Startups with Open Innovation: Accelerating Technological Change and Food Value Chain Flows in India

Chandra S.R. Nuthalapati*, K. Srinivas**, Neha Pandey* and Rajeev Sharma*

ABSTRACT

Entrepreneurial new firms can bring in radical innovations better with a risk-taking approach. Startups have been proliferating in all sectors of the economy including agriculture in developing countries in recent years. This paper harnesses a large database of start-ups in India and examines the nature of innovations of the start-ups employing open innovation framework. Several types of startups have come up in the last decade that are filling the gaps in the food value chains in infrastructure deficit regions of the country and introducing innovations by mobilising 8 billion USD investments. This fast-expanding knowledge flows have brought several innovations that could not be imagined just a few years back. Significantly, open innovation has taken root in Indian agriculture with the rise of startups and this has several positive implications. Open innovation is required at the present stage as Indian agriculture is in transition and moving towards a higher level of technologies with better and faster linkages among various food chain actors. There are concerns that need to be addressed about this innovation, bypassing the smallholders, as companies can only plan for their own innovations and marketing. The government needs to develop a policy framework to create the necessary enabling environment for the development of the startup ecosystem and to internalise and mainstream this open innovation into agricultural development strategies keeping the twin goals of growth and equity.

Keywords: Startups, Technological Change, Food Value Chain, Innovation

JEL.: L26, O36, Q13, Q16

INTRODUCTION

The debate on large versus small firms as the drivers of innovation has been veering towards the latter in development discourse in recent period that is nearer to the initial hypothesis of Schumpeter (Baumol, 2004; Dolfsma and van der Velde, 2014). Concomitantly, entrepreneurship has been rising simultaneously in most parts of the world as countries transition from managed economies to entrepreneurial economies triggering a shift in government policies away from constraining the freedom of business to contract through regulation, public ownership and antitrust towards a new set of enabling policies which foster the creation and commercialisation of new knowledge (Acs et al., 2004; Audretsch, 2009). While spillovers in knowledge generated in public and private sectors are hypothesised to lead to entrepreneurial new firms by Acs and Audretsch (Acs et al., 1994),

*Professor and Researchers, respectively, Institute of Economic Growth, University of Delhi Enclave, New Delhi-110 007, **National Academy of Agricultural Research Management (NAARM), Hyderabad.
Chesbrough (2003) postulated that innovations in the new millennium are to be jointly achieved. In this background, startups have been proliferating across the countries not only the developed, but also in developing countries in Asia, Africa and Latin America both in hi-tech sectors and traditional sectors like agriculture (Nanda and Rhodes-Kropf, 2013; Fabricio et al., 2015; De Bernardi and Azucar, 2020). Notwithstanding the proliferation of startups and a flurry of innovations in various segments of the value chain, the extant literature does not analyse these developments in developing country context empirically to mainstream these developments in the overall growth process. This paper endeavours to address this research gap.

This paper is organised as follows. The following Section expounds the conceptual framework and data source and methods. The third Section examines the nature of innovations of startups in regard to their functioning at various nodes of the value chain. The fourth Section brings out the discussion on open innovation knowledge flows leading to open innovation. The last Section concludes with policy suggestions.

II

CONCEPTUAL FRAMEWORK

Open innovation has been permeating every field of economic activity all over the world in the last two decades. More consciously and as a planned development process, after the word ‘open innovation’ was coined and formalised as a new paradigm of creating and profiting from technology by Chesbrough (2003) in his celebrated book. Initially, he called it the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively (Chesbrough, 2006). As the learning curve moved up with intensive debates and extensive applications over a period of the first decade, more details are added to say that open innovation is ‘a distributed innovation process based on purposively managed knowledge flows across organisational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organisation's business model’ (Chesbrough and Bogers, 2014). To start with, this kind of organisation of innovation is only possible in the economic activities as the level of sophistication is high and the processes are complex. However, the evolving experience in disparate industries showed that this can have traction in relatively conventional industries too (Chesbrough and Crowther, 2006; Medeiros et al., 2016). The ramping up of technology with newer innovations has been spurring transitions in the food industry, especially as the mid-stream and downstream of food value chains reached two-thirds magnitude in most of the world (Reardon et al., 2019) including India (Reardon et al., 2020). Research has shown that diverse actors in the long chains with heterogeneous needs (Sarkar and Costa, 2008) and an assortment of technologies required to produce the changing consumer demands (Bigliardi and Galati, 2013) all lead to open innovation paradigm for faster technology development.
STARTUPS WITH OPEN INNOVATION: ACCELERATING TECHNOLOGICAL CHANGE AND FOOD

and diffusion. The convergence of findings can also be seen in studies in agricultural economics showing the diffusion of innovation across all the actors in the entire chain when the processing firms bring in new technologies (Zilberman et al., 2019). However, the new paradigm involves disparate actors in both development and diffusion of innovations.

The knowledge flows can be outside in or outbound depending on the needs of innovation and the business models of the respective actors. While initial evidence showed that primarily the large companies initiate and move the process forward, subsequent experience proved that small and medium sized companies including startups, non-profit foundations, collective community actions and individual consumers can also catalyse significant transformations (Figure 1). Startups specifically need external knowledge sources in view of scarcity of internal resources and competencies (Di Pietro et al., 2018). The food system is ideally suited to combine the knowledge specificities of many actors including startups in open innovation framework (De Bernardi and Azucar, 2020, p 109-110).

![Figure 1. Startups and Large Companies Relationship.](source)

This paper employs open innovation framework to understand the operations of large number of agri-tech startups in India across various activities to fully make sense of their activities in totality. Being an exploratory study on this evolving ecosystem, this paper confines to broad delineation of the functions and interoperability mechanisms without going deeper into the technological products and associated marketing strategies. It classifies the startups working in food value chains based on the main purpose of each of its functioning, though there can be several interventions at different nodes of the value chain and overlap of functions. Then, it analyses the innovations and brings out salient features including the level of investments. It harnesses a large database of startups from Traxcn and also collates with other published as well as news items in business dailies.

III

NATURE OF INNOVATIONS IN FOOD VALUE CHAINS WITH STARTUPS AND IMPLICATIONS

There are several types of startups that have come in the last decade that are filling the gaps in the food value chains in infrastructure deficit regions of the country. Farmers in developing countries face multiple risks on several fronts
(Komarek et al., 2020) and these startups endeavour to address them using new generation IT tools such as internet of things (IoT), big data analytics, blockchain technology and so on. Many of these startups in India operate in tandem with various other related companies in downstream with the supermarkets, retailers, hoteliers, in the mid-stream with the processors, wholesalers and logistic firms, and in the upstream with the input companies and so on. It is here the open innovation framework is employed to discern the nature of emerging innovations and their diffusion through inbound and outbound as well as bi-directional knowledge flows as shown by Bogers et al., (2018). An effort is made to classify them based on their main line of activity, though they can have other initiatives too, so that the nature of arising startup initiatives can be analysed to unravel the mechanisms of knowledge flows for innovation. The six broad categories of startup innovations identified are- those providing output market linkages; facilitating input supply; enabling mechanisation, irrigation control and financial support; helping in quality maintenance, monitoring, traceability and output predictions (SaaS); post-harvest management and farming as a service (FaaS); and those supporting animal husbandry farmers. All these groups are discussed below with more details and analysis with interconnections. Finally, the nature of knowledge flows leading to the complicated web of open innovation network is examined.

