Disruptive Innovations in Food Value Chains and Small Farmers in India*

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I

Various segments of value chain from consumption to production that includes retailing, wholesaling, logistics, processing and production have been undergoing rapid and unprecedented changes in recent times in the country (Pritchard *et al*., 2010; Chand, 2012; Singh, 2012; Reardon and Minten, 2011; Vijayashankar and Krishnamurthy, 2012; Narayanan, 2014; Rao *et al*., 2016). This paper analyses the changes and increasing interactions in all nodes of value chains that include upstream (farmer-producers), midstream (processors, wholesalers and other logistics) and downstream (retailers) from a value chain perspective as well as with those of the sectoral innovation system.

The extant literature on the food system transformation in India does not analyse the changes in various segments from a value chain perspective in a dynamic setting of innovation systems. Besides, hard empirical evidence on the impacts of supermarket procurement is not available in the Indian context. This paper contributes to the literature on food value chains by addressing these two gaps. Domestic food production and distribution constitutes 90-95 per cent of the total food economy in developing countries (Reardon, 2015) including India and therefore this paper focuses on domestic food value chains and attempts to trace their interactions with innovation systems and associated impacts. The paper is organised as follows. After introducing definitions and concepts of agrifood system, innovations and transformations in Section II, Section III discerns policy determinants of agrifood system transformation including trends in innovations in value chains with new generation start-ups and associated issues. Development and consolidation of the processing segment of the value chain is examined in Section IV, while impacts of organised retailing[1] on smallholder cultivators are analysed econometrically in the fifth Section, employing Heckman selection correction model as well as two-stage least squares. The last Section brings together all the threads and concludes with some policy perspectives.

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II

Definitions and Concepts of Agrifood System, Innovations and Transformation: The term 'value chain' or value chain approach differs from the earlier approaches in studying different actors in their dynamic interactions and associated effects. One of the earliest definitions states that agribusiness is the 'sum total of all operations involved in the manufacture and distribution of farm supplies; production operation on the farm; and the storage, processing, and distribution of farm commodities and items made from them' (Davis and Goldberg, 1957). While this is comprehensive, the term 'agribusiness' does not address the net effect of interactions among all these nodes. Value chain approach is superior in so considering these actors in their dynamic settings.

A supply chain or value chain, as defined by Boehlje (1999) is a set of value creating activities in the production-distribution process and the explicit structure of linkages among these activities or processes. Value chain is associated with quality differentiation and value added from the consumer perspective, while supply chain is a supplier perspective with a focus on efficiency and logistics and coordination aspects of moving products from 'farm to fork'. However, there is a need to integrate both the terms as food systems need to deliver both value and efficiency (Reardon, 2015). On the other hand, food value chains (FVCs) 'comprise all activities required to bring farm products to consumers, including agricultural production, processing, storage, marketing, distribution and consumption' (Gomez *et al*., 2011).

The value chain framework, in this background, has been undergoing transformation in the post-Washington Consensus era as a 'third way' between state-minimalist and state coordinated approaches for 'value chain development' (Fowler, 2012; Werner *et al*., 2015). In their influential article in *Science,* a group of eminent scholars working in this area called for 'research focus on public policies, private-firm decisions, and food value chain innovations that can improve the functioning of domestic food value chains, not just on export channels' (Gomez *et al*., 2011).

Agricultural innovation typically arises through dynamic interaction among the multitude of actors involved in growing, processing, packaging, distributing and consuming or otherwise using agricultural products (World Bank, 2012). Application of these innovation systems framework is particularly promising for agricultural development because it can help identify where the most binding constraints to agricultural innovation are located and how better to target interventions to remove such constraints.

Innovation systems (IS) interact with value chains in multiple ways, and influence whether and how developing country firms learn and innovate through entering and interacting in these value chains (Pietrobelli and Rabellotti, 2011). The buyers and suppliers co-evolve in value chains in their interactions and also in their interactions with IS. On the other hand, governance structure in value chains also determine innovation among the actors of the chain (Willis, 2014). Further, sectoral system of innovation is critical to the development of sub-sectoral commodity chains (Somasekharan *et al*., 2014). Agricultural innovation systems (AIS) approach has replaced, as the dominant paradigm in many countries, earlier frameworks for investment and promotion of

knowledge like national agricultural research system (NARSs) of the sixties and agricultural knowledge and information systems (AIKSs) of the nineties. Concurrently, the locus of attention has been shifting from just research organisations to farmers to wide array of actors through this transformation.[2]

The first generation of value chain analyses focused on 'economic upgrading' of firms by interaction with lead firms, while the second generation focused on 'social upgrading' of the workers (small farmers in our case) and their employment and income (Kaplinsky, 2000; Gereffi *et al.*, 2005; Gereffi, 2014). Subsequent discourse on value chains underlined the chances of multiple heads (for value chains) or lack of drivers in a scattered chain and need for public policies to play a role in rebalancing these power relations and inequalities by creating incentives for lead firms to be inclusive (Pietrobelli and Staritz, 2013). Internal markets have become more important after global financial crisis especially for emerging economies like China, Brazil, India and others (Gereffi, 2014).

III

POLICY DETERMINANTS OF AGRIFOOD SYSTEM TRANSFORMATION

The policy background leading to the evolution of domestic food value chains is in line with the agri-food transformation in the world. Difficult reforms in agriculture have been finding favour with policy makers in the last few years. Doing away with the restrictions on movement of goods, increasing the role of private initiatives, and building supply chains for effective storage and transport with minimum spoilage are central to these reforms in the country. Though not aimed at agricultural sector alone, likely implementation of the long delayed goods and service tax (GST) enacted through 122nd constitutional amendment, likely to be effective from July 2017, has the potential to play catalytic role in agricultural development through easing movement restrictions. Some of the other reforms include- recent permission allowing 100 per cent foreign direct investment in domestic trading of processed food products, inauguration of the e-national agricultural market in April 2016, and proposed new model Agricultural Produce Market Committees Act 2017 for correcting some of the inadequacies of the APMC Act 2003, apart from the marketing reforms already implemented (Table 1). These policy changes have to be understood in the background of changing consumer preferences with growing disposable incomes domestically and sweeping agri-food transformation globally.

Trends in Innovations in Value Chains with New Generation Start-Ups: New generation start-ups have been emerging in the country since the last few years. These are entirely different from earlier waves of start-ups in the country, as they are driven primarily by information and communication revolution, globalisation and private initiative (Subramanya, 2015). Most of them are started by graduates with some innovations in various sectors of the economy including agriculture. Several people educated abroad return to the country with new ideas of changing the game in their chosen industry or service.

