. Standard for the handling and storage of all perishable items has been improving but still far away from where it can be and better the handling, storage and preservation of quality of fruits and vegetables, which would increase the price and consumption, which in turn, would provide a better return to the farmer. Supply chain management systems have the ability to track critical events and activities and when these events do not unfold as expected, they send out alerts and messages to notify appropriate managers to take corrective actions. Flexibility is still lacking supply chain system and it can be improved by enhancing responsiveness. Companies need flexible strategies that

match their operations, such as product design, sourcing, manufacturing and postponement. Establishment of pack house facilities having basic requirements such as washing tanks, sorting and grading devices and cold storage facilities at the premises of the Dedicated Economic Centres (DEC) (collecting centres) in major fruit and vegetable producing areas in the country, will overcome the problems of quality deterioration, contamination of fresh produce with harmful bacteria and other extraneous matter and will improve the safety of produce to a great extent.

Physical infrastructure variables are needed such as roads and electricity, which link villages to nearby assembly and wholesale markets and in turn with large wholesale and terminal markets and ports. There is huge lack of warehousing and cold storage facility and encouragement for the establishment of cold storage facilities. There is need of transportation facility such as refrigerated carriers to facilitate storage and transportation of perishable agricultural commodities. There is lack of encouragement for technological developments in the packaging of agricultural commodities and in promoting packaging facilities appropriate to specific commodities. Mega markets and food parks or terminal markets with a higher level of all facilities are to be established and most existing mega markets and food parks not accessible to common farmer needs to be addressed. To integrate whole supply chain there is requirement of collaboration and co-operation among supply chain partners. This will only happen if there is trust among the parties, upfront agreement on how to share the benefits, and a willingness to change existing mindsets. Once these elements are in place, supply chain partners can do joint decision making and problem solving, as well as share information about strategies, plans, and performance with each other.

The implication of current policies and institutions can be understood in the context of agricultural sector's large contributions to economic production, employment and the welfare of rural people, all of which have made it difficult for policy makers to take risk on agricultural policy reforms. Research work also suggests that stimulating private agri business investment, whether domestic or foreign- will require not only public investment in market infrastructure, but also supporting price and trade policies and comprehensive development of public market regulations and the institutions.

Information and Communication Technology and Agricultural Application

In order to disseminate information and provide different services in a cost effective manner, numerous ICT initiatives are being made in many countries. The developing world is looking towards ICT systems for solving their numerous information related problems. Literature argues

that use of ICT facilities free flow of information and makes available the services even to the most marginalised section of the society. Many public and private sector ICTs – enabled initiatives have been undertaken in India in the last decade especially to cater the needs of agricultural or overall rural sector development. But, one needs to understand to reach over 110 million farmers, spread over 500 districts and over 6000 blocks is an uphill task. Some of these initiatives include e- Choupals by ITC, DCM Shriram Consolidated Limited (DSCL), Hariyali Kissan Bazar, Drishti, AgMarknet, Gyaandoot, iKisan, Reliance Fresh, Parry Kiosks by EID parry etc.

Integrated Supply Chain Model: ITC e-Choupal (India)

ITC e-Choupal is a virtual market place where farmers can transact directly with a processor and can realize better price for their produce. Geographical distances do not restrict participation in the e-Choupal. The main disadvantage of conventional market is that information asymmetry is inherent in the market whereas e-Choupal provides for transparent transactions. This enables the participation of smaller as well as larger players. The main attractiveness of e-Choupal is that it can be used for connecting large producers/small producers and small users/large users, thereby eliminating the need for hierarchy of brokers. Internet is used as a low transaction cost backbone for communication.

Initially, e-Choupal came up as an experimental business model. But now e-Choupal presence is there in different states like Madhya Pradesh, Uttaranchal, Haryana, Andhra Pradesh, Karnataka, Uttar Pradesh, Rajasthan, Maharashtra and Kerala and in different commodities like soyabean, wheat, coffee, aquaculture etc. ITC firstly launches e-Choupal at the pilot stage in a state; this amounted to 50 to 100 e-Choupals. ITC e-Choupal' services today has got to more than 3.5 million farmers cultivating a range of crops - soyabean, coffee, rice, wheat, pulses, shrimp - in more than 38,000 villages through nearly 6500 kiosks across the states in India.