3.1. Output Market Linkages

Accumulated evidence shows that reducing the chain of intermediaries between the farmer-producer and consumer can benefit the former through higher price realisation (Chand, 2017; Nuthalapati et al., 2020; Pingali et al., 2019). A large number of startups focus on innovations for linking the farmers in far-flung areas with the buyers of their produce (Table 1). The important players among them include- Udaan, BigBasket, Swiggy, Zomato, Grofers, Ninjacart, WayCool, ZopNow, ShopKirana, Jumbotail, DeHaat, AgriBazaar, Bijak, Farmpal, and MilkBasket. The first four of these start-ups are unicorns involved in direct procurement from farmers and selling to other supermarket chains and other downstream actors. Udaan is a fastest growing B2B full stack platform dealing in several items like electronics, garments, footwear, kitchen and home appliances along with staples and fruit and vegetables (Poojary, 2019). Despite being the direct sellers of food, the other three unicorns, viz., BigBasket, Swiggy and Zomato engage directly with farming community and procure through viz., like direct sellers of food. By September 2020, large investments are attracted by these startups to the tune of 6.96 billion USD, which is invested in building the long neglected modernisation of the value chains as well as for innovations. Significant investments are in Swiggy (1.6 billion), Zomato (972 million), BigBasket (1.02 billion), and Udaan (900 million). Some of the other startups raising considerable investments include Grofers (535 million USD), Ninjacart (164 million), WayCool (65 million), Jumbotail (25 mn), and Bijak (15 mn).
## TABLE 1. STARTUPS CONNECTING FARMERS WITH OUTPUT MARKETS

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Overview</th>
<th>Founded year</th>
<th>City</th>
<th>Funding</th>
<th>Company stage</th>
<th>Annual revenue USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bigbasket (Unicorn)</td>
<td>Online marketplace of grocery products</td>
<td>2011</td>
<td>Bangalore</td>
<td>Yes</td>
<td>7.88E+08</td>
<td>Series F</td>
</tr>
<tr>
<td>Zomato (Unicorn)</td>
<td>Online platform enabling food ordering and delivery</td>
<td>2008</td>
<td>Gurgaon</td>
<td>Yes</td>
<td>9.75E+08</td>
<td>Series J</td>
</tr>
<tr>
<td>Swiggy (Unicorn)</td>
<td>Online platform for food ordering and delivery</td>
<td>2014</td>
<td>Bangalore</td>
<td>Yes</td>
<td>1.62E+09</td>
<td>Series I</td>
</tr>
<tr>
<td>Udaan</td>
<td>Online B2B marketplace for multi-category products</td>
<td>2016</td>
<td>Bangalore</td>
<td>Yes</td>
<td>900000000</td>
<td>Series D</td>
</tr>
<tr>
<td>Grofers (Soonicorn)</td>
<td>Online retail store offering groceries</td>
<td>2013</td>
<td>Gurgaon</td>
<td>Yes</td>
<td>5.48E+08</td>
<td>Series D</td>
</tr>
<tr>
<td>Ninjacart (Soonicorn)</td>
<td>App-based B2B platform offering vegetables and fruits</td>
<td>2015</td>
<td>Bangalore</td>
<td>Yes</td>
<td>1.63E+08</td>
<td>Series C</td>
</tr>
<tr>
<td>WayCool (Soonicorn)</td>
<td>E-distributor of farm groceries with a three-hour delivery promise (Acquired by More and Amazon)</td>
<td>2015</td>
<td>Chennai</td>
<td>Yes</td>
<td>65736870</td>
<td>Series C</td>
</tr>
<tr>
<td>ZopNow (Soonicorn)</td>
<td>Online grocery platform</td>
<td>2011</td>
<td>Bangalore</td>
<td>Yes</td>
<td>12045360</td>
<td>Series A</td>
</tr>
<tr>
<td>Agrevolution (DeHaat)</td>
<td>Provider of end-to-end farming services to the farming communities</td>
<td>2012</td>
<td>Patna</td>
<td>Yes</td>
<td>16507907</td>
<td>Series A</td>
</tr>
<tr>
<td>Bijak</td>
<td>Online B2B marketplace to trade agriculture commodities</td>
<td>2019</td>
<td>Gurgaon</td>
<td>Yes</td>
<td>14591780</td>
<td>Series A</td>
</tr>
<tr>
<td>Jumbo tail</td>
<td>Online B2B platform for packaged food, fruits and vegetables</td>
<td>2015</td>
<td>Bangalore</td>
<td>Yes</td>
<td>25361400</td>
<td>Series B</td>
</tr>
<tr>
<td>Shop Kirana</td>
<td>Mobile-based B2B marketplace for groceries</td>
<td>2015</td>
<td>Indore</td>
<td>Yes</td>
<td>12472215</td>
<td>Series B</td>
</tr>
<tr>
<td>Otipy</td>
<td>App-based platform offering fruits and vegetables</td>
<td>2019</td>
<td>Delhi</td>
<td>Yes</td>
<td>2500000</td>
<td>Seed</td>
</tr>
<tr>
<td>Kisan Network</td>
<td>B2B marketplace for farmers, bulk buyers and retailers</td>
<td>2015</td>
<td>Delhi</td>
<td>Yes</td>
<td>3493115</td>
<td>Seed</td>
</tr>
<tr>
<td>Crofarm</td>
<td>Digital supply chain of fruits and vegetables from farm to business</td>
<td>2016</td>
<td>Gurgaon</td>
<td>Yes</td>
<td>5866696</td>
<td>Seed</td>
</tr>
<tr>
<td>Aibono</td>
<td>Services for farm data collection &amp; analytics and mobile application for farm management</td>
<td>2013</td>
<td>Bangalore</td>
<td>Yes</td>
<td>6488656</td>
<td>Seed</td>
</tr>
<tr>
<td>Clover Ventures</td>
<td>Provider of supply chain solution for fruits and vegetables</td>
<td>2017</td>
<td>Bangalore</td>
<td>Yes</td>
<td>6930813</td>
<td>Series A</td>
</tr>
<tr>
<td>Teabox Satvacart</td>
<td>Online retailer of tea and coffee</td>
<td>2012</td>
<td>Bangalore</td>
<td>Yes</td>
<td>19000000</td>
<td>Series B</td>
</tr>
<tr>
<td>Tokri</td>
<td>Online platform to buy fresh produce and groceries</td>
<td>2014</td>
<td>Pune</td>
<td>Yes</td>
<td>2500000</td>
<td>Seed</td>
</tr>
</tbody>
</table>

(Contd..)
TABLE 1 (CONCLD.)

