Agritech Startups in India: A Revolutionary Idea Giving Birth to Agripreneurs

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Abstract ***Indian Agriculture employs ~45% of the country's workforce and generates 17.5% of GDP with export earnings of more than US $ 41 billion in 2021. However, numerous operational and organizational challenges prohibit this sector from realizing its potential worth. Various socio-economic challenges including smallholder farmers, infiltration of Farmer-Producer Organizations, shortage of agriculture-related information and conflicts of actual pricing awareness plague farmers. In an attempt to increase the income of farmers, Government of India is exploring means to enhance agricultural producing, improve processing of foods and explore advertising and promotion options via implementation of state-of-the-art skills. Recently, India has seen a spurt in the number of agritech start-ups that are not only making latest technology available but also helping farmers to better their lives. Indian farmers are now confident to make the digital leap owing to greater accessibility. Agritech start-ups are showing a spike in Big Data Analytics, Supply Chain/Market-linked Model, FaaS, and IoT-Enabled Innovations. India's agritech start-up ecosystem has flourished recently and nearly 1000 agritech start-ups are operating at different levels of agri-value chains contributing around 9 percent with a value of USD 313 million clocking 29 per cent Year-on-Year growth. Business models in agritech are still in an embryonic stage. Income representations could range from margin-based to transaction-based to subscription-based, based on the sector. As the target to attain higher revenue looms on the horizon, agritech start-ups can attempt a horizontal integration of stakeholders into a platform model where end-to-end affiliation with farmers is streamlined. Nascency in funding and minimum infiltration by current agritech firms provide an opportunity for recognized actors like e-commerce, established retailers and food processing giants to create impact of scale. The expected revenue generated from agritech in India is expected to be USD 24 billion by 2025, of which only 1 per cent has been realized.***

Index Terms- Agripreneurs, Agritech startups, Big Data Analytics, Food-supply chain, IoT enabled innovations, Market-linked model, Supply Chain model

I. INTRODUCTION

Agriculture is the oldest economic sector in the world [5] and serves as the principal basis of living for 58% of the world's population. Indian economy is basically an agrarian economy. India - the world's second most populous country (population of 1.36 billion as of 2019) - ranks as the sixth largest economy by GDP (nominal) and the third largest by purchasing power parity (PPP). However, the Indian agricultural industry utilizes limited technology, due to which it contributes only 17-18% to its GDP [7], despite employing 53 percent of the population. A large number of people employed in agriculture is of disguised nature. They seem to be employed but their marginal productivity is zero. Half of the Indian population engaged in agriculture is suffering from issues like (a) obsolete equipment, (b) poor infrastructure and (c) lack of access to the markets. With the era of start-ups in India, things have started to evolve. Start-ups have undeniably given a push to growth [12] and overhauled the agricultural industry [18]. Agritech start-ups in India are trying to address these issues for improving the productivity and profits of the farmers. Agritech start-ups have the potential to improvise the food value chain by embracing technology for connecting farmers, retailers and consumers. They can use the technology in crop growing, sorting and packaging, food processing, shipping and marketing. These are some of the favourable areas of investment attracting most of the funding.

Indian agritech start-ups are providing innovative solutions for improving supply chain by using internet service, big data analytics, digital platform, artificial intelligence (AI) and Internet of Things (IoT). The Agritech start-ups are playing significant role in the post Covid-19 era. During the pandemic, the major challenge was to maintain the supply chain. The Agritech start-ups played a significant role in keeping the supply chain alive and meet the demands of the consumers. Due to panic, the consumers started purchasing food items in bulk and resulted in an artificial crisis. The Agritech start-ups were able to maintain the food supply chain by connecting farmers, producers, distributors, retailers and consumers. Thus, it was a difficult task for the

Agritech start-ups to address the challenges and manage food supply chain by using modern technology. Agritech start-ups are playing an important role in minimizing the price of the produce by eliminating the middle-man and resolving unemployment problems in rural areas by providing business/job opportunities. Today the customers are getting fresh supplies at their door-step at a reasonable price; the credit goes to Agritech start-ups. They have made it possible by developing highly innovative business models with completely different business models existing in the markets.