TABLE 1. STATE-WISE PROGRESS OF MARKETING REFORMS AT THE END OF 2016

	Area of marketing reforms	States adopted the suggested area of marketing reforms
(1)	(2)	(3)
1.	Establishment of private market yards/ private markets managed by a person other than a market committee.	Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Gujarat, Goa, Himachal Pradesh, Karnataka, Maharashtra, Mizoram, Nagaland, Orissa (excluding for paddy/rice), Rajasthan, Sikkim, Telangana, Tripura, Punjab, UT of Chandigarh, Jharkhand, Uttarakhand, West Bengal.
2.	Establishment of direct purchase of agricultural produce from agriculturist (Direct Purchasing from producer)	Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Gujarat, Goa, Haryana (for specified crop through establishment of Collection Centres) Himachal Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Mizoram, Nagaland, Rajasthan, Sikkim, Telangana, Tripura, Punjab (only in Rule), UT of Chandigarh (only in Rule),Jharkhand, Uttarakhand and West Bengal.
3.	Establishment of farmers/ consumers market managed by a person other than a market committee (Direct sale by the producer)	Arunachal Pradesh, Assam, Chhattisgarh, Gujarat, Goa, Himachal Pradesh, Karnataka, Maharashtra, Mizoram, Nagaland, Rajasthan, Sikkim, Tripura, Jharkhand, Uttarakhand and West Bengal.
4.	Contract Farming Sponsor shall register himself with the Marketing Committee or with a prescribed officer in such a manner as may be prescribed.	Andhra Pradesh, Arunachal Pradesh, Assam, Chhattisgarh, Goa, Gujarat, Haryana Himachal Pradesh, Jharkhand, Karnataka, Maharashtra, Madhya Pradesh, Mizoram, Nagaland, Orissa, Punjab (separate Act), Rajasthan, Sikkim, Telangana, Tripura and Uttarakhand.
5.	To promote and permit e-trading	Andhra Pradesh, Chhattisgarh, Gujarat, Jharkhand, Haryana, Himachal Pradesh., Karnataka, Rajasthan, Sikkim, Goa, Madhya Pradesh, Maharashtra, Mizoram, Telangana, Uttarakhand and Uttar Pradesh.
6.	Single point levy of market fee across the State	Andhra Pradesh, Rajasthan, Gujarat, Goa, Haryana, Himachal Pradesh, Chhattisgarh, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Mizoram, Nagaland, Sikkim, UT of Chandigarh, Punjab, Telangana, Uttar Pradesh and Uttarakhand
7.	Single trading license valid across the State	Andhra Pradesh, Chhattisgarh, Goa, Gujarat, Haryana, Himachal Pradesh, Karnataka, Rajasthan, Madhya Pradesh, Maharashtra, Mizoram, Nagaland, Telangana, Sikkim and Uttar Pradesh

Source: Government of India (2017).

The government has been encouraging start-ups with some policy initiatives. Schemes like 'Start-up India' as a flagship programme offers tax incentives under Finance Act, 2016 to them for three years out of five years on approval by the Inter-Ministerial Board and this was increased to 3 years out of seven years in the 2017-18 budget. Large number of technology business incubators (TBIs) numbering 104 by end of October 2016 were started across all the states.[3] National Academy of Software and Services Companies (NASSCOM) initiative of 10000 start-ups programme, and start-up registry by non-state players have also been catalysing their growth.

There are no structured studies on the nature and impacts of these start-ups on farming as well as the ecosystem needed to scale them up. A study by Singh (2015) goes into the functioning of three start-ups working on machine rentals (ZFS) in Punjab, input services in PPP mode operated K3 centres in UP and input and output services start-up by GAPL in Bihar. The PPP mode in UP turned out to be far more inclusive, while both machine rental services in Punjab as well as *Dehaat* Centres (under GAPL) in Bihar

mainly catered to the relatively upper size categories of farmers. The study concluded that the services were effective in all the three start-ups and that agri-services can be provided in an organised chain.

 We briefly trace the start-ups in agriculture in regard to their innovations in agricultural services (Table 2). The evidence so far is anecdotal and rigorous empirical

TABLE 2. START-UPS AND INNOVATIONS IN FOOD VALUE CHAINS IN INDIA

Input/output based (1)	Start-up (2)	Innovation (3)	Area of operation (4)	Year of starting (5)	Remarks (6)
Input based	*Flybird*[a,e]	Developed low-cost irrigation controller called SIRI by installing sensors in soil	Karnataka, Tamil Nadu	2013	Villgro and Rianta Capital's Artha Initiative joined hands with NAARM's technology business incubator, a-IDEA, and IIM-Ahmedabad's CIIE and CIBA to invest in Flybird
	Agrostar[b,m]	M-platform to procure inputs by giving missed call	Gujarat, Maharashtra, Rajasthan	2013	Raised 4 million fund from IDG Ventures along with existing investor Aavishkaar. And $10 million Series B funding led by Accel in 2017
	BigHaat.com[c]	Provides seeds and other inputs through Android App and partnered with several companies	Karnataka, Andhra Pradesh, Telangana, Rajasthan	2015	Partnered with IFFCO eBazar to start pilot stores in Ghaziabad and Karnal to sell seeds
	Stellaps[a,d]	Developed automated dairy solutions to reduce input costs using advanced cloud-based analytics and activity meters	Karnataka	2012	Funded by Omnivore Capital
	EcoZen[a]	Developed solar-powered irrigation and cold storages and offers a quarterly lease	Karnataka, Uttar Pradesh, Himachal Pradesh, Maharashtra	2012	Raised Rs.6.2 crores in Series A funding from Omnivore Capital
	M.I.T.R.A[f] (Machines Information Technology Resources Agriculture)	Develops innovative machinery to suit requirements of farmers	Maharashtra (Nashik), Karnataka, Gujarat, Andhra Pradesh	2012	External funding from Unilazer Ventures, the private investment arm of media veteran Ronnie Screwvala. Also, Omnovore Capital invested in this.
	EM3[f]	Makes machinery affordable by renting out. Modelled on *Machinery Link Sharing* of USA	Madhya Pradesh, Bihar, Eastern Uttar Pradesh	2014	Raised Series A funding of Rs. 27.5 crores from Soros Economic Development Fund, via Aspada Investments
	CropIn[g]	Uses cloud platform and get details of farms and inputs applied to make every crop traceable for meeting global best practices. Used two applications SmartFarm and SmartRisk	14 states. Headquartered in Bangalore	2010	Supports several companies including GPI, ITC, Mahindra McCain Foods in managing their farmers and farms

Contd.

TABLE 2. CONCLD.

Input/ output based (1)	Start-up (2)	Innovation (3)	Area of operation (4)	Year of starting (5)	Remarks (6)
	Aarav Unmanned Systems[e]	Develops products using drones to collect farm related data and information for precision agriculture to topographic surveying and industrial inspection	Kanpur-based	2013	Series A funding from Startup Xseed Ventures, 3ONE4 Capital
Output based	Ninjacart[h]	App based direct farmer to stores model. Has collection centres and distribution centres	Bangalore and Hyderabad	May, 2015	Raised $3 million in Series A round of funding from Accel Partners with participation by Qualcomm Ventures, M&S Partners (Singapore)
	Agrihub[b]	Fosters agriculture ecommerce ecosystem by bringing together seed providers, agricultural equipment providers, retailers for better production decisions of farmers	Bangalore-based. Working in Maharashtra, Gujarat, Tamil Nadu Nadu, KTK, Uttar Pradesh	2016	-
	SV Agri[i]	Works with potato farmers by providing better seeds as well as working on supply chain and processing	Maharashtra, Gujarat	2013	Raised Rs.25 crores in Series B funding led by impact venture capital firm Lok Capital
	Sabziwala[j]	Procures directly from farmers and supplies fruits and vegetables in pre-weighted and pre-priced packs	National Capital Region	2016	-
	BigBasket[k, l]	Online grocery store as well as supplier to restaurants and *kirana* stores. Started *Farmer Connect* programme to procure directly from farmers with collection centres	Bangalore-based and working in 8 tier I and 17 tier II cities	2011	Raised 220 million from investors