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Overview</th>
<th>Founded year</th>
<th>City</th>
<th>Funding Total USD</th>
<th>Company stage</th>
<th>Annual revenue USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milkbasket</td>
<td>Subscription based daily need items delivery (Milk and F&amp;V)</td>
<td>2015</td>
<td>Gurgaon</td>
<td>Yes</td>
<td>40575340</td>
<td>Series B</td>
</tr>
<tr>
<td>Farmpal</td>
<td>Online platform delivering farm produce to businesses</td>
<td>2017</td>
<td>Pune</td>
<td>Yes</td>
<td>136390</td>
<td>Seed</td>
</tr>
<tr>
<td>MeraKisan</td>
<td>Online marketplace that connects consumers with local farmers</td>
<td>2014</td>
<td>Pune</td>
<td>Yes</td>
<td>1000000</td>
<td>Seed</td>
</tr>
<tr>
<td>VnF</td>
<td>Online platform to purchase fruits and vegetables</td>
<td>2018</td>
<td>Mumbai</td>
<td>Yes</td>
<td>2000000</td>
<td>Seed</td>
</tr>
<tr>
<td>Inl Farms</td>
<td>Provider of farming services to horticulture industries</td>
<td>2009</td>
<td>Mumbai</td>
<td>Yes</td>
<td>14634837</td>
<td>Series A</td>
</tr>
<tr>
<td>FarmTaaza</td>
<td>Manages supply chain of fruits and vegetables from farm to business (Acquired by WayCool)</td>
<td>2015</td>
<td>Bangalore</td>
<td>Yes</td>
<td>10693115</td>
<td>Series A</td>
</tr>
<tr>
<td>Daily Ninja</td>
<td>Hyper-local subscription based delivery service (Acquired by BigBasket)</td>
<td>2015</td>
<td>Bangalore</td>
<td>Yes</td>
<td>10744109</td>
<td>Acquired</td>
</tr>
<tr>
<td>Smerkato</td>
<td>Online B2B platform offering multi-category grocery products</td>
<td>2016</td>
<td>Bangalore</td>
<td>Yes</td>
<td>na</td>
<td>Funded</td>
</tr>
<tr>
<td>GeeCom</td>
<td>Online E-commerce platform offering agricultural products and supplies</td>
<td>2018</td>
<td>Indore</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
</tr>
<tr>
<td>Farmley</td>
<td>Online platform linking farmers with customers (Earlier called TechnifyBiz)</td>
<td>2016</td>
<td>Delhi</td>
<td>Yes</td>
<td>na</td>
<td>Funded</td>
</tr>
<tr>
<td>Kirana Monk</td>
<td>App-based B2B marketplace offering farm produce</td>
<td>2018</td>
<td>Sonipat</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
</tr>
<tr>
<td>Atomaday</td>
<td>App-based video shopping platform offering fruits and vegetables</td>
<td>2017</td>
<td>Bangalore</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
</tr>
<tr>
<td>Green-N Good</td>
<td>Online retailer of organic products</td>
<td>2012</td>
<td>Jaipur</td>
<td>Yes</td>
<td>na</td>
<td>Funded</td>
</tr>
<tr>
<td>Organo fresh</td>
<td>B2B wholesaler of fruits and vegetables</td>
<td>2017</td>
<td>Chandigarh</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
</tr>
<tr>
<td>Solutions</td>
<td>Online B2B marketplace for agriculture products</td>
<td>2017</td>
<td>Pune</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
</tr>
<tr>
<td>Farmcon</td>
<td>B2B platform to procure fresh fruits and Vegetables (Sabziwala and LivLush merged as Kamatan)</td>
<td>2016</td>
<td>Bangalore</td>
<td>Yes</td>
<td>na</td>
<td>Series A</td>
</tr>
<tr>
<td>LivLush</td>
<td>Online B2B platform offering farm produce</td>
<td>2018</td>
<td>Bangalore</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
</tr>
</tbody>
</table>

Source: Compiled from Traxcn database as of February 2020.
While BigBasket has been procuring directly from the farmers since the last several years (Nuthalapati et al., 2017), several startups embarked on direct procurement in recent years and the quantities are significant and increasing. For example, Udaan is procuring fruits and vegetables in Delhi and Karnataka and dealing with a quantity of 500 tonnes per day, apart from 5000 tonnes of staples (Poojary, 2019). Ninjacart supplies fresh produce to Flipkart for its Flipkart Quick and deals with 1500 tonnes a day (Velayanikal, 2020). Zomato acquired Bangalore-based WOTU in 2018 and renamed as ‘Hyperpure’ for starting direct procurement from farmers through operations in B2B foodtech space (Kashyap, 2019, 2020), while Swiggy entered hyperlocal grocery delivery recently and also procured from farmers directly (Garg, 2020). Leveraging e-mandi model, Agribazaar works with 200,000 farmers and connects them with procurement agencies and food processing companies like Britannia, AgroPure and others at no cost, though it collects transaction fee from the buyers (Mitter, 2020). DeHaat, based on the franchise model connects farmers with traders, institutional financers and buyers like Reliance Fresh, Zomato, Udaan, etc., on one platform in 20 regional hubs in eastern India and serves 210,000 farmers (Singh, 2020a). It is noteworthy that several of the active startups work in the states with poor agricultural marketing infrastructure in central and north India. Further, they provide several related services to which we return towards the end of this Section. While several startups fail to survive or make it to the bigger leagues, some are acquired by bigger companies. For example, ZopNow was acquired by More and later Amazon; FarmTaaza by WayCool; and DailyNinja by BigBasket. Pivoting from B2C to B2B, as has been done by Ninjacart, WayCool, has been a trend recently and B2B startups seem to get higher funding chances relatively (Sheth et al., 2020).

3.2 Startups Facilitating Input Supply

Several studies showed that availability and quality of inputs to the farmers is a serious problem impinging productivity and profitability of farmers, where flyby night operators make quick money by selling spurious seeds, fertilisers and pesticides (Parthasarathy and Shameem, 1998). The transformation of input industries and delivery systems are critical in this regard (Pray and Nagarajan, 2014). Several startups have been offering solutions to optimise the use and enable delivery of assured quality inputs to farmers (Table 2). These online services have been of help in the times of pandemic to follow social distancing and purchase inputs from home using smartphone. Agrostar is the largest startup in input supply to farmers and is expected to be unicorn soon. It has mobilised 47 million USD in funding and reached Series C funding so far. It has been serving farmers in Gujarat, Maharashtra and Rajasthan with 400, 000 active users and one million downloads of its app. By partnering with leading national and multinational companies to sell their products through AgroStar, it enables farmers in buying seeds, nutrients, crop protection, as
well as hardware products from its platform and app (Apoorva, 2019). Similar services are provided by BigHaat, Khetinext, Gramophone, and several others. Many of them combine input provision with agri-advisory and other services.

TABLE 2. STARTUPS ENABLING ONLINE PROCURING OF QUALITY INPUTS

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Overview</th>
<th>Founded year</th>
<th>City</th>
<th>Funding</th>
<th>Total funding USD</th>
<th>Company stage</th>
<th>Annual revenue USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agrostar</td>
<td>Online platform offering agri-inputs, content, and advice on procurement of farm inputs and provides information</td>
<td>2008</td>
<td>Pune</td>
<td>Yes</td>
<td>47182672</td>
<td>Series C</td>
<td>11618100</td>
</tr>
<tr>
<td>Khethinext</td>
<td>Mobile app that enables procurement of farm inputs and provides information</td>
<td>2017</td>
<td>Hyderabad</td>
<td>Yes</td>
<td>5386498</td>
<td>Series A</td>
<td>na</td>
</tr>
<tr>
<td>Gramophone</td>
<td>App-based platform providing farm input products and information to the farmers</td>
<td>2016</td>
<td>Indore</td>
<td>Yes</td>
<td>8062080</td>
<td>Series A</td>
<td>578400</td>
</tr>
<tr>
<td>Marut Drones</td>
<td>Provides drone-based precision agriculture services</td>
<td>2019</td>
<td>Guwahati</td>
<td>Yes</td>
<td>100085</td>
<td>Seed</td>
<td>na</td>
</tr>
<tr>
<td>LeanAgri</td>
<td>Technology solutions providers for farmers</td>
<td>2017</td>
<td>Pune</td>
<td>Yes</td>
<td>567108</td>
<td>Seed</td>
<td>93300</td>
</tr>
<tr>
<td>BharatAgri</td>
<td>Platform that provides crop management solutions for farmers</td>
<td>2017</td>
<td>Pune</td>
<td>Yes</td>
<td>1291537</td>
<td>Seed</td>
<td>93300</td>
</tr>
<tr>
<td>BigHaat</td>
<td>Online marketplace offering farm inputs</td>
<td>2015</td>
<td>Bangalore</td>
<td>Yes</td>
<td>2569628</td>
<td>Seed</td>
<td>103894</td>
</tr>
<tr>
<td>A-One Seed</td>
<td>Wholesale online B2B marketplace of seeds</td>
<td>2019</td>
<td>Hisar</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Terra Agro</td>
<td>Agro biotech manufacturer and supplier of biological farm inputs</td>
<td>2016</td>
<td>Jaipur</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>AgriApp</td>
<td>Online marketplace for agriculture farm inputs</td>
<td>2016</td>
<td>Bangalore</td>
<td>Yes</td>
<td>na</td>
<td>Funded</td>
<td>na</td>
</tr>
<tr>
<td>SmartFarms</td>
<td>Online B2B distributor of agricultural input products</td>
<td>2019</td>
<td>Gurgaon</td>
<td>Yes</td>
<td>na</td>
<td>Seed</td>
<td>na</td>
</tr>
<tr>
<td>FarmGuru</td>
<td>Online platform for group buying of farm input products</td>
<td>2015</td>
<td>Pune</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>BehstarZindagi</td>
<td>Online marketplace for agricultural supplies</td>
<td>2016</td>
<td>Delhi</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Unnati</td>
<td></td>
<td>2016</td>
<td>Noida</td>
<td>Yes</td>
<td>452321</td>
<td>Seed</td>
<td>101,28,605</td>
</tr>
</tbody>
</table>