India is the second largest producer of agriculture-based products, with majority of the farmers practicing conventional farming methods. Lack of adequate technological infrastructure, financial support, digital knowledge and awareness on latest development in the field of agriculture are some of the major factors responsible for slow growth of Agritech start-ups in India. Lack of education in India is one of the hindrances behind modernization of agriculture and effective food supply value chain. "Digital India" is one such step taken by the Indian government to safeguard reduction in the rural-urban digital divide, by connecting rural areas with high-speed internet networks and educate them about the latest technologies and help them in adopting technology to increase their productivity and income.

II. LITERATURE REVIEW

Indian agriculture has been a success story explained in terms of integration of supportive government policy, intensive research by the field scientists and hard work by the farmers. From a country with the existence as 'ship to fork' in the fifties, India has graduated into 'farm to fork' [20] through the vibrant green revolution. The Indian agriculture is now not only self-reliant but a major exporter of agricultural produce. India is the first, second or third lead producer of many agri-commodities on the world scale. However, Indian agriculture is beset with several handicaps. The foremost challenges faced by the Indian agriculture sector are smallholder farmers, lack of reach of Farmer-Producer Organizations (FPOs), scarcity of agridata and conflicts of actual value awareness by farmers. The regulated market model (*mandi*) presented obstacles such as scarcity of such hubs, meagre set-up, steep operational costs and lack of clarity in formulating the pricing [14]. In an effort to double the income of farmers, the Government of India is regularly exploring means to enhance agri produce, processing of foods and promotional opportunities by implementing best innovative knowledges, thereby generating a great demand for food and agritech start-ups across India [2]. With nearly half of its population engaged in agriculture, India depends on agriculture as its major source of income. However, in the last few years, India has seen a spurt in the number of agritech start-ups that are making technology more available and resulting in improving the lives of the farmers. Necessity is often termed as the mother of invention – and as such, the Covid-imposed lockdowns over the past year have resulted in greater digital penetration, thus encouraging farmers to take the digital leap and utilize technology in the best possible way. Today's entrepreneurs have realized that investing in agriculture is one of the very few safe and profitable ventures [13]. New technological avenues like precision-farming, big-data, hybrid seeds, artificial intelligence, geo-tagging, monitoring via satellites, and mobile applications can be implemented at different stages of agriculture processes to increase productivity and farm incomes.

Agri start-ups are building a noise in India. This is because they disturb the outdated ways of undertaking business and prioritize effectiveness, thereby endearing the trust of probable stakeholders. The dynamics of Indian agriculture is undergoing a significant change. This segment is igniting a novel green revolution based on sophisticated know-hows (Fig. 1).

Fig 1: A conceptual framework on agritech start-up opportunities in Indian agriculture (Source: King et. al., 2021 and Author's inputs)

The primary challenge faced by farmers and agri-supply chains is scarcity of relevant data on agriculture. Agriculture-related info can be broadly grouped as: (a) demand-specific, and (b) supply-specific. Demand-specific info is easy to understand. Dealers have experience of seasonal demands - such as fruits during the summer season, dry fruits during the winter season, and so on. Supply-specific info can vary. Compared to consuming, which is a regular pattern, supply of agri production varies, as different crops have diverse times for harvest, and the yield mostly gets sold right after harvest. With data deficiency regarding other producers' harvests, lack of good amenities for storage and hearsay noise about what's selling in market, farmers and traders both grieve from untrustworthy data when it comes to supply. Farmers don't always receive prior information about weather and rain, have minimal heads-up on anticipated river patterns and provision for water, nor do they have any idea of cold-chain which can encourage them to achieve higher prices in the market. Harvest also suffers from unreliable tracking as the goods pass via a cloudy supply chain. All the above leads to erratic supplies and hence fluctuating market prices.

Challenges in Agriculture Sector

- Small farm holdings:

In 1970, the average land holding per farmer was 2.3 ha which came down to ~0.87 ha in 2017. The small land holding is a major reason behind farmers' economic condition today as they are unable to afford modern tools and technology for their farming, better cropping choices. Further, they do not have access to good quality seeds, pesticides, fertilizers, financial services.