Source: a) Anand (2016a); b) Jain (2016); c) Mallya (2016); d) Tiwari (2016); e) Shankar and Vignesh (2016); f) Goyal (2016); g) Chandra (2016); h) Rao (2016a,b), Dongray (2016), Alam (2016); i) Nair (2016); j) Fernandes (2016); k) Anand (2016b); l) Govind and Chakraborty (2016).

research is still non-existent and therefore this is intended to pave way for such research on impacts. Few start-ups in different segments of value chain are shown here, though there are a large number of them. Broadly, they can be shown as rendering either input services or output services in marketing and related jobs. *BigHaat.com, Flybird, AgroStar, Stellaps, Kedut, EcoZen, MITRA, EM3, Skymet, YCook, IFFCOKisan, Aarav Unmanned Systems,* and *CropIn* are some of the start-ups involved in input services. For output services, there are several like *Ninjacart, TheAgrihub, SVAgri, Sabziwala, Flipkart*, and *Big Basket*. The input-based start-ups disrupt the upstream value chain connection farmers with input suppliers for seeds, fertilisers, pesticides and machinery by

connecting farmers directly with the input companies. On the other hand, the output-based start-ups connect the farmer with the buyer of farmer produce and is some cases (*Ninjacart and Bigbasket*) buy directly from farmers in collection centres like supermarkets. Besides these start-ups, online retailing companies like *Amazon* started buying directly from farmers replicating *Amazon Fresh* model for its grocery business that started in 2016 in tie-up with 12500 *kirana* stores (Ganguly, 2016).

All the new age start-ups have been implementing various innovations in product, process, marketing and organising. Their innovations have been impacting value chains of agricultural commodities for higher efficiency and equity. Few of them might eventually become big players and scale-up respective innovations in food value chains. Therefore, increased start-up activity might be beneficial to the sector in general and small farmers in particular. However, it has to be noted that there are vested interests from the current traders, commission agents and related persons, who would not want these changes in food value chain and disintermediation. The reports in several places of obstructions and threats to the employees of *Flybird* and *Ninjacart* (Alam, 2016; Anand, 2016a) as well as opposition by political parties to marketing reforms in Maharashtra (Banerjee, 2016; Ghadyalpatil, 2016) are harbingers of this resistance.

Though there are several start-ups in the agricultural sector, their activity is relatively low in agriculture (Anand, 2016a; Mitra, 2016). The total investment in agri-start-ups was just one per cent of the total 6 billion invested in 2015 indicating difficulty of attracting investments into agriculture in a developing country setting and endorsing the notion put forward five decades by Schultz (1964) that private investment is deterred by risk in agriculture. Further, these investments have been declining in the last two years.[4] According to CorpVCCEdge, funding for agri start-ups has been declining and to the tune of 50 million in 2016 compared to 56 in 2015, and 123 million in 2014. There has been a move towards agri and processed foods category and packaged foods segment (Mitra, 2016). Therefore, as OECD (2012) shows public support of entrepreneurship is often justified in case of market failures, as manifested in poor funding for agri-start-ups.

Late-stage investors are not yet showing the same level of enthusiasm (Shankar and Vignesh, 2016), which means agri-tech start-ups will likely suffer cash crunch for scaling up. On the other hand, late stage funds are doing well in consumer-tech urban India, unlike in agriculture. These start-ups need a combination of early-stage funds, debt, etc., and not just venture capital or equity. The age of start-up for financial incentives needs to be increased (from the current 3 year) as a longer period of time (5-8 years) might be good, in view of the fact that OECD studies show that survival of start-ups become lower to around 40 per cent by seven years (Calvino et al., 2015). Though the 2017-18 budget made it five years in a block of seven years, there is still scope for improvement. The Board for these approvals need to have representatives from ministry of Agriculture. There has to be many more business incubators that focus on food and agriculture, as well as starting accelerator programmes. A case in point is the accelerator programme promoted by International Institute of Information Technology, Indian School of Business and Telangana state government teaming up with ICRISAT to start an accelerator exclusively for start-ups working in agriculture.[5]

IV

MODERNISING MIDSTREAM OF VALUE CHAIN- FOOD PROCESSING

Innovations in midstream of the value chain can have significant impacts on agricultural performance, and might potentially benefit producers and consumers alike. Despite the likely positive impacts, they have received less attention in the literature and policy discussions on agriculture in the world as a whole (Minten *et al.*, 2014; Reardon, 2015). India is no exception to this general trend and in fact the situation is rather grim with lack of needed incentive structure. Processed foods were considered rich people food for a long time and suffered heavy taxation, riddled with so many taxes including steep taxes for packaged products (Dev and Rao, 2005), despite the fact that most of the foods undergo some processing before being consumed. This has been gradually changing with successive reduction in excise duties and state taxes to benefit the farmers (Rao, 2009; Rao and Dasgupta, 2009). The concept of cold chain has been non-existent until the late nineties and post-harvest losses are very high because of poor infrastructure. Transport costs are relatively high leading scholars like Mattoo *et al.* (2007) to conclude that importing from other countries is cheaper than transporting from one part of the country to another. Standards and protocols for food safety and laws for food safety were absent until recently (Dev and Rao, 2005). The Food Safety and Standards Authority of India started functioning since 2008 under the Ministry of Health and Family Welfare.

The food policy in India has mainly focused on increasing the farm production with a view to substitute imports which became a common feature during the immediate post-Independence years until the eighties. Therefore, the issue of processing the food did not arise as a policy question until the eighties (Rao, 2009). On the other hand, the industrial policy since the second five year plan concentrated on the heavy industries required to build up the necessary infrastructure for the industrial development. Though there were some food processing industries in the organised sector, they were part of small and village industries and have no separate identity.
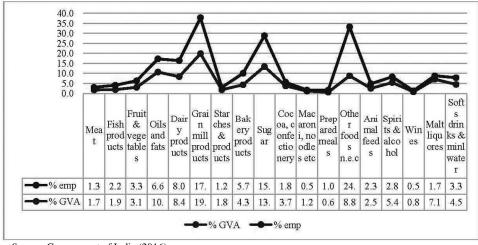
The consistent rise in per capita incomes and the shifting of the incomes after 1981 to a higher growth path led to the rise in middle classes, who have the purchasing power to buy the processed foods. The growth of manufacturing industry also necessitated encouraging food processing sector. The central government, in view of these changes, has started attempts to invigorate the sector by forming a separate ministry for food processing industries in 1988. The policy framework for the sector was liberalised after the country embarked on full scale liberalisation in 1991. Several policy initiatives for liberalising licensing system, foreign investment and taxation have been put in place since then, for encouraging the sector.

The entire sector was deregulated and no license is required except in case of items reserved for small-scale sector and alcoholic beverages. Automatic approval for foreign investment up to 100 per cent equity in food processing industries is available except in a few cases. Hundred per cent export-oriented units are permitted to import raw material and capital goods free of duty. The excise duty on food processing items was removed in 1991 and again imposed in 1997. This excise duty of 16 per cent was again removed in

2001. As against standard excise duty of 12 per cent, processed fruits and vegetables currently carry a merit rate of 2 per cent without CENVAT or 6 per cent with CENVAT.