Source: Compiled from Traxcn database as of February 2020.

3.3 Startups for Mechanisation, Irrigation and Financial Services

Farming in the Indian context is becoming difficult for lack of suitable equipment especially for small farmers, enormous drudgery in irrigation fields and waste of water and lack of financial services. Startups have been finding these gaps and operating efficient services across the length and breadth of the country (Table 3). Some of them focus on accurate and timely assessment of soil moisture and developing data-driven controlled irrigation models. Kisan Raja is an innovative device allows farmers to remotely control the agricultural motor using their mobile or landline and used by 34200 farmers in India (Gogoi, 2019), apart from being
### TABLE 3. STARTUPS HELPING IN EFFICIENT MECHANISATION, IRRIGATION AND FINANCIAL SERVICES

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Overview</th>
<th>Founded year</th>
<th>City</th>
<th>Funding</th>
<th>Company stage</th>
<th>Annual revenue USD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mechanisation</strong></td>
<td></td>
<td></td>
<td></td>
<td>USD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FarMart</td>
<td>Web and mobile-based application for renting farm equipment</td>
<td>2015</td>
<td>Gurgaon</td>
<td>Yes</td>
<td>Seed</td>
<td>35000</td>
</tr>
<tr>
<td>EM3 Agri Services</td>
<td>Provider of farming services to the farming communities</td>
<td>2013</td>
<td>Noida</td>
<td>Yes</td>
<td>Series B</td>
<td>1173648</td>
</tr>
<tr>
<td>RAVGO</td>
<td>Digital farm and construction equipment rentals marketplace</td>
<td>2015</td>
<td>Gurgaon</td>
<td>No</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>JFarm Services</td>
<td>Online marketplace platform for equipment rental</td>
<td>2017</td>
<td>Chennai</td>
<td>No</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Tringo</td>
<td>Mobile based app offering farming equipment on rent</td>
<td>2016</td>
<td>Mumbai</td>
<td>No</td>
<td>Unfunded</td>
<td>240000</td>
</tr>
<tr>
<td><strong>Irrigation</strong></td>
<td></td>
<td></td>
<td></td>
<td>USD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FlyBird Innovations</td>
<td>manufactures irrigation controllers</td>
<td>2013</td>
<td>Bangalore</td>
<td>Yes</td>
<td>Seed</td>
<td>66400</td>
</tr>
<tr>
<td>Intech Harness</td>
<td>Provider of an IoT-based automated water pump controller</td>
<td>2018</td>
<td>Pune</td>
<td>Yes</td>
<td>Funded</td>
<td>na</td>
</tr>
<tr>
<td>Sense It Out (F6s)</td>
<td>IoT controller for greenhouse management deployed as a service</td>
<td>2015</td>
<td>Pune</td>
<td>Yes</td>
<td>Funded</td>
<td>na</td>
</tr>
<tr>
<td>KisanRaja</td>
<td>Technology Solutions for Agriculture</td>
<td>2006</td>
<td>Bangalore</td>
<td>No</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Satyukt</td>
<td>Data and analytics solutions for earth observations</td>
<td>2018</td>
<td>Bangalore</td>
<td>No</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Kritsnam Technologies</td>
<td>IOT-based solutions for water monitoring and management</td>
<td>2015</td>
<td>Kanpur</td>
<td>Yes</td>
<td>Seed</td>
<td>na</td>
</tr>
<tr>
<td><strong>Financial services</strong></td>
<td></td>
<td></td>
<td></td>
<td>USD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jai Kisan</td>
<td>Online supply chain platform for farmers</td>
<td>2017</td>
<td>Mumbai</td>
<td>Yes</td>
<td>Seed</td>
<td>97900</td>
</tr>
<tr>
<td>SG Agtech Innovations</td>
<td>Online platform for providing digital and financial solutions to farmers</td>
<td>2018</td>
<td>Chennai</td>
<td>No</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>SafalFasal</td>
<td>Online marketplace for agricultural products</td>
<td>2019</td>
<td>Mumbai</td>
<td>No</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Jai Kisan</td>
<td>Online supply chain platform for farmers</td>
<td>2017</td>
<td>Mumbai</td>
<td>Yes</td>
<td>Seed</td>
<td>97,900</td>
</tr>
<tr>
<td>Niruthi technology</td>
<td>Location-specific crop monitoring and yield prediction solution provider</td>
<td>2005</td>
<td>Hyderabad</td>
<td>No</td>
<td>Unfunded</td>
<td>3,40,900</td>
</tr>
<tr>
<td>Gramcover</td>
<td>Insurance marketplace focused on rural areas</td>
<td>2015</td>
<td>Noida</td>
<td>Yes</td>
<td>Seed</td>
<td>3,17,500</td>
</tr>
<tr>
<td>SatSure</td>
<td>Data services for crop health monitoring and assessment</td>
<td>2016</td>
<td>Bangalore</td>
<td>Yes</td>
<td>Funded</td>
<td>30,400</td>
</tr>
<tr>
<td>PayAgri</td>
<td>Online platform to bring cashless ecosystem in Agriculture</td>
<td>2017</td>
<td>Chennai</td>
<td>Yes</td>
<td>Seed</td>
<td>9,775</td>
</tr>
<tr>
<td>Farmguide</td>
<td>Digitizing agri supply chain and services</td>
<td>2014</td>
<td>Gurgaon</td>
<td>Yes</td>
<td>Seed</td>
<td>1,57,200</td>
</tr>
<tr>
<td>AgRisk Tech</td>
<td>Core banking, payments, transaction banking, and financial inclusion solution provider</td>
<td>2009</td>
<td>Mumbai</td>
<td>No</td>
<td>Unfunded</td>
<td>na</td>
</tr>
</tbody>
</table>

*Source: Compiled from Traxcn database as of February 2020.*
harnessed by the World Bank for a project on saving water in rice. Bangalore-based FlyBird installs sensors in the soil to detect moisture content and controls irrigation at a low cost to the farmers and this can be of use especially for high value crops (Ayyar and Desikan, 2016). There are others like Intech Harness that provides solutions for water pump controller and Sense It Out, Kritssnam, Agrirain, Manna Irrigation.