The e-Choupal model has been specifically designed to tackle the challenges posed by the unique features of Indian agriculture, characterized by fragmented farms, weak infrastructure and the involvement of numerous intermediaries, who block critical market information from passing to the farmers and use that information for getting a big margin for themselves. But e-Choupal sets things in order as it smoothens the flow of information to the farmers by disintermediating intermediaries from the chain of information flow and at the same time leveraging the physical transmission capabilities of them as they deliver critical value at every link for a very low cost in a weak infrastructure environment. The structure of e-Choupal network is shown in Figure 1.

The project e-Choupal is an ICT platform for carrying

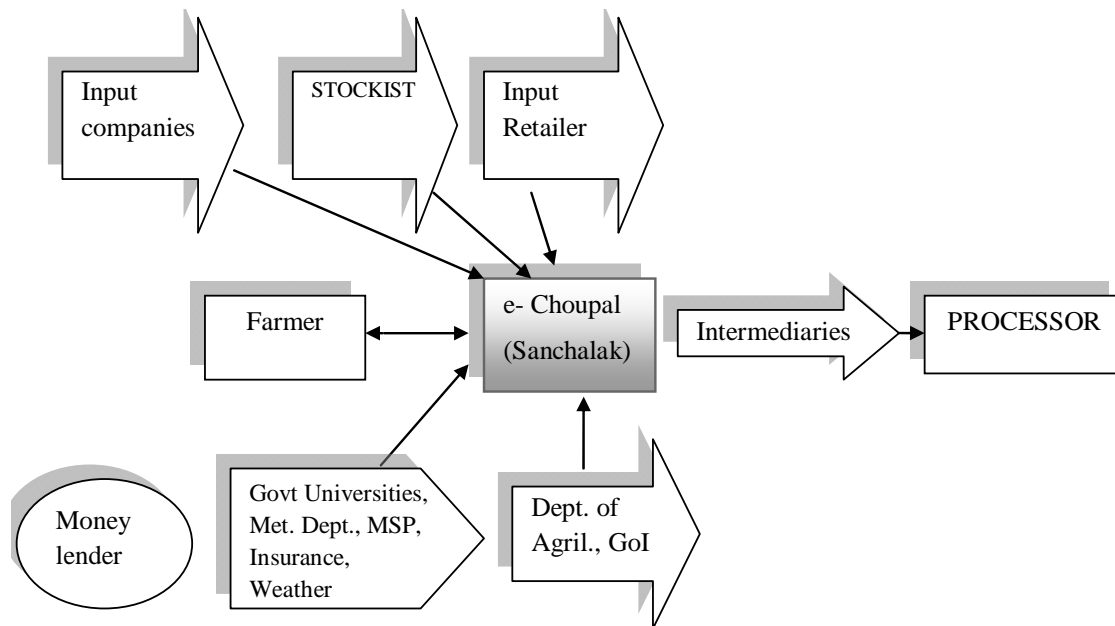


Figure 1. ITC e-Choupal supply chain model. Source: Conceptualised by Author.

out trade in a number of locations. In this, ITC sets up a back-up physical service support at the village level, called Choupal, through Sanchalak: a lead farmer, who acts as the interface between computer and the farmer. ITC accumulates information regarding weather, modern farming practices, and market prices from sources like Meteorological Department, Agri-universities, mandis (regional market) etc., and upload all information on to e-Choupal web site.

All information is customized according to local farmer's needs and provided into the local language through computer set up established by ITC in Sanchalak's house. As observed in Figure 1, that Sanchalak assesses this information facilitates its dissemination to farmers which is generated through the information gathered from Dept. of Agriculture (GoI), Universities, Indian Meteorological Department (IMD), input firms, stockist, retailers and many more. Information regarding weather and scientific farming helps farmers to select the right crop and improve the productivity of their farms. Availability of market information helps farmers to become market oriented. They know what price ITC is quoting and the price prevalent in the local market (Mandi), thereby helping better price realization for farmers.