The concept of food parks, agri-export zones, mega food parks, cold chains and human resource development have been initiated besides several incentive schemes during this period. The central government has released a food processing policy in 2001 and again in 2005, while a new policy is being finalised. The new agro-processing industries set up to process, preserve and package fruits and vegetables are allowed under Income Tax Act, a deduction of 100 per cent for five years and 25 per cent of profits for the next five years since 2004-05. However, the role of state is considered to be vital. Hence, the centre has urged the state governments to allow exemption for this sector from sales tax and other local taxes. Several state governments have also announced food processing policies. Most recently, centre has allowed 100 per cent FDI in domestic trading of food products including through e-commerce to boost growth of the sector. As many as 42 food parks were sanctioned with a total government subsidy of 2100 crores. The developers are expected to invest an amount of Rs 4500 crores for infrastructure development which in turn kick-in investments of around the same amount for setting up of processing units.
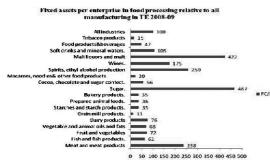
The Achilles heel of organised food processing sector continues to be very low value added at just 12 per cent in 2012-13 and much less in some of the important industries like vegetable oils and fats (5.49 per cent), dairy products (8.9 per cent), grain mill products (10 per cent) and fish products (10 per cent) (Government of India, 2016). Leading industries in terms of gross value added are grain mill products, sugars, and oils and fats and other foods (8.81 per cent) (Figure 1). In regard to employment, leading industries changes to other food products (24 per cent), grain mill products (18 per cent), and sugars (15.4 per cent).

	Mea t	Fish prod ucts	Fruit & vege table s	Oils and fats	Dair y prod ucts	Grai n mill prod ucts	Star ches & prod ucts	Bak ery prod ucts	Sug ar	Coc oa, c onfe ctio nery	Mac aron i, no odle s etc	Prep ared meal s	Othe r food s n.e.c	Ani mal feed s	Spiri ts & alco hol	Win es	Malt liqu ores	Soft s drin ks & minl wate r
% emp	1.3	2.2	3.3	6.6	8.0	17.	1.2	5.7	15.	1.8	0.5	1.0	24.	2.3	2.8	0.5	1.7	3.3
% GVA	1.7	1.9	3.1	10.	8.4	19.	1.8	4.3	13.	3.7	1.2	0.6	8.8	2.5	5.4	0.8	7.1	4.5

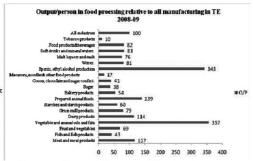*Source*: Government of India (2016).

Figure 1. Share of Sub-Sectors in Organised Food Processing Sector in 2012-13 in Employment and Gross Value Added.

The main paradox in food processing industries is the dichotomy between organised and unorganised segments as the former is capital intensive and the latter is labour intensive. While output and value added are higher in the organised segment, unorganised segment with one-fifth of output employs three times higher employment. Employment in unorganised segment was 47.93 lakhs in 2010-11 (from 37.08 lakhs in 2000-01), while organised segment employed 16.89 lakhs in 2012-13 making the total to 64.82 lakhs. The share of employment creation in the organised segment was just 26 per cent of the total employment created in food processing sector, compared to a huge share of 78 per cent in output. The fixed capital per firm and output per person are lower in organised segment itself relative to total manufacturing (Figures 2 and 3). As could be seen from these figures, food processing industries operate at just 45 per cent of the fixed capital per enterprise relative to the average of all manufacturing industries and produce 82 per cent of output/ person compared to manufacturing average. This is the major problem in this sector leading to low productivity of persons engaged in this work (Chadha and Sahu, 2003). While this is the situation on the average, some of the industries like grain mill products, tobacco industries, macaroni, noodles and other products, and several others perform poorly with low capital per enterprise as well as output except spirits, and vegetable oils and fats.

Source: Annual Survey of Industries

Figure 2: Fixed Assets per Enterprise in Food Processing Relative to all Manufacturing

Source: Annual Survey of Industries.

Figure 3. Output/Person in Food Processing Relative to all Manufacturing in TE 2008-09

The sector witnessed an impressive growth of 12 per cent per annum from 2004-09 compared to just 6 per cent in the previous two decades before that. However, the growth momentum was lost after 2011. In terms of share of this sub-sector in the manufacturing sector in regard to both output and employment was declining. The share of organised food processing plummeted from 17.31 per cent in 2005-06 to 11.59 per cent in 2012-13, while employment during the same period went down from 17.12 per cent to 11.95 per cent. Similarly, share of employment in unorganised segment declined from 17.41 per cent to 13.74 per cent in 2010-11. While unorganised food segment added one million jobs from 2000-01 to 2010-11, organised segment stagnated at around 16 lakh jobs since

2009. It needs further analysis to understand the underlying causes for this decline of share in manufacturing.

On the other hand, the growth of exports and inflow of FDI into the sector were impressive. Foreign direct investment, which was just 11759 crores or 2.62 billion US dollars from 2005-2011, has accelerated to 5.3 billion from April 2012 to December 2015. In fact, the sector received a total of 4 billion dollars in 2013-14 alone. Exports worth Rs.36172 for processed foods and Rs.33442 crores of marine products coming to a total of 69614 crores out of a total of Rs.131,000 crores of agricultural exports constituting 53 per cent of all exports.

The growth of food processing and increasing exports from this segment of value chain have been increasing its interactions with other segments like farmer-producers for sourcing of raw materials either directly through contract farming or through wholesalers and other means. Large number of studies found higher incomes and inclusiveness with contract farming in the country (Dev and Rao, 2005; Kumar, 2006; Ramaswami *et al*, 2009; Swain, 2011; Sharma, 2016a). Few studies however show exclusion of small farmers (Swain, 2011; Sharma, 2016b). On the question of state intermediation in contract farming between agri-business firms and farming community, Kumar (2006) in his study found that state mediation in contract farming might help only powerful larger farmers, while direct links between agribusiness firms and farmers help in the contract farming to be more inclusive and beneficial to the latter. In a study on fishery value chains in Kerala, Somasekharan *et al.*, (2015) found that concentration and consolidation are taking place at the processing node of the chain, wherein the number of exporters has come down and professional players are upgrading their positions in the value chains. The pre-processing node of the chain is getting integrated to the processing sector, causing a major transformation of the existing value chain.

Logistics constitute another important part of the mid-stream of the value chain. We briefly mention here about the state of cold chain development and move on to the downstream of the value chain. Lack of awareness on building cold chain as a way of reducing losses and improving efficiency and farmer profitability has been costing the farming community for a long time in the country. Efforts over the last two decades centred around building up huge cold storages to the relative exclusive of other players in the cold chain. Now, it is realised that bulk and hub storage requirements reached nearly 90 per cent and that there is a need to focus on pre-cooling pack houses, refrigerated vans, and ripening chambers, as shown in Table 3 (NCCD, 2015). The increasing availability of modern cold storages has led to important changes in potato value chains, with significant

TABLE 3. COLD-CHAIN INFRASTRUCTURE GAP IN INDIA IN 2015

Type of infrastructure (1)	Infrastructure requirement (A) (2)	Infrastructure created (B) (3)	All-India gap (A-B) (4)
Pack-house	70, 080	249	69,831
Cold-storage (Bulk) in million metric tones	341.64	318.24	3.28
Cold storage (Hub) in million metric tones	0.94		
Reefer vehicles in numbers	61826	9000	52826
Ripening chambers in numbers	9131	812	8319

Source: NCCD (2015).

implications for smallholders. All potato farmers, small and large, participate in cold storage and the availability of cold storages is associated with improved efficiency in value chains because of lower wastages even as a number of these storages become involved in input, output and especially credit markets (Minten *et al*., 2014).