Several startups focus on mechanisation of farming activities through renting easy to use machines or aggregating companies that can rent machines. FarMart, EM3 Agri Services, M.I.T.R.A and others have been providing these services at lower cost and some of them are finding good traction among farmers (Singh, 2017). Sickle innovations, Distinct Horizon, TractorJunction, Khetibadi and J Farm service are some of the other startups in mechanisation services. KamlKisan develops farm equipment for small farm owners to reduce labour dependence and has rental services in Karnataka, Jharkhand and Andhra Pradesh (Ravi, 2017).

As we move from traditional marketing services to the modern marketing channels, lack of support structures to provide handholding through credit is a handicap for the farmers. Some of the start-ups resolve this issue through making credit available in a transparent online procedure at lower rates of interest, along with other services. Apart from Jai Kisan, SGAgtech and SafalFasal shown in Table 3, there are others like Samunnati, FarMart, PayAgri, Kissht, SatSure, Farmguide, Niruthi and so on. GramCover acts an insurtech platform too. Some of the startups with market linkage also provide loans. For example, there are the startups like Udaan, Bijak and Clover.

3.4 Startups for Quality Maintenance, Monitoring, Traceability and Output Predictions

Several innovative products have been developed and popularised by startups in this area for quality assaying, quality maintenance through advisories, traceability, and yield predictions through mobile imagery, digitisation and advanced software (Table 4). One of the most popular startup in this category seems to be CropIn that has clients in 30 countries and chosen by the World Bank as a project on sustainable livelihoods and adaptation to climate change. Basically a farm-to-fork traceability business model, it collects information from various sources like weather, satellite and ground data and delivers targeted solutions to the agribusinesses on a B2B model and at the same time has a unique farmer application for the companies to interact directly with the farmers (Anand and Raj, 2019). The Government of India has also roped in CropIn to streamline crop cutting experiments and their accuracy.

SaaS start-ups such as Intellolabs, Agricxlab and QZense and RaavTechlabs focus on quality assessment of agri-commodities. Intellolabs developed an app to test, grade, and analyse the visual quality parameters of agri-commodities to enable better price for the farming community and had been working with the Government of Rajasthan to grade grains in mandis (Prasad, 2018). Agricxlab harnessed deep
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Overview</th>
<th>Founded year</th>
<th>City</th>
<th>Funding Total USD</th>
<th>Company stage</th>
<th>Annual revenue USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CropIn</td>
<td>Provider of saas-based farming solutions to agribusinesses</td>
<td>2010</td>
<td>Bangalore</td>
<td>Yes</td>
<td>15623458 Series B</td>
<td>1622700</td>
</tr>
<tr>
<td>Intello Labs</td>
<td>Image recognition based solutions for multiple industries</td>
<td>2016</td>
<td>Bangalore</td>
<td>Yes</td>
<td>8750809 Series A</td>
<td>157400</td>
</tr>
<tr>
<td>FarmERP</td>
<td>Software suite for control over farm operations and traceability</td>
<td>2005</td>
<td>Pune</td>
<td>Yes</td>
<td>1438880 Series A</td>
<td>311600</td>
</tr>
<tr>
<td>Jivabhumii</td>
<td>Connecting consumers to farmer groups/cooperatives. Uses Blockchain technology for traceability</td>
<td>2015</td>
<td>Bangalore</td>
<td>Yes</td>
<td>na Funded</td>
<td>316400</td>
</tr>
<tr>
<td>Agricx</td>
<td>Provider of AI-based stack solutions for grading</td>
<td>2016</td>
<td>Thane</td>
<td>Yes</td>
<td>774776 Seed</td>
<td>40700</td>
</tr>
<tr>
<td>qZense Labs</td>
<td>Provider of an IoT device for food quality check for grading</td>
<td>2019</td>
<td>Bangalore</td>
<td>Yes</td>
<td>253386 Seed</td>
<td>na</td>
</tr>
<tr>
<td>AgNext</td>
<td>Platform for monitoring and improving agricultural food quality for grading</td>
<td>2016</td>
<td>Mohali</td>
<td>Yes</td>
<td>4336741 Seed</td>
<td>97000</td>
</tr>
<tr>
<td>OneWater</td>
<td>Soil and groundwater sensing and analytics product</td>
<td>2015</td>
<td>Ahmedabad</td>
<td>No</td>
<td>na Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>AmviCube</td>
<td>Developer of paddy quality tester for rice mills</td>
<td>2014</td>
<td>Raichur</td>
<td>Yes</td>
<td>na Funded</td>
<td>na</td>
</tr>
<tr>
<td>Amnex</td>
<td>Provider of precision agriculture solutions</td>
<td>2008</td>
<td>Ahmedabad</td>
<td>Yes</td>
<td>na Funded</td>
<td>18783400</td>
</tr>
<tr>
<td>NEERx Systems</td>
<td>Develops integrated hardware and software platform for precision agriculture</td>
<td>2017</td>
<td>Bangalore</td>
<td>No</td>
<td>na Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>NERx Agri</td>
<td>Provides smart agriculture solutions</td>
<td>2019</td>
<td>Gandhinagar</td>
<td>Yes</td>
<td>na Funded</td>
<td>na</td>
</tr>
<tr>
<td>RML Agtech</td>
<td>Online portal for agriculture information sharing</td>
<td>2007</td>
<td>Mumbai</td>
<td>Yes</td>
<td>4000000 Series A</td>
<td>779068</td>
</tr>
<tr>
<td>FarmBee</td>
<td>Online platform providing data-driven agricultural solutions</td>
<td>2006</td>
<td>Pune</td>
<td>Yes</td>
<td>9099055 Seed</td>
<td>760200</td>
</tr>
<tr>
<td>MyCrop Technologies</td>
<td>Provider of information, expertise, and resources for agriculture sector</td>
<td>2016</td>
<td>Ahmedabad</td>
<td>Yes</td>
<td>na Funded</td>
<td>na</td>
</tr>
<tr>
<td>Agrojay</td>
<td>Online information dissemination platform for agriculture farmers</td>
<td>2019</td>
<td>Nashik</td>
<td>No</td>
<td>na Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Namma-Uzhavan</td>
<td>Online agriculture information dissemination platform for farmers</td>
<td>2018</td>
<td>Coimbatore</td>
<td>No</td>
<td>na Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Nebulaa's Matt</td>
<td>Crop quality assessment system</td>
<td>2016</td>
<td>Jaipur</td>
<td>Yes</td>
<td>294730 Seed</td>
<td>141400</td>
</tr>
<tr>
<td>TartanSense</td>
<td>Analysing health of plants using drones</td>
<td>2015</td>
<td>Bangalore</td>
<td>Yes</td>
<td>2139340 Seed</td>
<td>1800</td>
</tr>
</tbody>
</table>

(Contd.)
TABLE 4.CONCLD.

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Overview</th>
<th>Founded year</th>
<th>City</th>
<th>Funding Total USD</th>
<th>Company Stage</th>
<th>Annual revenue USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yuktix</td>
<td>Technology sensor products for remote monitoring and control of devices</td>
<td>2013</td>
<td>Bangalore</td>
<td>Yes</td>
<td>133229 Seed</td>
<td>76500</td>
</tr>
<tr>
<td>Fasal</td>
<td>AI-powered IoT platform for precision agriculture</td>
<td>2018</td>
<td>Bangalore</td>
<td>Yes</td>
<td>1720000 Seed</td>
<td>na</td>
</tr>
<tr>
<td>Blooom</td>
<td>Online mobile-based platform for agriculture risk prediction and mitigation</td>
<td>2009</td>
<td>Delhi</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
</tr>
<tr>
<td>Skymet Weather</td>
<td>Crop insurance and weather forecasting data services</td>
<td>2003</td>
<td>Noida</td>
<td>Yes</td>
<td>11768115 Series C</td>
<td>5827100</td>
</tr>
</tbody>
</table>

Source: Compiled from Traxcn database as of February 2020.

learning technology to grade agri-commodity and certify in 30 seconds and acts as a bridge between cold storages and procurement companies (Patil, 2018). On the other hand, women entrepreneurs founded QZense employs a unique combination of near-infrared spectral sensors and olfactory sensors for analysis of internal spoilage, ripeness, sweetness, and shelf life that can be used at any stage of the supply chain though initially deployed by retailers to gauge and maintain quality for driving down inventory losses and spur margins (Balakrishnan, 2020). Soil and groundwater sensing and analytics products is brought out by OneWater, while an innovative paddy quality tester for rice mills came out from AmviCube. Another useful innovation is by Krishiantra from Udupi, Karnataka for rapid soil testing in 35 minutes and that can be shared in cloud and sms with advisory. Cheruvu also enables soil testing facilities and advisory along with comparisons to neighbour’s field. TartanSense developed technologies to assess health of plants drone imageries.