- Low penetration of FPO model:

Although the Government of India tries to organise marginal farmers and encourages them through cooperatives for distributing profits among other associates by forming FPOs, due to lack of available knowledge and skills to manage and run such organisation, the model is currently unsustainable.

- Lack of agri-data:

There is lack of agri-data in India. The farmers have no clue on demand and supply of their produce. Information relating to demand and supply is little, farmers produce what they are capable of producing

without the knowledge of demand, which lead to excess production and fall in price. Farmers experience loss after all efforts. The farmers do not receive reliable data regarding weather and rains, and neither they gain admission to cold-chain and other storage amenities which can enable them get better rates in future.

- Lack of agri-credit:

Most of the marginal farmers are deprived of finance and institutional credit. They are largely depending on local money lenders and end up paying high interest rate on loans. This mostly emanates from low investment in agricultural development.

- Low price realisation by farmers:

The latent cause behind low price realisation on agricultural produce is the major issue. An Indian farmer normally realises only 8-10% of the ultimate price of the yield that reaches the end-consumer, wihch is well below the value realised by farmers from developed nations (almost 30%). All this is due to poor bargaining power of the marginal farmers due to fragmentation, leading to limited access to agri-services; and thus, making decisions based only on hearsay.

Research Gaps – Exploring opportunities for reinventing the food supply chain

According to a report by Ernst and Young (2020) titled 'Agritech - towards transforming Indian agriculture' [6], technology is playing a significant role in resolving many problems faced by the stakeholders involved in traditional supply chain of agriculture. The expected revenue generated from Agritech is expected to reach US $ 24 billion by 2025, the breakdown of which is shown in Table 1.

Table 1: Breakdown of expected agritech revenue by 2025 (estimated USD 24 billion) (Source: E&Y, 2020)

Issue	Agri Sector	Revenue Potential
Unpredictability in pricing of inputs; compromising in quality of selection of inputs	Farm inputs leading to market linkages	USD 1.7b
Limited access to technology	Precision agriculture	USD 3.4b
Lack of large-scale testing	Quality management and accountability	USD 3.0b
Inept post-harvest supply chain	Supply chain technology and output markets	USD 12.0b
Lack of financial resolutions	Finance services	USD 4.1b

Agritech is reforming the way agriculture has previously been interpreted across the value chain –

- Stakeholders across market linkages are effortlessly merging state-of-the-art expertise with physical set-up to provide inputs at an increased value surety
- Precision agriculture is helping farmers better their produces by over 30%
- Quality supervision and accountability are helping farmers achieve improved recognitions by rewarding top quality yield
- Stakeholders running supply chain technology and production markets are removing inadequacies such as high wastage of farm produce, which is beneficial to both farmers and consumers
- Thorough access of credit and crop insurance, finance services could serve 30% and 65% of farmer households respectively

III. JUSTIFICATION OF STUDY

India's start-up environment has nowadays become pulsating and streamlined – through job creation, by resolving consumer issues, and by creating global products. International funders realize this and are queuing up to enter our country. The growing easiness of undertaking business is attracting investors into previously neglected areas. The government is now responding with a renewed feeling of priority. Subsequent to the launching of "Startup India", State Governments have begun launching several start-up schemes. Some states had start-up policies even before the Central Government declared such initiatives. Armed with a burgeoning population and globally-renowned purchasing potential, India has sufficient capability as both creator and buyer, thus implying that start-ups in India have an enviable assortment of customer categories, products and business models to select from. India is now 3rd largest in the world when it

comes to being a start-up hub; but sadly, the major population is still someway involved in the agriculture industry, which is one of the perilous segments to be working in because of its dependency on issues like weather, market unpredictability and topography, which are beyond our control. The biggest way of giving this segment a big push is by furthering agriculture technology through these up-and-coming start-ups. There is a requirement to scrutinize the impacts of these start-ups in transforming Indian Agriculture and better understand the ways by which the livelihoods of farmers are being enriched.