ITC's example also shows the key role of information technology, in this case provided and maintained by a corporation, but used by local farmers in helping to bring about transparency, to increase access to information, and to catalyse rural transformation, while enabling efficiencies and low cost distribution that make the

system profitable and sustainable. ITC has been successful in making the farmer feel the sense of ownership and encourage them to generate additional revenue by eliminating middleman. Participating farmers have been able to enhance their income and eliminate the delay in getting the payment once the product is sold. It has helped in reducing debt burden of the farmers. The success of e-Choupal has given new lessons to the government agencies and corporate in the country. By embarking on this initiative, ITC has shown that ICT platforms can benefit even the farmers and rural India.

Supply Chain Framework of Reliance Fresh (India)

Reliance Fresh was the first foray into retailing by behemoth known as Reliance Industries Limited. Reliance Fresh is somehow different from business model of ITC e-Choupal mainly in terms of use of information technology and being a tool for increasing productivity by assisting farmers, which is major part of ITC e-Choupal model. But for the Reliance Fresh it is more about procuring the material, processing it and then distributing to various retail outlet for timely availability of the food produce in most efficient and effective form by utilisation of information technology in best possible way. Reliance Fresh was launched by opening retail stores in Hyderabad on November 2006; then, it 12 opened "Fresh" outlets in Chennai increasing the total store count to 40. Reliance tested its retail concept by controlled entry, beginning in the southern states.

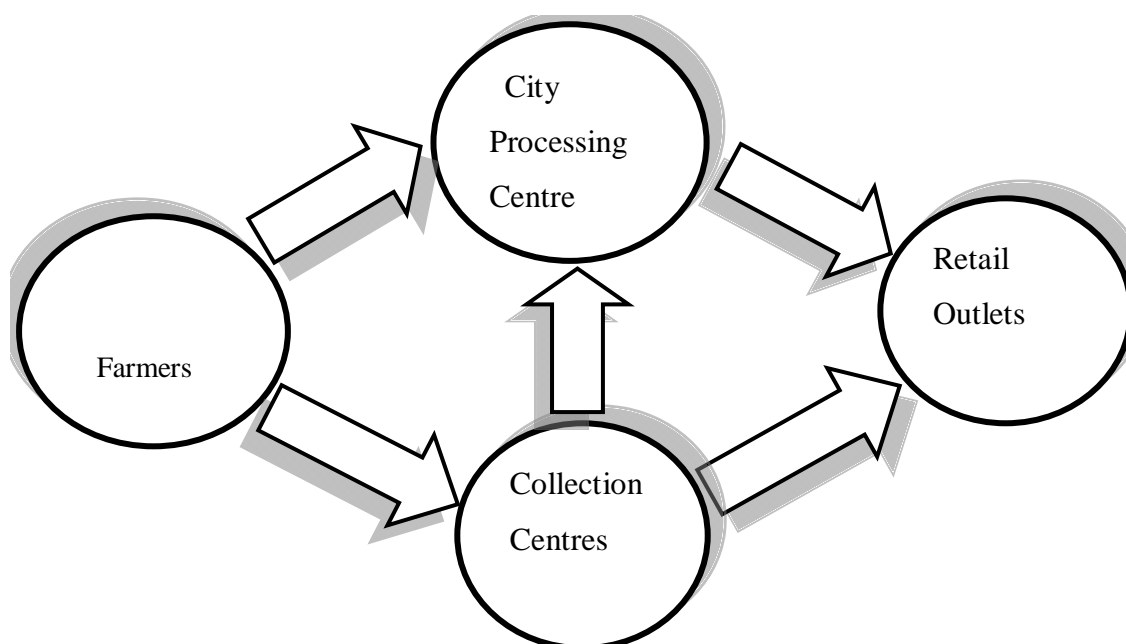


Figure 2. Reliance Fresh Supply Chain Framework. *Conceptualised by Author.*

There were three basic reasons for Reliance Industries Limited (RIL) choosing foods and vegetables for entering into retailing sector as Reliance Fresh (Figure 2). First, it wanted to go after the very core of the great Indian retail opportunity in terms of agricultural based business. Second, its aim was to build a high-profitability business and food was perhaps the best place to start. Third, the grossly inefficient food supply chain provided a well-resourced and well managed organization like RIL with an opportunity of amending the flaws which would also make business sense and to materialise that it has increased the number of stores in June 2013, around 1,500 from 1,150 in 2010.