V

MODERNISING RETAIL END OF VALUE CHAINS AND IMPACTS

More power to the retailers at the end of value chain is typical of the demand-driven value chains arising out of the ongoing agri-food transformation in the world as a whole. The world has been witnessing rapid emergence and diffusion of supermarkets across developing countries of Latin America, Asia and Africa in waves after the nineties (Reardon *et al*., 2003). India is the last major frontier and has been part of the third wave of supermarket diffusion after China and is followed by countries of the African continent (Pritchard *et al*., 2010). Modern retail is propelled by demand side factors like high growth in disposable incomes, urbanisation, recognition of the private initiative in policy making and related factors in the country as in several other countries in the world. In a real sense, supermarkets took off in the early years of the new millennium and grown at a high rate with some India specific characteristics like early entry into fresh fruit and vegetables, and direct procurement from farmer- producers (Reardon and Minten, 2011). This organised retail started to grow again after some restructuring and consolidation after 2015. After slipping since 2009 in global retail development index developed by A T Kearney, India is again back in top ranking in global retail development index developed by A T Kearney in 2016, after China and ahead of Malaysia.

There has been some consolidation going on in the sector with Future Group merging with Bharti Retail and acquiring many small chains like EasyDay, Nilgiris, Heritage, Big Apple, Sangam Direct and expanding their network of shops across all states. Reliance bolstered by its telecom foray is trying to expand its footprint in grocery retailing through online entry. As on June 2015, there were 3499 modern retail stores, 413 convenience stores and 112 cash and carry stores[6] (USDA, 2015). The contribution of these supermarkets (or organised retailers) in food segment is estimated to be 3-5 per cent of 360 billion food market. It is likely to grow at a faster rate in view of the underlying demand side factors, domestic investment and FDI regulations.

Direct procurement from farmer producers of fruits and vegetables, leading to "disintermediation", is the most striking feature of the supermarkets. This coupled with their centralised distribution system creating back end infrastructure separates them from the traditional marketing channels. Much of research after 1990 focused on the chances of participation and welfare effects on smallholder cultivators in developing countries, as these supermarkets start direct procurement amid fears of their procurement bypassing small farmers because of higher transaction costs. There is evidence to suggest that participation in supermarket procurement has benefitted the cultivators through income gains, higher and stable prices, employment and technology adoption (Minten *et al*.,

2009; Miyata *et al*., 2009; Neven *et al*., 2009; Rao and Qaim, 2011, 2012, 2013; Bellemare, 2012; Michelson *et al*., 2012; Michelson, 2013; Hernandez *et al*., 2015).

There are some concerns in the country that the penetration of supermarkets will trigger consolidation of land holdings, putting in risk the livelihoods of millions of small farmers (Singh 2012; Chandrasekhar, 2011). Supermarket chains overlooking small farmers for their procurement of fresh produce was found in a number of countries in Latin America that include Guatemala (Berdegue *et al*., 2005), and Mexico (Reardon *et al*., 2009) and in Africa in Kenya (Rao and Qaim, 2011). There are also some exceptions to this general pattern of exclusion in Latin America, particularly in a sector dominated by small holders. The examples include tomatoes in Guatemala and guavas in Mexico (Reardon *et al*., 2009) and Nicaragua (Michelson, Reardon and Perez, 2012) and tomatoes in Indonesia (Hernandez *et al*., 2015). The perception of large farmers as riskier marketing options, availability of family labour, organising into cooperatives and resource provision contracts can be four pathways for inclusion of small farmers into the supermarket supply chains (Reardon *et al*., 2009). Therefore, this is an empirical question in the specific socioeconomic and agronomic context. We present evidence here from a semi-arid region in South India among vegetable growers.

Data and Methodology: The primary data used in the study were collected from villages near the city of Hyderabad, the state capital of Telangana. The survey, commissioned by the Centre for Economic and Social Studies (CESS), Hyderabad, was implemented in 2010 in four mandals spread over two adjoining districts of Rangareddy and Medak in the state. These mandals were identified based on inputs obtained from key informants that include officers of state horticulture department, members of *Rythu bazaar* committee and procurement officers of the supermarket chains operating in the city of Hyderabad. The selected mandals covered most of the villages which supply vegetables to the supermarkets in the city. Once census was implemented in the selected villages, we identified 4 high intensity villages and 1 low intensity village in each mandal for implementing household surveys. In each high intensity village, 10 supermarket farmers and 5 traditional market farmers were selected randomly for interview and in each low intensity village, 10 traditional market farmers were selected randomly from the census list. The sample so selected comprises of 254 vegetable growers, out of whom 150 sell to supermarkets and 104 to traditional marketing channels.

Empirical Framework: Participation in supermarket channel is not randomly distributed, and farmer households self-select into selling to this modern marketing channel. Ignoring such selection bias might result in overestimation of the impact of supermarket participation on net income. Therefore, Heckman selection correction model is employed in this paper, following several scholars that include Miyata *et al*., (2009), for controlling the effect of self-selection bias on net incomes of the participating farmers. This model gives selection and outcome equations together using maximum likelihood estimation procedure. A variable (supermarket network) figures as an instrument in the selection equation. Selection of instrument is based on assumption that such variable affects participation decision, but not the outcome variable. Then, results of this model are compared with those from simple ordinary least squares (OLS) for finding out the

extent of selection bias and two-stage least squares with instrumentation or IVREG for robustness check.

The core equation to be estimated is:

$$Y_i = B_0 + B_1 X_1 + B_2 \ d_i + \varepsilon_i \qquad\qquad ....(1)$$

where the unit of observation is household. Y_i is net income per acre, d_i is a variable denoting the treatment - which is participation in the supermarket channel in the present context. We have considered two indicators of treatment viz., participation dummy and share of produce sold to supermarkets. ξ_i is an error term which is identically and independently distributed with mean zero. X_1 indicates a vector of household characteristics variables that may influence net margin per acre reported by the farmer households. X_1 includes household characteristics variables (Age of head of household, Education of HHH, family size, off farm participation), physical asset variables (Ratio of land allotted to high value crops, share of plot irrigated, total farm land, total farm and livestock assets), social capital variable (Membership in co-operatives) and transaction cost variable[7] (Distance from Rythu bazaar). The physical asset and social capital variables are lagged at 2005, one year before supermarket started procuring in the region to rule out reverse causality. In other words, the values of these variables, if taken at present period, may be influenced by higher income earned by the households because of their participation in the supermarket channel. We first consider d_i as a dummy for participation in the supermarket channel, with '1' for supermarket participation and '0' for non-participation. However, the extent of participation in the supermarket varies significantly across farmers. Therefore share of produce sold to the supermarket channel is also taken as a treatment variable to check the robustness of the results.