IV. RESEARCH OBJECTIVES

In this backdrop, the following research objectives were identified and analysed:

1. To identify the prevalent scenario in the Indian agritech start-up ecosystem and get an insight into the world of Indian agritech start-ups
2. To better understand the opportunities and challenges faced by agritech start-ups
3. Examine the policy changes for start-ups and subsequent enactment by Central and State Government
4. To acknowledge the growing importance of agritech start-ups in the current scenario; and examine and recommend steps that could be taken by government/policy-making authorities to create a conducive environment for these new-age entrepreneurs ("agripreneurs") and encourage more mushrooming and long-term sustainability of agritech start-ups

V. MATERIALS AND METHODS

- Research Methodology – Research Design

The present article is based on analysis of secondary data and information obtained from published literature or through personal contact. After meticulous review of available literature, suitable research methods and appropriate aggregation of thoughts and views were designed. In this study, non-experimental research design (descriptive research) was undertaken to discover the relationship between existing variables without tampering the existing situation. All the data source used in the manuscript have been appropriately cited in the list of references.

Business models in agritech are categorised as:

- Margin-based models: market linkages can be created on the input or output side, and margins can be earned on the buy-sell combination
- Subscription-based models: an amalgamation of software, hardware and services can be provided to assist farmers in improving crop yields, monitoring quality of produce and tracing produce along the value chain
- Transaction-based models: charges can be equated to the number of transactions served (e.g., loans)
- The Supply chain model are broadly demarcated as:
- Upstream (Input) Marketplace model: Mapping input vendors to farmers upwards in the agricultural value chain
- Downstream (Output) 'Farm-to-Fork' model: Mapping farmers to businesses/retail customers for fresh produce and processed food

Demand initiators like budding customer undercurrents towards intake of healthier food due to urbanization, attempt to lessen food surplus, and ecological aspects (e.g., climate change, scarcity of water, etc.) are egging the acceptance of agritech across the country. Indian agritech actors have received a collective outlay of USD 532 million as of April, 2020. An evaluation with global trends reveals that Precision Agriculture and Farm Management enterprises in India are under-funded. Worldwide funders can reflect on learnings from their successes in these sectors to achieve their full potential in our country.

VI. ANALYSIS AND DEDUCTIONS

Central and State Governments have been enthusiastically launching new ideas to promote agritech in India. For example, the National Agricultural Market (eNAM) proposes to eradicate information irregularity in pricing through an electronic trading portal. Technology partnerships are being formed to foresee prices of agri yield using artificial intelligence to assist farmers in capably preparing their harvest cycle. Aggressively promoting local data on soil health and facilitating access to government research services could further help start-ups to hasten agritech adoption. The government has been promoting start-ups under the 'Start-up India' initiative since 2016. Rao et al

(2017) [17] documented the growth of agricultural start-ups. Basically, they provide either input or output benefits in the marketing chain. Examples of start-ups involved in input services are BigHaat.com, Flybird, AgroStar, Stellaps, Kedut, EcoZen, MITRA, EM3, Skymet, YCook, IFFCOKisan, Aarav Unmanned Systems, and CropIn. For output services, there are numerous start-ups like The Agrihub, SVAgri, Sabziwala, Flipkart, and Big Basket [4]. Ninjacart, Dehaat and Crofarm (Otipy) are revolutionizing the agrifood space. This uniqueness of start-up value chain transformation is not restricted to creating awareness amongst farmers but also simultaneously choosing local kirana shops and small agrifood businesses that are an essential chunk of the agrifood ecology. Concurrently, the start-up system can influence the bigger front-end players who demand quality produce in bulk and face concerns when directly linking with farmers. This is radically different to the retail wave at the turn of the century, wherein the living of unorganised retailers was suspected to be weak.