As it (Figure 2) suggests, source has been the farmers and City processing centre and collection centres works as intermediary part of chain to avail the produce at retail outlet. Farmers also see advantage of quantity procurement by Reliance Fresh of vegetables they need from them and they can go there and get their consignment graded at their collection centre. The centre would get the price-band and quantity of vegetables it needed to collect that particular day. Reliance Fresh provides a good example of a successful case, depicting improvement in the economic conditions of the farmers through their network, rising income levels and more opportunities. Both ITC e-Choupal and Reliance Fresh model operates on a very small scale, and are able to meet the administrative and infrastructural constraints to turn out to be a successful model. If this supply chain model is expanded, then the viability of it largely depends on the integration of variables and development of agricultural infrastructural

facilities. By embarking on this initiative, ITC has shown that ICT platforms can benefit even the marginal farmers.

Since the rural economy in India or, for that matter, in any developing country has very strong linkage with agricultural economy, the major thrust of these initiatives has been the agriculture and allied sectors. But integration between these models is lacking due to lack of proper coordination among various sub-system in supply chain. The Government of India (GOI) has formulated an ambitious National e- governance plan (NeGP) which identifies 25 mission mode projects including agriculture to be implemented through different ministries at the centre well state level. All these supply chain initiatives share the common objective of empowering Indian agriculture to take the right decisions related enhancement of productivity, realisation of revenue and improvement in their overall performance.

Integrated Value Supply Chain for Indian Agriculture

Food supply chain management refers to the process whereby the movement of agro based product(s) from the initial supplier to the ultimate user occurs with all non-value adding expenses. Usually supply chain management is between partners such as a retailer and a preferred supplier, or a restaurateur and a preferred supplier of a particular ingredient. From a supplier's perspective, supply chain management can mean more than this. It means that with due care, one can actually provide the needed produce to penultimate user with a

lower cost. Successful supply chain management can be summed in one phrase; detail, detail and detail. In reality it means studying in detail the entire process from harvest to the penultimate user. In doing so, all steps and costs should be established. After that, it is a matter of establishing what economies can be exercised along the way to the benefit of all the stockholders. And one needs to apply that and adapt that in slightly different way for perishable agriculture produce.

Despite the changes in the global and domestic scenario, poverty and food insecurity continue to haunt millions of Indian citizens. With about 30 percent of the population being poor and about 20 percent of the population being under-nourished, the need for ensuring food security for all remains of paramount importance. Along with that is the continuing need to stabilize food price and supplies as a means to achieve household level food security. The changed circumstances of today provide opportunities to design new instruments for a more efficient and welfare improving food grain management system, in which consumers benefit from stable prices even as the interests of the farmers do not suffer.

The production of agricultural commodities has substantially increased in the country over the decades due to continuous efforts made by the government in terms of technological intervention at different level of production system, coupled with its price support policy. The production, supply and distribution of many agricultural commodities are mainly influenced by government regulations. In the process of economic liberalization, it has been felt that there is need to re-orient policies and regulations related to agricultural commodities. In response to this, the government has initiated agricultural policy reforms related to the production and marketing of agricultural commodities. Although, the pace of this reform process is very slow. Besides, there are numerous rules and regulations, and the infrastructural gaps, which are hindering the smooth flow of agricultural commodities from farm to fork. A lack of integration from various stakeholders in the supply chain leads to inefficiency in the agricultural system, causing high post-harvest losses, quality deterioration, high cost of commodity transfer, information symmetry and lack of transparency. Each participant of chain acts independently with little and no collaboration in physical and information flow (Mittal, 2007).

The consumption basket of Indian consumer is changing as a shift is noticed towards the high value commodities. Therefore India needs intensive and diversified farming to address new challenges for sustainable production and processing practices that promote the balanced approach to the problems of food quality, safety, and environmental management.