Precision agriculture using advanced analytics and prediction platforms are supposed to be the game changing technologies and exclusive preserve of top six companies and likely to be bypassed for the developing world (Lianoset al., 2016). However, startups enter this segment of value chain and make them possible through their innovations in a cost-effective manner for the smallholder farmers in developing country context such as in India. Precision agriculture solutions are provided by software platforms of Amnex, AS Agri Systems, BKC Aggregator and NeerXTechnovation. Agricultural information sharing has few startups attending and they include RML Agtech, FArmBee, MyCrop Technologies, Agrojay and NammaUzhavan. Crop yield predictions are facilitated by Fasal, Yuktix, Bloom and Skymet. Many of these startups leverage satellite images to geotag farms, assess crop health and estimate output. Fasal captures real-time data on growing conditions from on-farm sensors and delivers farm-specific, crop-specific actionable advisories to farmers via mobile in vernacular languages. Likely to be unicorn soon is SourceTrace that operates in 26 countries with a digital platform that helps capture information regarding agriculture, financial services and retail through existing mobile and
wireless networks in developing economies and also a two-way interactive digital platform (NASSCOM, 2019).

3.5 Startups for Post-Harvest Management and Farming-as-a Service

As the value chains became elongated with nearly two-thirds of food being consumed in urban areas in India (Reardon et al., 2020), the requirements for processing, logistics, wholesaling and associated services have been increasing over the past few decades. Startups have been crucial in the segment of logistics with several of them acting as third party logistic partners for other startups as well as established food companies like Britannia and several others. Apart from that, few startups made innovative products for cold storage and saving the produce from post-harvest damage before being transported. Table 5 examines the startups in mid-stream of the value chain.

The solar-powered small-size cold storage unit of Ecozen Solutions; and low-cost storage cum transportation solution called Sabjikothi, developed by Saptakrishi, for extending shelf-life of vegetables from 7-30 days have tremendous potential to cover the shortcomings for smallholder farmers. Another area many startups have been playing considerable role is storage of agri-produce. In a country where it is estimated that there is storage gap of around 35 per cent, their role can play crucial role in reducing food damage. A2Z Godaam of Arya Collateral is foremost among them. It is a digital platform for search, discovery and fulfilment of warehousing for farmers, FPOs, corporate and other stakeholders. It goes beyond storage by integrating with other services like financial and market linkages (Kashyap, 2020a). Similar post-harvest services are provided by another startup called Origo with 3.5 million tonnes of storage capacity in 500 warehouses across 15 states.

Farming as a service (FaaS) has been growing with several urban people wishing to engage in cultivation of fruits and vegetables often in organic modes on the one hand and on the other several smallholders wishing to have support in several related services to make their farming profitable. Several startups have been testing this area and seem getting good response. Farmizen, and Hoshachiguru provide min-farms to be rented by prospective cultivators and can also opt to take services from them for technically sound and cost effective cultivation (Hariharan, 2018). These startups collect rent and also fee for their services. On the other hand, startups like Vegrow and EMB partners with smallholders for profitable cultivation that might also lead to aggregation of fragmented farms for achieving economies of scale (Sangwan, 2020).Rooftop gardening by Khetify; indoor hydroponics by Agro2o and end to end farm enabling services for greenhouses by Kheyti represent the other emerging areas for startup ventures.
TABLE 5. STARTUPS HELPING IN POST-HARVEST MANAGEMENT, FARMING AS A SERVICE (FAAS)

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Overview</th>
<th>Founded year</th>
<th>City</th>
<th>Funding Total USD</th>
<th>Company stage</th>
<th>Annual revenue USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-harvest management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecozen Solutions</td>
<td>Manufactures and supplies solar-powered irrigation pump controllers</td>
<td>2009</td>
<td>Pune</td>
<td>Yes</td>
<td>10590520</td>
<td>Series A</td>
</tr>
<tr>
<td>Saptakrishi (Sabjikothi)</td>
<td>Provider of a micro-climate storage solution for farmers</td>
<td>2018</td>
<td>Kanpur</td>
<td>Yes</td>
<td>na</td>
<td>Funded</td>
</tr>
<tr>
<td>New Leaf Dynamic Technologies</td>
<td>Off-grid refrigeration</td>
<td>2012</td>
<td>Delhi</td>
<td>Yes</td>
<td>na</td>
<td>Funded</td>
</tr>
<tr>
<td>Agrigater</td>
<td>Provider of agricultural logistics platform connecting grain shippers and carriers</td>
<td>2019</td>
<td>Bhopal</td>
<td>Yes</td>
<td>na</td>
<td>Funded</td>
</tr>
<tr>
<td>Star Agriwarehousing and Collateral Management</td>
<td>Agricultural warehousing and post-harvest supply chain solutions</td>
<td>2006</td>
<td>Mumbai</td>
<td>Yes</td>
<td>72000000</td>
<td>Series C</td>
</tr>
<tr>
<td>Arya Collateral Warehousing Services</td>
<td>Warehousing and collateral management services for agri commodities</td>
<td>1982</td>
<td>Noida</td>
<td>Yes</td>
<td>9333310</td>
<td>Series A</td>
</tr>
<tr>
<td>Farmizen</td>
<td>Develops and operates digital application for community supported farming</td>
<td>2017</td>
<td>Bangalore</td>
<td>Yes</td>
<td>296585</td>
<td>Seed</td>
</tr>
<tr>
<td>Triton Foodworks</td>
<td>Integrated business for soil-less cultivation of fruits &amp; vegetables and supply of produce</td>
<td>2014</td>
<td>Delhi</td>
<td>Yes</td>
<td>na</td>
<td>Seed</td>
</tr>
<tr>
<td>Agro2o</td>
<td>Manufacturer and supplier of indoor hydroponics system</td>
<td>2017</td>
<td>Delhi</td>
<td>Yes</td>
<td>na</td>
<td>Seed</td>
</tr>
<tr>
<td>Kheyti</td>
<td>Greenhouse and end-to-end farm enabling services</td>
<td>2015</td>
<td>Hyderabad</td>
<td>Yes</td>
<td>na</td>
<td>Seed</td>
</tr>
<tr>
<td>Khetify</td>
<td>DIY rooftop farming and gardening kits</td>
<td>2016</td>
<td>Delhi</td>
<td>No</td>
<td>na</td>
<td>Unfunded</td>
</tr>
<tr>
<td>Farmizen</td>
<td>Develops and operates digital application for community supported farming</td>
<td>2017</td>
<td>Bangalore</td>
<td>Yes</td>
<td>296585</td>
<td>Seed</td>
</tr>
<tr>
<td>HosaChiguru Vegrow</td>
<td>Agri Infrastructure and developer Provider of tech-enabled farming services to farmers</td>
<td>2006</td>
<td>Bangalore</td>
<td>No</td>
<td>2500000</td>
<td>Seed</td>
</tr>
</tbody>
</table>

Source: Compiled from Traxcn database as of February 2020.