The purpose of this exercise is to estimate β_2 which represents the impact of participation in the supermarket channel on the net margin per acre reported by the sample households. However, participation in the supermarket channel is not randomly distributed. In other words, farmers self-select to supply to supermarket driven marketing channel, making participation in the supermarket channel endogenous to the outcome process[8] (Rao and Qaim, 2011). It is likely that participation in the supermarket channel is driven by unobserved characteristics such as farmer's attitude towards risk and innovation, and enterprising ability. Ignoring these variables may bias the estimate of the impact of supermarket participation on the outcome variable. In a sense, identification of a causal impact is not so easy in such context. Two methods can be adopted to deal with such problems. We can add a variable to the model as a proxy for these missing variables on farmer's inherent characteristics or replace the treatment indicator - supermarket participation with an instrument that purifies it from the effects of the same variables on which we don't have enough information (Angrist and Krueger, 2001). However, the survey data on farmer's inherent characteristics are not easily available. We therefore adopt the latter approach and instrument the supermarket participation dummy.

An instrument is a variable that is closely related to the treatment variable but is not related to the outcome variable. We instrument the treatment variable- d_i a dummy indicating whether a household participates in the supermarket channel or share of

produce sold to the supermarket with a variable that denotes farmer's social network in supermarket market channel. We choose social network of farmer households in the supermarket channel as an instrument based on insights gained through significant qualitative work in the survey region. Most supermarket chains appoint natives of the region as the procurement agents who mediate the relationship between the supermarket chain and the local farmers.

Our qualitative work suggest that farmers with friends and relatives working as a local agent of the supermarket stand a better chance of supplying their harvest to the supermarket compared to those who lack such social capital. However, some may argue that because the supermarket farmers sell their produce to the supermarket chain, they end up having more friends and relatives in the supermarket channel compared to the traditional market farmers. In other words, the instrument that we have used may suffer from reverse causality. To counter that argument, we resorted to recall questions to get information on the social network that farmers possessed 4 years ago, i.e. just before the supermarket started direct sourcing in the survey region. This obviates the concern that the social network that we used to instrument supermarket participation is endogenous to process of participation in the supermarket channel. We did not find much change in the social network possessed by the supermarket and traditional market farmers over this period.[9]

Determinants of Participation: We first estimate the probit equation of determinant of supermarket participation (Table 4). Farmer households headed by a member with higher education are more likely to sell to the supermarket compared to the households headed by less educated member. Contrary to the expectation, the coefficient of the variable denoting farm size is found to be insignificant, suggesting that in a setting dominated by smallholders, farm size is not an important factor for participation in the supermarket channel. The positive and significant sign of the variable denoting the ratio of land allotted to high value crops indicates that specialisation in vegetables does, however, matter for participation in the supermarket channel. Farmer households who have allotted higher proportion of their land to growing vegetables are more likely to sell their produce to the supermarket. While the endowment of farm equipment does not matter for participation in supermarket, access to irrigation does differentiate supermarket farmers from their traditional market counterparts. While some of the earlier studies found small farmer inclusion in supermarket procurement (Maertens and Swinnen, 2009; Miyata *et al*., 2009; Wang *et al*., 2009; Bellemare, 2012), several studies reported similar results on the availability of irrigation as positive determinant of inclusion (Balsevich, 2005; Hernandez *et al*., 2007; Neven *et al*., 2009; Dev and Rao, 2005).

Farmer households endowed with higher share of plots with access to irrigation are more likely to sell their produce in the supermarket. Expectedly, farmer households located further away from the alternative marketing channel such as wholesale market or *Rythu bazaar* are more likely to sell their produce to the supermarket compared to those who are located near the traditional market. Perhaps, for the farmer households located away from the traditional market, access to supermarket reduces transaction costs of selling their produce significantly. Social network matters for participation in the supermarket channel, as evident in the positive and significant sign of the variables

TABLE 4. DETERMINANTS OF PARTICIPATION IN SUPERMARKET CHANNEL

Dependent Variable: 1 for Supermarket Participation, 0 for Non Participation	
Independent variable (1)	Coefficient with 't' value (2)
Age of HHH (years)	-0.00 (0.01)
Education of HHH (completed years)	0.10** (0.05)
Ratio of high value land, lagged at 2005 (per cent)	0.01* (0.00)
Share of plot irrigated, lagged at 2005 (per cent)	0.01** (0.00)
Family size (No. of persons)	0.01 (0.06)
Total farm land owned, lagged at 2005 (in acres)	-0.00 (0.06)
Dummy for Co-operative, lagged at 2005 (1=membership in groups, 0 otherwise)	-0.03 (0.25)
Total farm assets owned, lagged at 2005 (in Rupees)	0.00 (0.00)
Total livestock owned, lagged at 2005 (in Rupees)	-0.00 (0.00)
Dummy for off-farm participation, lagged at 2005 (1=Yes, 0=No)	-0.29 (0.19)
Distance from traditional market (in Kms)	0.03** (0.01)
Supermarket network, lagged at 2005 (Number of friends/relatives working in supermarket)	0.96*** (0.26)
Constant	-1.31** (0.66)
Observations	245
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

Source: Calculated using field study data.

denoting number of friends and relatives working in the supermarket network, lagged at 2005. Having friends and relatives working in the supermarket network significantly increases the probability of supplying their produce to the supermarket channel.

Impact of Participation on Net Income: In the second stage, we estimated the outcome equation, i.e., the effect of participation in supermarket channel on the net income per acre of vegetable farming. We first estimated the result in OLS, using the dummy for participation in the supermarket channel as a treatment indicator. To account for selection bias, we estimated the result in IVREG (2SLS) using the instrumental variable, viz., number of friends and relatives working in the supermarket network, lagged at 2005. The result estimated in both methods show positive and significant effect of participation in the supermarket channel (Table 5). *A priori*, we expect that accounting for selection bias should reduce the effect of participation in the supermarket channel. The estimates of OLS, which assumes that participation in the supermarket channel is random and hence so selection bias is involved, show that participation in the supermarket channel increases the net income per acre of vegetable farming by Rs.10,200 per acre. However, once we account for selection bias in 2SLS (IVREG), the effect of supermarket participation gets magnified. This might be due to the fact that some of their

unobserved shortcomings in marketing their vegetable produce got solved with collection centres of supermarkets. Several scholars noted this advantage with supermarkets and negative selection bias (Bellemare, 2012; Michelson, 2013).