Due to high level of government regulations, the investment in the organized private agribusiness is low. The

new corporate entries are not just participating in the chain to source the required material, (mainly indirectly from the farming community) but they focus more on the primary source of agricultural produce particularly farming community through contract farming and tools by procuring agri produce from farmers. In the context, development of direct linkages with farmers will attain greater importance. It is important the corporate participants in agribusiness chain have an understanding of supply chain, right strategy and leadership. Indian agriculture also needs more public investment and policy support in several areas to overcome prevailing structural weaknesses such as low scale of operations, high post-harvest losses, poor state of rural infrastructure, lack of product diversification, inadequate research and development (R & D) spending, low productivity, absence of marketing infrastructure and inadequate financial support.

Modern agriculture is highly knowledge intensive and increasingly information driven, under which each participant in supply chain yearns for timely and accurate information for various decision. Therefore, knowledge and information are important factor for accelerating agricultural development by increasing agricultural production and improving marketing and distribution efficiencies. In addition to connecting small farmers and artisans to markets, ICTs also facilitate most agricultural decisions such as what to cultivate, how to cultivate and harvest, when and where to sell, and at what price to maximize the returns. Effective decision making related to all these aspects ultimately determines the efficiency of supply chain (Rao, 2007). Therefore, a proper and information flow among stakeholders of any business activity is the key for strengthening supply chain efficiency. The rapid and innovative developments in ICTs can provide immense opportunities to public as well as private sector agencies to integrate these technologies in their supply chain systems. ICTs are especially useful for dissemination of information, provision of services, and enabling various transactions and awareness creation among the rural masses far removed from the government. ICTs provide modern, effective and speedy modes of communication that convey new resources of knowledge and information to society.

Strengthening vertical relationships between various stages of production and processing in the agribusiness sector has always been an important area for empirical analysis by researchers and policy makers across the world. However, the pace of change in supply chain integration and responsiveness of production system towards a market driven approach is slower in India compared to elsewhere in the world (Haan et al., 2003). Farmers are still more comfortable growing traditional crops, particularly rice and wheat, as they have already discovered the market for their marketable surplus- be it a government procurement arrangement or private local traders. But the shift in market demand needs a balancing approach to

meet the supply of deficit commodities such as pulses, oilseeds and high value food items. This balancing in demand and supply can be ensured by strengthening buyer-supplier relationship efficiently, and by disseminating of accurate and timely information to all the participants of the business chain (Mittal, 2007).

Issues and opportunities in agricultural supply chain

Agriculture is inherently a fragmented and unorganized sector involving a diverse range of distinct stakeholders such as inputs supplier, farmers, traders, commission agents, processors and distributors. As compared to developed countries, the Indian agriculture supply chain is far more complex and difficult to manage because of its unorganized nature and a large number of intermediaries (Sachan et al., 2005). The enormous wastage of agri-produce annually is due to gaps in basic infrastructure, which leads to instability in prices and low realization of prices by the farming community. Another important reason for inefficient supply chain is the inadequacy of logistics infrastructure, that is, roads, railways, airport, seaports, information technology, telecommunications and energy production, which is poor as compared to other developed and developing countries (Sahay and Mohan, 2003).

The agriculture supply chain suffers from inefficiency at every stage. Lack of proper infrastructure for procuring agricultural produce from the farm gate to the consumer has led to huge losses in transit. The farmer hardly benefits by any price rise while the many layers of intermediaries enjoy high margins. Even when farmers are forced to sell their produce at throwaway prices in times of bumper crops, prices at retail level remain higher by many multiples. This has also led to large mark-ups in pricing due to extra layers of intermediaries. Cumulative wastage in agriculture supply chain is estimated to be around US\$ 11 billion, or 9.8 percent of the agricultural component of the GDP (Ahya, 2006). About 25-30 percent of agricultural production gets wasted due to improper handling and storage, pest infestation, poor logistics, inadequate storage and lack of transportation infrastructure (Sachan et al., 2005). Apart from this, only a small quantity of agricultural production is processed for value addition. Efficiency in food production is very low and this is mainly due to inefficient sourcing of raw material, which is the major part of processing costs (Ali and Kapoor, 2005). To assess the critical issues at each level of agricultural supply chain, the agricultural system can broadly be categorized into five sub-systems- agricultural input, agricultural production, food processing, distribution and marketing, and consumer demand.