3.6 Startups for Farmers in Animal Husbandry

Animal husbandry sector, with one-third of gross value added in agriculture, does attract startup ventures though not in proportion to its contribution to value added and support to smallholder cultivators (Table 6). The leaders in this segment are Licious and FreshtoHome that engage in farm-to-fork model and supply to the consumers directly. They received funding to the tune of 95 million (Series E funding) and 47
### TABLE 6. STARTUPS IN ANIMAL HUSBANDRY

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Overview</th>
<th>Founded year</th>
<th>City</th>
<th>Funding Total USD</th>
<th>Company stage</th>
<th>Annual revenue USD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Licious (Soonicorn)</td>
<td>Online platform for delivery of meat and seafood</td>
<td>2015</td>
<td>Bangalore</td>
<td>94500000</td>
<td>Series E</td>
<td>9133000</td>
</tr>
<tr>
<td>Fresh to home (Soonicorn)</td>
<td>Manages supply chain of meat and seafood from farm / fishermen to home</td>
<td>2012</td>
<td>Bangalore</td>
<td>47200000</td>
<td>Series B</td>
<td>929567</td>
</tr>
<tr>
<td>ZappFresh</td>
<td>Online fresh meat delivery service</td>
<td>2015</td>
<td>Delhi</td>
<td>9059375</td>
<td>Series A</td>
<td>4087400</td>
</tr>
<tr>
<td>Caprabook</td>
<td>Software for goat farm management</td>
<td></td>
<td>Satara</td>
<td>na</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Eggoz</td>
<td>Full-stack egg producer using advanced technology, IoT based</td>
<td>2017</td>
<td>Bihar Sharif</td>
<td>751549</td>
<td>Seed</td>
<td>3629000</td>
</tr>
<tr>
<td>PoultryMon</td>
<td>Hatchery management solutions for poultry farms</td>
<td>2018</td>
<td>Hyderabad</td>
<td>na</td>
<td>Funded</td>
<td>na</td>
</tr>
<tr>
<td>Aquaconnect</td>
<td>Developer of products for data-driven farming in shrimp</td>
<td>2017</td>
<td>Chennai</td>
<td>1101687</td>
<td>Seed</td>
<td>2043000</td>
</tr>
<tr>
<td>INCEVE</td>
<td>Provider of SONARs for catching fishes</td>
<td>2016</td>
<td>Bangalore</td>
<td>na</td>
<td>Funded</td>
<td>na</td>
</tr>
<tr>
<td>Stellapps</td>
<td>Provider of farm optimization and monitoring support for milk</td>
<td>2011</td>
<td>Bangalore</td>
<td>19009146</td>
<td>Series B</td>
<td>6895700</td>
</tr>
<tr>
<td>Country Delight</td>
<td>Online retailer of dairy products</td>
<td>2015</td>
<td>Gurgaon</td>
<td>19636337</td>
<td>Series B</td>
<td>7964500</td>
</tr>
<tr>
<td>Prompt AMCS</td>
<td>Automatic milk collection system for dairy industry</td>
<td>2011</td>
<td>Ahmedabad</td>
<td>na</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Meri Dairy</td>
<td>Provider of dairy management software for milk collection centers</td>
<td>2008</td>
<td>Jaipur</td>
<td>na</td>
<td>Unfunded</td>
<td>na</td>
</tr>
<tr>
<td>Farmery</td>
<td>Production, marketing and delivery of raw cow milk</td>
<td>2015</td>
<td>Delhi</td>
<td>na</td>
<td>Unfunded</td>
<td>765800</td>
</tr>
<tr>
<td>Eruvaka</td>
<td>Provider of IoT based on-farm diagnostic equipment. Animal nutrition and</td>
<td>2012</td>
<td>Vijayawada</td>
<td>6780764</td>
<td>Series B</td>
<td>1360200</td>
</tr>
<tr>
<td>Krimanshi</td>
<td>Developer &amp; supplier of sustainable feed for livestock animals</td>
<td>2018</td>
<td>Bangalore</td>
<td>na</td>
<td>Seed</td>
<td>na</td>
</tr>
<tr>
<td>Tropical Animal</td>
<td>Developer of in-vitro animal breeding platform</td>
<td>2014</td>
<td>Gurgaon</td>
<td>na</td>
<td>Seed</td>
<td>262000</td>
</tr>
<tr>
<td>Genetics (TAG)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aquaconnect</td>
<td>Developer of products for data-driven farming in shrimp</td>
<td>2017</td>
<td>Chennai</td>
<td>1101687</td>
<td>Seed</td>
<td>2,04,300</td>
</tr>
</tbody>
</table>

Source: Compiled from Traxen database as of February 2020.

Million (Series B funding) respectively. Apart from them, large ticket investments are in dairy sector start-ups CountryDelight (20 million) and Stellaps (19 million) and fishery startup Aquaconnect (11 million). Both Licious and Fresh to Home procure directly from farmers. While Caprabook is for goat farm management, PoultryMon is for hatchery management solutions. Dairy sector has few startups in Stellaps, Country Delight, Prompt AMCS, Meri Dairy and Farmery. Eruvaka and Krimanshi deal with...
sustainable feed solutions, while Eruvaka has developed AI based on-farm diagnostic equipment.

Listed as one of the 100 Technology Pioneers of 2020 by the World Economic Forum 2020, Stellaps digitises farm-to-consumer chain and enables dairy ecosystem partnerships including facilitating digital payments and hassle-free credit and insurance to marginal dairy farmers, apart from better milk quality and traceability (Kashyap, 2020b). It works with its innovative software solutions for dairies to enable contactless procurement, and for adhering to sanitary guidelines. It has been managing 10 million litres of milk per day and covers two million farmers in 30000 villages.

IV
OPEN INNOVATION KNOWLEDGE FLOWS

The foregoing analysis reveals that open innovation as explained by Chesbrough (2003) has been taking root in Indian agriculture by joint development and diffusion of innovations by startups and other actors in the food value chain. The entry of startups has accelerated flows between food chain actors in regard to making and diffusing innovations to the end users, as the foregoing analysis shows. The knowledge flows are both outbound from the startups to the companies and other actors and sometimes in the opposite direction as well as bi-directional, as brought out in the cases above. Some of the companies have founded their own startups for various knowledge generation and use. For example, Godrej Agrovet instituted a venture capital fund in the name of Omnivore as an anchor investor for investing in startups. It is a leading agribusiness company in poultry feed, dairy products, vegetable oil and processed foods (Joint venture with Tyson Foods of USA for processed foods). This company has so far completed two funds with 40 million and 97 million and about to start the third one (Putrevu, 2020). Among its investments are startups working in various segments of food value chain and include DeHaat (Full-stack market place), Stellaps (Dairy platform), GramCover (Rural fintech and farm finance), Bijak (B2B agricultural commodity platform). The company has also acquired two startups for digital supply chain solutions for farm business (Chaudhari, 2012).