VII. RESULTS AND DISCUSSION

India is contending with the US and China in the global agristart-up domain. As per Agfunder, India observed an upsurge in funding from US $ 619 million in H1 2020 to US $ 2 billion in H1 2021, only behind the US (US $ 9.5 billion) and China (US $ 4.5 billion). An E&Y study estimates the Indian agritech market potential to touch US $ 24 billion by 2025, of which only 1 per cent has been captured so far. Indian agritech start-ups are mainly in the markets, where e-commerce companies rule the roost in providing fresh and organic produce directly from farmers. Of late, many startups have arisen which provide state-of-the-art and workable solutions for farmer's concerns, like biogas plants, solar powered cold storage, fencing and water pumping, weather forecasting, spraying machines, seed drills, vertical farming, etc. [19]. Escalation in internet use, jump in smartphone infiltration and mushrooming of numerous government schemes in rural areas are promoting acceptance of technology in the farm segment [8] (Fig. 2)

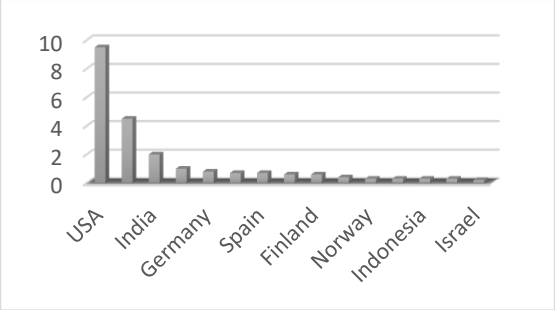

Fig 2: Top 15 countries by funding (US $ billion) in H1 2021 (Source: agfundernews.com)

In 2013, India had only 43 start-ups while as of 2020, there are more than 1000 Agritech start-ups. The outbreak of Covid19 has disrupted many industries along with agri industries. The restrictions imposed by lockdown affected supply chain, the shutting down of hotels and restaurants, fast food services, organised retail channels and the sharp drop in consumer demand affect the whole supply chain. However, the Agritech start-ups have established strong networks and steady supply chain with the help of technology and managed to grow with all restriction on movement, labour storage. Moreover, they ensured the movement of food items during the lockdown.

In fact, they are transforming the agriculture landscape in India, and opening up immense possibilities to drive the agriculture sector to a new height in spite of disruption happened due to the pandemic crisis. Although in the initial phase of the lockdown, several start-ups were struggling for survival, but within a few weeks, they stabilized themselves in pandemic situation. Despite a pandemic-hit, Agritech start-ups in 2020 saw over US $ 300 million of investments. The number of such start-ups has shown steady growth of around 25% with around 600-700 start-ups dominating the Indian Agritech ecosystem.

More than 500 Agritech start-ups are operational in India, i.e., one in every nine companies globally. These start-ups were successful in raising US $ 248 million as of June 2019. They are developing and refining market linkages through digital platform by providing current data to the farmers and promoting clarity across the value chain, by providing worthy inputs to the farmers for optimizing produce and offering microfinancing alternatives to farmers to manage risks. The ultimate objectives of these start-ups were to improve the supply chain to increase

farmer profits from sales and better products and price to the customers. Agritech start-ups are now capable of resolving inherent obstacles in Indian agriculture and are able to support through right information and proficiencies.

Agrostar, BigHaat, Agrevolution, Agronxt, Ninjacart, Agrihub and FarmGuru are major players in the upstream marketplace, while Krishi Star, Crofarm, Sabziwala and BharatBazar are engaged in increasing efficiencies in downstream supply chain i.e., farm-to-fork. Far Mart, EM3 Agri Services, RAVGO and Oxen are some of the successful players in farming-as-a-service model, and they are playing a significant role in providing farm equipment on rent to ease the weight of capital investments for farmers. In addition to this, FlyBird, Cropin and Exabit Systems are using IoT or Big Data-led innovation model and they have deployed smart technology to assist farmers. So that the farmers get access to information on time and drive productivity. Kheyti, Drip, Kamal Kisan and Nanopix are playing important role in driving innovative solutions in the space of agriculture by engineering led-innovation. The table below attempts to elucidate the increasing infiltration of technology at every major step of an agricultural value chain.