A sustained increase in agricultural production and productivity is largely dependent on the continuous development and use of modern agricultural inputs such

as seeds of a better quality, fertilizers, pesticides, farm implements and machinery. Due to a fragmented input market, farmer faces numerous problems in acquiring quality inputs on time and a reasonable price. Policy reforms introduced during the late 1980s have attempted to encourage greater private sector participation in the agricultural input industry, which has stimulated a noticeable increase in investment in plant breeding research and seed production (Singh and Morris, 1997).

The price support system was introduced by government in 1965 by setting up Agricultural Prices Commission (APC) now renamed as Commission of Agricultural Costs and Prices (CACPC). This provided the opportunities to farmers to sell their produce on MSP if the market price dropped below the MSP for that commodity. The government is supposed to procure all agricultural commodities for which MSP has declared in such situation. The basic objective of food grain procurement by government agencies is to ensure remunerative prices to producer and reasonable prices to consumers, and to maintain price stability in market (Jha and Srinivasan, 1999).

Agriculture can realize its full potential by applying the principal of supply chain management by strengthening the collaboration between various stakeholders, non-exploitative vertical and horizontal integration, market reforms, precision farming, contract farming, demand-led diversification, and the extensive and intensive use of information technology for real time communication across the chain (Balakrishnan, 2006).

The nature of the integration model is an implementation issue that needs to be addressed with a view to consumer's needs and other variables such as industry and market characteristics. One theme that appears to hold constant throughout the literature in this area is the importance of taking a holistic view, and the systemic nature of interactions between the participants. The recognition of the interdependence of all partners in a supply network appears to be an important catalyst for effective integration. In this sense, organizations moving to implement integrated supply chain management systems could be seen to be formalizing strategies to better manage this inter-dependence, and to leverage it to mutual advantage. At the same time, it is also apparent that this requirement to take such an holistic and systemic view of the supply chain acts as an impediment to more extensive implementation. The strategic nature of adopting a supply chain-wide perspective, on the one hand provides significant potential benefit, and on the other requires trading partners to think and act strategically. The challenge for developing more effective and integrated networks is to encourage such a mind-set, and use it to promote adoption and implementation of enabling technologies and methods. In other words, this review of the literature serves to highlight the inter-dependence between integration (technologies, logistics,

and partnerships), a strategic view of supply chain systems, and implementation approach. All three need to inform and underpin each other in order for management of supply chains to be able to deliver on the promise of benefits for all trading partners.

Economic reforms and liberalization in the agriculture sector have emphasized the need for transforming Indian agriculture by designing agricultural supply chain model covering innovations at farming levels, which can help farmers regain profitability in a sustainable manner under changing conditions with proper assurance of market arrangements (Rao and Punwar, 2004). The reforms in agricultural marketing system to ensure participation for establishing direct linkage with farmers, capacity building and infrastructure development in regulated markets, extension of road network and transportation, storage and warehousing, market intelligence system, introduction of commodity by establishing commodity are some important areas of interventions, but the changes are taking place at a very slow pace.

For establishing an efficient and effective supply chain system in the Indian agriculture, there is an urgent need to improve the functioning of regulated markets and amend the APMC Act by the all state government as per the model act on agricultural marketing suggested by the central government to ensure private participation in supply chain system in an organized and legal manner. This will enable private agro processing units and business operators to link themselves with farming community directly, eliminating multiple intermediaries. For increasing efficiency in food processing segment, the process of raw material sourcing needs to be redesigned in an efficient organizational framework with proper backward linkages. The emergence of agribusiness activities and food retailing is providing both opportunities and challenges to policy makers. There is need to assess all the existing policies affecting the agricultural supply chain and modify them as per the requirements of market forces, with proper regulatory mechanisms to protect the interest of all the stockholders in the chain.

Further research opportunities

As our assessment indicates, there is a lack of empirical research on the significance and benefits of food supply chain management. Although a majority will agree to the importance and potential benefits of it, somehow food supply chain management does not seem to occur often enough in practice. Organizations appear to have significant difficulties in evolving from theory to the successful implementation and practice of supply chain management. This is a crucial yet challenging dilemma to solve. In many cases, food supply chain does not have seamless chains, optimized flows, or networks of integrated organizations. In reality, the frameworks and their

corresponding terminologies, once more elaborately illustrated, ultimately are dealing with companies trying to make dyadic relationships better. Therefore, Indian agriculture needs methodical approaches for the implementation of supply chain system and we need sound empirically based research to continue to develop the field and to explore the concepts related to supply chain. It will require significant efforts, applying both qualitative and quantitative research projects to further develop these concepts in order to advance both practical applications and academic theories.