One of the largest processing company ITC has upgraded its eChoupal to more collaborative mobile platform in the name of eChoupal 4.0 and other companies like Bayer is harnessing the same (Anand, 2020). ITC has invested in alternative investment funds (AIF) that fund startups and is also investing directly in startups to aid in improving the business (Naik, 2019). Reliance, that started JioMart ecommerce company recently, has backed or acquired startups like Grab A Grub (Last-mile logistics company), C-Square Info Solutions (Software for managing logistics of distribution and retail operations), Fynd (e-commerce company), Reverie Language Technologies (language localisation technology platform), Haptik (AI-backed B2B
STARTUPS WITH OPEN INNOVATION: ACCELERATING TECHNOLOGICAL CHANGE AND FOOD 431

chatbot maker), and Netradyne (Driver and commercial vehicle safety). Reliance continues to scout for many more startups as partners in innovations for food chain (Soni, 2020). Walmart-owned Flipkart launched a venture fund with 100 million to support early-stage startups and also a startup accelerator called Flipkart Leap for deep engagement with B2C and B2B startups with supply chain solutions (Poojary, 2020). It has also been leveraging supply solutions of Ninjacart for its grocery delivery initiative ‘Flipkart Quick’ to procure directly from farmers and committed to invest 50 million to strengthen Ninjacart (Velayanikal, 2020). Similarly, Amazon acquired the ecommerce grocery startup ZopNow in 2018. On the other hand, a startup by name StarAgri floated its own initiative for market linkages in the form of Agrobazaar.

The interconnections between startups themselves and their business partnerships with input companies, processors, aggregators, traders, hotels and restaurants, supermarkets, ecommerce companies, research organisations, various governments (federal as well as provincial), international institutions like the World Bank, various crop associations like tea growers association, constitute a complex web. This fast expanding knowledge flows has brought several innovations which could not be imagined just few years back. The vibrancy of the food value chains in India during the pandemic can be attributed to some extent to the activities of the startups (Medhi, 2020; Mitter, 2020; Narain, 2020). The ecosystem has been bringing to the ready access of farming community several innovative products including online marketing of farmers produce, precision agriculture solutions for crop and animal husbandry, traceability solutions, storage solutions, online financing, innovative field level cold storages, irrigation control, customised mechanisation solutions on rent, rapid quality assessment and grading, third party logistic solutions. Most of the innovations explained above are innovations flowing from the startups to other actors in the value chain, which itself has been accelerated and invigorated with missing links covered up. It needs to be highlighted here the fact that innovations in value chain organisation can accelerate technology adoption by the farming community (Swinnen and Kujipers, 2019).

v

SUMMARY AND CONCLUSIONS

Entrepreneurial new firms can bring in radical innovations better with risk-taking approach. Startups have been proliferating in all sectors of the economy including agriculture in developing countries in recent years. Their demand for capital that can support risky innovative ventures catapulted a venture capital industry in the country in the new millennium and enhanced flow of capital. This paper harnesses a large database of startup data in India and examines the nature of innovations in the startups working in agriculture in open innovation framework, analyses startups according to their roles in the value chain, funding and investment and revenue.
There are several types of startups that have come up in the last decade that are filling the gaps in the food value chains in infrastructure deficit regions of the country and introducing innovations. Our estimates show that they mobilised investments to the tune of 8 billion USD into food and agriculture sector producing four unicorns and three soonicorns by the end of 2020. Most of these startups operate in tandem with various other related companies in downstream with the supermarkets, retailers, hoteliers, in the midstream with the processors, wholesalers and logistic firms, and in the upstream with the input companies and so on. The entry of startups has accelerated flows between food chain actors in regard to making and diffusing innovations to the end users. The knowledge flows are both outbound from the startups to the companies and other actors and sometimes in the opposite direction as well as bi-directional.

The interconnections between startups themselves and their business partnerships with input companies, processors, aggregators, traders, hotels and restaurants, supermarkets, ecommerce companies, research organisations, various governments (federal as well as provincial), international institutions like the World Bank, various crop associations like tea growers association, constitute a complex web. These fast expanding knowledge flows have brought several innovations which could not be imagined just few years back in developing countries. The ecosystem has been bringing to the ready access of farming community several innovative products including online marketing of farmers produce, precision agriculture solutions for crop and animal husbandry, traceability solutions, storage solutions, online financing, innovative field level cold storages, irrigation control, customised mechanisation solutions on rent, rapid quality assessment and grading, third party logistic solutions. These innovations are from the startups to other actors in the value chain, which itself has been accelerated and invigorated with missing links covered up.

The accelerated and intensified knowledge flows across disparate actors in the food value chains, leading to emergence and faster diffusion of innovations, are the essence of innovation system (World Bank, 2012). The emergence of open innovation in agriculture augurs well to flows and to harness higher level of technologies. The factors leading to open innovation, termed erosion factors by Chesbrough and Bogers (2014), significantly influence the evolution of this innovation system. Most of these erosion factors including startups getting venture capital, rise of internet with 800 million internet users, widespread use of social media, universities becoming innovation hubs, and mobility of employees, are present in India and they combine to create this open innovation system. Venture capital has grown over the years and India has become one of the favoured destinations (Dossani and Kenney, 2002; Nuthalapati and Singh, 2019). After a long period of stagnation and ‘technology fatigue’ (Naraynmoorthy, 2007), Indian agriculture is in transition and moving towards higher level of technologies with better and faster linkages among various food chain actors. As experience in other countries demonstrated, open innovation is required during the transition stage to higher level of technologies and the
innovations will be less radical without knowledge flows (Medeiros et al., 2016). The government needs to develop policy framework to create necessary enabling environment for development of the startup ecosystem that include venture capital industry, and associated policy changes. It is worth mentioning few key measures like early stage support through seed fund, encouragement to angel investors, mass incubators, level playing field for non-technical startups.

The nascent stage of development of this open innovation needs dispassionate research on these developments from the purview of equity and the possibility of scaling up these ventures. Also required is research focus on the type of business models, collaboration and licensing agreements between companies, universities and governmental agencies. The limited and available evidence points to the startup innovations accessible more to the larger farmers (Singh, 2016; Hennessy et al., 2016). Food chain actors resisting these open flows will be worse off in terms of net welfare gains and this will be much more problematic if the farming community are bypassed by these innovations.

Policymakers in Europe have internalised the three core principles of open innovation (Open science, open innovation and open to the world) in its Mission-oriented Innovation Policy (MIP) as the core of the Horizon Europe programme. Preliminary studies in the Netherlands show that corporate startup collaborations can improve innovation performance and enhance competitive advantage and at the same time mediating and moderating factors are important to be kept in mind (van der Boezem et al., 2015). This is warranted as startups and chain actors interact with others keeping their own interests rather than the wider interests and therefore this innovation has to be internalised and mainstreamed into the agricultural development planning, mindful of the twin objectives of growth and equity (Lele and Goswami, 2017; Korreck, 2019; Singh, 2020). The entry of open innovation in food value chain actor bodes well for the agricultural sector and it calls for wider engagement by economists in research related to the factors leading to this innovation in terms of business mechanisms, socio-economic contexts, technological drivers and both supply and demand side factors.

REFERENCES


Balakrishnan, Rekha (2020), “These Women Entrepreneurs Aim to Transform the Fresh Food Supply Chain in India and Tap into a Market Worth $2B”, *Yourstory*, 22nd June. Available at: https://yourstory.com/herstory/2020/06/women-entrepreneurs-agritech-product-supply-chain


Kashyap, Sindhu (2019), *From 350 to 1,000 Restaurants in 4 Months: How Hyperpure by Zomato is Changing the Way Restaurants Work*, *Yourstory*, Available at: https://yourstory.com/2019/04/hyperpure-zomato-h2b-farm-to-fork-model


Poojary, Thimmaya (2019), Bridging the Gap: How B2B Ecommerce Startup Udaan Seamlessly Connects India and Bharat, September 30, Yourstory, Available at: https://yourstory.com/2019/09/startup-b2b-ecommerce-retail-udaan