TABLE 5. REGRESSION RESULT FOR NET INCOME PER ACRE WITH SUPERMARKET PARTICIPATION DUMMY AS TREATMENT VARIABLE

Independent Variables	OLS	IVREG (2SLS)
(1)	(2)	(3)
Dependent Variable : Net income per acre of vegetable cultivation		
Age of HHH (years)	89.99	105.44
	(134.10)	(137.79)
Education of HHH (completed years)	410.97	209.91
	(659.06)	(724.84)
Ratio of high value land, lagged at 2005 (per cent)	53.45	24.52
	(58.29)	(71.51)
Share of plot irrigated, lagged at 2005 ago (per cent)	41.26	24.46
	(38.89)	(45.85)
Family size (No. of persons)	-132.07	-186.09
	(828.80)	(844.58)
Total farm land owned, lagged at 2005	-2,108.59***	-2,133.20***
(in acres)	(776.72)	(789.12)
Dummy for Co-operative, lagged at 2005	3,670.73	3,410.09
(1=membership in groups, 0 otherwise)	(3,523.70)	(3,594.87)
Total farm assets owned, lagged at 2005 (in Rupees)	0.06	0.06
	(0.04)	(0.04)
Total livestock owned, lagged at 2005 (in Rupees)	-0.01	-0.00
	(0.03)	(0.04)
Dummy for off-farm participation, lagged at 2005	7,328.22***	8,366.43***
(1=Yes, 0=No)	(2,814.13)	(3,199.34)
Distance from *Rythu bazar* (in Kms)	-205.68***	-242.19***
	(71.24)	(88.30)
Dummy for supermarket participation (1=Yes,	10,200.16***	17,678.18*
0=No)	(2,822.31)	(10,768.08)
Constant	15,284.08	14,888.66
	(9,737.89)	(9,899.35)
Observations	245	245
R-squared	0.163	0.138
Standard errors in parentheses		
*** p<0.01, ** p<0.05, * p<0.1		

Source: Calculated from field study data.
Note: The selection equation of 2SLS is not presented here, as the results correspond to those in Table 4.

The estimates in 2SLS show that the participation in supermarket channel results in an increase in net margin per acre of vegetable farming by Rs. 17,678, more than what we got when the selection bias was not controlled. In other words, the selection bias works in an opposite way. Farmers who a priori get lower returns from vegetable farming are more likely to get higher return upon participation in the supermarket channel. We further estimated the selection and outcome equations using Heckman selection correction model. The robustness of the result is further vindicated by Heckman selection correction method, which estimates the result in maximum likelihood method while controlling for selection bias with the same instrumental variable used in 2SLS (Table 6). The results confirm that participation in the supermarket channel increases net margin per acre by Rs. 22834 that compares with Rs.10,200 in OLS.

TABLE 6. REGRESSION RESULT OF NET INCOME PER ACRE
(HECKMAN SELECTION CORRECTION MODEL)

Variables (1)	Outcome equation (2)	Selection equation (3)
Age of HHH (years)	116.03	-0.00
	(136.65)	(0.01)
Education of HHH (completed years)	60.32	0.11**
	(690.69)	(0.05)
Ratio of high value land, lagged at 2005 (per cent)	2.72	0.01**
	(64.21)	(0.00)
Share of plot irrigated, lagged at 2005 (per cent)	15.36	0.01**
	(41.58)	(0.00)
Family size (No. of persons)	-217.68	0.01
	(841.83)	(0.06)
Total farm land owned, lagged at 2005 (in acres)	-2,164.71***	-0.01
	(788.11)	(0.06)
Dummy for Co-operative, lagged at 2005 (1=membership in groups, 0 otherwise)	3,302.96	0.01
	(3,578.84)	(0.26)
Total farm assets owned, lagged at 2005 (in Rupees)	0.06	0.00
	(0.04)	(0.00)
Total livestock owned, lagged at 2005 (in Rupees)	0.00	-0.00
	(0.03)	(0.00)
Dummy for off-farm participation, lagged at 2005 (1=Yes, 0=No)	9,058.47***	-0.32*
	(2,984.92)	(0.19)
Distance from *Rythu Bazar* (in Kms)	-251.99***	
	(74.84)	
Dummy for supermarket participation (1=Yes, 0=No)	22,834.05***	
	(6,958.35)	
Distance from traditional market (in Kms)		0.04***
		(0.01)
Supermarket network (5 years ago)		0.83***
		(0.24)
Constant	14,159.98	-1.44**
	(9,875.98)	(0.65)
/athrho	-0.44*	
	(0.23)	
/lnsigma	9.93***	
	(0.06)	
Observations	245	245

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Calculated using field study data.

What do we make of the significance of other variables, which are consistent across OLS, 2SLS and Heckman selection correction model? It seems that being large farmer households is not exactly an advantage in the vegetable farming as evident in negative and significant sign of the farm land, lagged at 2005. Lack of access to alternative marketing channels such as *Rythu bazaar* negatively affects the returns reported by farmers in vegetable farming. The distance from *Rythu bazaar* has negative and significant sign, which indicates that further the farmers are located away from the *Rythu bazaar*, lower return that they are likely to get in the vegetable farming. The income flow from off-farm source does have positive effect on the net margin per acre of vegetable farming, as access to income obtained from other sources relaxes the cash constraint.

Proportion of Produce Sold to Supermarket as Treatment Variable: Even within supermarket farmers, the effect of participation varies across farmers depending upon the proportion of the produce sold to supermarkets (Table 7). The result shows that higher the share of produce sold to the supermarket channel, higher is the effect on the net income per acre reported by the farmer households. Like the decision to participate in the supermarket channel, the decision on how much to sell to the supermarket may be endogenous to farmers' inherent characteristics. We therefore instrument the variable denoting share of produce sold to the supermarket channel to account for selection bias using two-stage least squares method with instrumental variable.

TABLE 7. REGRESSION RESULT FOR NET INCOME PER ACRE WITH SHARE OF PRODUCE
SOLD TO SUPERMARKET AS TREATMENT VARIABLE

Variables (1)	OLS (2)	IVREG (2SLS) (3)
Dependent variable: Net income per acre of vegetable cultivation		
Age of HHH (years)	31.18 (133.42)	15.07 (137.56)
Education of HHH (completed years)	367.25 (655.42)	237.56 (700.60)
Ratio of high value land, lagged at 2005 (per cent)	52.20 (58.24)	37.69 (64.24)
Share of plot irrigated, lagged at 2005 (per cent)	43.95 (38.45)	34.36 (42.42)
Family size (No. of persons)	-7.89 (824.17)	32.54 (833.82)
Total farm land owned, lagged at 2005 (in acres)	-2,140.07*** (774.13)	-2,140.93*** (780.21)
Dummy for co-operative, lagged at 2005 (1=membership in groups, 0 otherwise)	3,983.76 (3,500.43)	4,001.32 (3,528.06)
Total farm assets owned, lagged at 2005 (in Rupees)	0.06 (0.04)	0.06 (0.04)
Total livestock owned, lagged at 2005 (in Rupees)	-0.01 (0.03)	-0.01 (0.03)
Dummy for off-farm participation, lagged at 2005 (1=Yes, 0=No)	6,275.80** (2,777.78)	6,534.52** (2,838.05)
Distance from *Rythu Bazar* (in Kms)	-173.25** (69.59)	-180.18** (71.23)
Share of produce sold to supermarket (per cent)	256.43*** (63.67)	377.92* (227.90)
Constant	18,573.12* (9,800.77)	19,129.10* (9,928.28)
Observations	244	244
R-squared	0.175	0.162

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Calculated using field study data.
Note: The selection equation of 2SLS is not presented here, as the results correspond to those in Table 4 and 6.