As above points emphasise on need of greater problem oriented and issue based research which employs integrated approaches to solving postharvest issues, apart from missing links in our understanding and implementation of food supply chain, postharvest technology, proper linkages must be established in agriculture and processing sector. Innovations in postharvest technology and particularly in the development of infrastructure could help achieve this goal. The processing of fruits and vegetables for export and for domestic markets requires utmost attention in developing country like India. Waste generated by processing factories must be put to profitable usage, either through conventional technologies or through the adoption of biological processes (Verma and Joshi, 2000).

One additional aspect that requires discussion is the challenge in designing, developing and managing cross-organizational processes when organizations are still struggling with internal process management. Few, if any, examples exist of truly process-oriented organizations. Yet process management is, in many ways, mentioned as a prerequisite for supply chain management.

The need for further research to capture both the characteristics of successful implementation, and the factors determining the level of implementation is captured by Akkermans (1999) when he states:

. . . the Supply chain management literature has shown very little empirical evidence of successful strategic moves towards supply chain management [and later] . . . we do not yet have causal relationships between the various factors driving effective supply chain management and their interrelations with performance improvements in areas like inventory management, supply chain costs, and customer satisfaction.

There has been some research into a range of barriers to extensive adoption, particularly with regards to cost, ease of implementation and conflicting standards being identified as restricting wider use. An emergent theme in the literature is the discussion of implementation in terms of extent (that is, formal organizational links with suppliers and customers, application ICT tools to incoming goods, formal agreements with suppliers, etc.), focus (overall strategic plan), and expected benefit (source of

competitive advantage). There is an opportunity to pursue a range of questions. What is the true extent of implementation of techniques and methodologies used for the management of the supply chain? Do organizations that implement supply chain management techniques progress from a basic implementation to a more extensive one over time? Are there significant geographic and demographic factors that impact on the decision to implement such as company size or industry sector? Can companies be distinguished from one another on the basis of this extent of implementation model? How Food Corporation of India (FCI) has been coordinating among its different sister units and different scheme run by government of India. All the different aspect of PDS and contract farming is subject with desire of further more research work. Given the apparent contradiction in the literature between promised benefits and still limited evidence of extensive implementation, the examination of factors creating and reinforcing this apparent gap would appear beneficial.

Conclusion

While exploring the subject of food supply chain in Indian agriculture one can say upliftment and integration of agricultural system is utmost important. There is also lack of emphasis on both formal and informal risk management options available, although in practice, most analytical attention will likely focus on the scope for improving or supplementing formal mechanisms, including institutional and financial arrangements, technological changes, adoption of improved management practices, and/or investments in infrastructure. If the government is mainly focused on the position and welfare of poorer farmers, then greater attention would need to be given to alternative informal mechanisms and improving their efficacy. Study also suggests that there is lack of attention been paid to areas categorized as 'high vulnerability', either for individual chain participants or the chain as a whole. Research towards agricultural infra-structure and supply chain has not been given its due and that should be undertaken on the needs/options for policy and regulatory reforms that affect farmer/agro-enterprise risk management as well as the possible revision/reform of governmental risk management instruments. Aspects like cold chain needs to be given more consideration as it could results in the reduction of losses and retention of the quality of horticultural produce. While the introduction of a cold chain facility nationwide due to some institutional, structural and financial constraints may not be immediately possible in India, attempts must be made

to develop a cool chain. Usefulness of ICT is well established in improving productivity of Agricultural sector and this needs to be addressed by authorities. Food loss reduction is less costly than an equivalent increase in food production. If efforts are not made to modernize the harvest handling system for horticultural crops, then postharvest losses will continue to have a negative economic and environmental impact. There is no doubt that postharvest food loss reduction significantly increases food availability. An efficient collaboration between stakeholders will reduce risk, losses and greatly improve the efficiency to ensure food security and development.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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