Comparison of estimates obtained in OLS (where selection bias is not controlled for) with that of IVREG (2SLS) confirm that the positive effect of supermarket participation stands no matter what indicator of treatment (of participation in the supermarket channel) variable that we consider (Table 7). The result of our study on positive and significant impact of selling to supermarket procurement centres is in line with several studies in

developing countries (Key and Runsten, 1999; Neven *et al.*, 2009; Minten *et al.*, 2009; Miyata *et al.*, 2009; Rao and Qaim, 2011; Hernandez *et al.*, 2015). Further, once selection bias is controlled, an increase in the share of produce sold to the supermarket by 1 per cent increases net margin per acre by Rs. 256 (in OLS), which compares with Rs. 378 per acre (in IVREG/2SLS). Similar instance of negative selection bias was reported by Bellemare (2012). The sign and significance of other variables in the model with the share of produce sold to the supermarket as a treatment indicator remains the same as when we consider the supermarket participation dummy as a treatment indicator, confirming the robustness of our result.

<div align="center">VI</div>

<div align="center">CONCLUSIONS</div>

This paper focuses on domestic value chains and disruptive innovations at different nodes in value chain framework in its interaction with innovation systems. Also, it presents endogeneity corrected evidence on the impacts of supermarket procurement in semi-arid region of the country. Forces of globalisation, changing demand pattern with rising incomes and urbanisation, rapid strides in information and communication technologies, and transformative roles for institutional actors in state, private sector and civil society have been altering the landscape of agricultural production and marketing in the last few years. Emerging new generation start-ups have been bringing in several innovations in product, process, marketing and organisation in agriculture. These start-ups rendering input and output services, mainly relying on online and mobile platforms, have been altering the value chain and roles of different actors and cutting down the length of value chain.

The start-up activity in agriculture, however, falls short of the total activity and accounted for just one per cent of total investment of six billion dollars in 2015. Further, late stage funds for scaling up are virtually non-existent. This is not coincidental since studies in other countries show empirical evidence of market failures in entrepreneurial activity in agriculture and need for the state to intervene (For e.g. Hall, 2007; Calvino *et al.*, 2015). Therefore, certain amount of start-up fund may be earmarked for spurring innovative start-ups in food and agriculture. Other suggestions to channel entrepreneurial activity in food and agriculture include remodelling technology business incubators under Indian Council of Agricultural Research (ICAR) on business principles and ensuing representation of ministry of agriculture in the inter-ministerial board for start-up promotion.

Several changes have been occurring in mid-stream of the value chain in the segments of food processing, cold chain, wholesalers, and logistics and they impact other actors of the value chain. The continued growth of food processing has been encouraging contract farming to bring firms in direct contact with the farmers for supply of required level and quality raw material cutting down the risk. Many studies in the country showed that they led to higher incomes, though findings on inclusion are not conclusive. Employing 65 lakh persons directly, the food processing sector is perennially operating at a very low capital base obviously with primitive technology and low output per person that again reduces earnings. Development of cold chains increased efficiency of value

chains through reduced wastages and earnings in crops like potato. However, recent studies show that the weak link in developing cold chain in the country lies in other components like pre-cooling units (pack houses), refrigerated vans, ripening chambers etc. One should not lose sight of the fact that all these improvements will increase interaction between value chain actors across the length and breadth of the country, especially as the legal environment is going to become more conducive with GST introduction by mid-2017.

There are now increased interactions between retailers, wholesalers, processors, logistics, cold storages, farmers and consumers. The major change in food value chain arises from the emergence of supermarkets since the early years of the new millennium, as a part of third wave of geographical spread in the world. Several organised retailers like Reliance Fresh, Future Group, Amazon, Big Basket, Flipkart and others have started their private labels and this has the effect of their increased role in processing also (Sinha *et al.*, 2012; Rao *et al.*, 2016). They started selling fresh produce early in their growth compared to other countries and also started direct procurement early to tide over supply requirements in the poor infrastructural background. This paper presented evidence on impacts of supermarket procurement in a semi-arid region from a study of 254 vegetable growers that sell to both supermarkets and traditional markets. Analysing the data using different methods to control selection bias showed that there has been a significant and positive impact of participating in supermarket procurement on net income. Further, the entry into these new markets is not conditioned by land ownership, but rather by possession of irrigation. Therefore, policy makers may consider improving conditions for entry of resource poor farmers into these modern markets, which might become much more dominant in the years to come as happened elsewhere in other developing countries. The experience of China is particularly relevant in this context. Hu and Gale (2016) showed that Chinese Government's scheme of direct procurement between supermarkets and farmers by providing several incentives like investments to build collection centres, tax exemptions for their procurements from cooperatives and others, has helped farmers in forming large number of cooperatives and gain by selling directly to supermarkets.[10]

NOTES

1. 'Organised retailing' and 'supermarkets' are used interchangeably in this paper.

2. India had witnessed efforts to introduce agricultural innovation system (AIS) as the dominant paradigm with the World Bank aided 250 million dollar National Agricultural Innovation Project (NAIP) implemented by the Indian Council of Agricultural Research (ICAR) that ended in 2012Agricultural innovation systems (AIS) approach has replaced, as the dominant paradigm in many countries, earlier frameworks for investment and promotion of knowledge like national agricultural research system (NARSs) of the sixties and agricultural knowledge and information systems (AIKSs) of the nineties (Spielman and Birner, 2008).

3. The detailed listing can be seen at: http://www.startupindia.gov.in/uploads/pdf/List_of_Incubators.pdf. As many as 32 of them are related to agriculture and highest number (24) of all the TBIs are situated in Tamil Nadu. Inter-ministerial committee for micro, small, medium enterprises gave comprehensive recommendations for the sector in 2013. TBIs by organisations like CSIR, DST, NCL and some of the state governments especially Karnataka, Tamil Nadu, Telangana and others are notable.

4. The Hindu Business Line reported on findings of a report by News Corp VCCEdge in the news item available at: https://www.pressreader.com/india/the-hindu-business-line/20161025/281784218633274.

5. This agri-tech accelerator programme has the participation from Riverbridge Ventures Innovations Platform (RViP). It engages with start-ups through its unique scaling model and work as a full-time partner for enabling and scaling the efforts of the participating start-ups. News item available at:

http://www.thehindubusinessline.com/news/national/thub-icrisat-team-up-for-agri-accelerator/article9296557.ece Accessed on 3.11.2016.

6.   However, this figure can be an underestimate as Reliance operated 3043 stores by December 2015.

7.   The variables used in outcome and selection equations are same except for the instrumental variable in selection equation using supermarket network. There is another difference in that distance from Rythu bazar is taken in the outcome equation and distance from traditional market is taken in the selection equation. This is justified as Cameron and Trivedi (2009) state that covariates of outcome (x) and selection equation (z) can be same variables or different variables based on the user's assumption. However, z is part of x, if the users suspects that additional covariates affect y but not w, or vice versa, if one suspects that additional covariates affect selection but not outcome (net income).

8.   Problems of attribution is similar to technology adoption as discussed in Rao (2013). While technology adoption is the defining variable in that case, participation in supermarket procurement is the confounding variable in this case.

9.   Threshold to judge the strength of an instrument is for the F statistic of instrument has to be 10 (Stock *et al.*, 2002). In this case, F statistic is 12.31 and satisfy the necessary condition for use of this instrument.

10.   As many as 15600 co-operatives were started by the end of 2011 as a result of these incentives. CarreFour started its global hub of procurement in China with this and the programme was a huge success (Hu and Gale, 2016).

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