Table 2: Major stages of an agricultural value chain that requires technological intervention (Source: NASSCOM 2018)

Value Chain Stage	Technology Intervention required
Inputs / Knowledge	Getting required solutions directly on mobile Apps assisting in forecasting weather Choice Mechanism for farmers to choose rates for selling their crops Solutions for managing nutrition and control of pests AI
Harvesting / Conveyance	Mobile-controlled motors Drip irrigation systems, hi-tech sprinkler mechanisms, etc. GPS-enabled tractors with automatic steering controls Machinery for counting crop Mechanical systems to segregate crops from weeds
Dispensation and storing	Imaging technology to sort based on select profiles (colour, size, etc.) Smartphone fitted sensors for effective crop monitoring Mechanical measurement of moisture content in grains
Distribution, Packaging and Handling	Apps to sell agri products directly Forecasting of price fluctuations to check inflation Real-time pricing of products Online platform for selling grain GPS for effective tracking

Major problems faced by Start-ups in Agritech:

- Indifference to Investors: Since this industry has a lack of surety, people are reluctant to invest in agritech companies
- Unbending Old Models: The current situation is too rigid to bypass and devise new business strategies. People assume that proper tactics don't exist in agriculture; and when business plans fail to match prospects, the stakeholders withdraw
- Information on sowing and pre-harvest activities: Big firms that are dependent on agricultural yield desire prior statistics from pre-harvest activities onwards. They also need a platform where farmer groups can implement technical knowhow to generate maintainable profits — such as mobile notifications for weather, popular farming practices, and assistance on managing aggression from pests
- Low productivity and lack of visibility: Low productivity and lack of visibility in Supply Chain are other factors that affect the agritech business. Many start-ups are taking help of Blockchain and Artificial Intelligence to solve these issues

- Guidelines from the Government: With the implementation of schemes such as Digital India, Make in India, Start-up India, Skill in India, we are already witnessing a marked improvement at the government level. It will still take some more time to materialize at the ground level
- Lack of commercial guidance: Despite witnessing initial success, many of the existing agri-firms are encountering snags to promote their business past a level because of deficiency in advice on markets. Project incubators usually provide such help to start-ups through building capacity, establishing networks, gaining resources, and other required support. Unfortunately, not many of the current incubators (around 300) nor their progressive type namely accelerators have the proficiency and aptitude to motivate the farm-oriented initiatives.
- Shortage of Subject Matter Experts/ Mentors: There is still a lack of availability of guides in this domain. The limited available skilled ones do not boast the desired business acumen. Educational support also needs to be paramount to breed the next cohort, and requirement for training support for the cutting-edge upcoming technologies
- Climate change, water availability and droughts: Trends show an anxiety over managing calamities. Start-ups should focus more on new technology to handle these problems
- Technical knowhow: With the progress of technology at a fast pace, the awareness required to make use of it is mandatory, especially when it can affect R&D. Currently, there is next to zero innovation adoption here
- Funding: Funding still lags the broader tech industry because the industries are geographically and conceptually outside areas flush with funding, this remains a challenge for upstart innovation programs. Many state governments are providing grants to push innovation forward but that is still very limited. This leaves agricultural start-ups in a tough position; they will have to find profitability sooner than most.
- Rural area connectivity issues: For implementation of smart agriculture practices in remote rural areas, a strong and reliable internet connectivity is of paramount importance
- Mounting e-wastes: With the arrival of smart technology, electronic wastes have started to accumulate. The dumps of discarded IoT tools and outdated computer and other electronic devices are further aggravating this. As we understand, systematic advancements of hardware are making the previous versions outdated – hence, discarding them is creating pile-ups. Thus, proper management of e-waste is essential for ensuring long-term sustainability
- Barriers to entry for new firms: The big companies that initially entered the market do have an obvious monopoly. Furthermore, the low competition in the market prohibits new entrants. The capital provided by a big party in this sector might not be well-suited for those with a smaller platform – thus preventing the newcomers from having enough clientele
- Loss of manual employment: With agri IoT becoming more streamlined and the effects become automated, it will result in job loss for a large majority of manual labour. Other industries will have to generate more capacity to engage this staff, for which the economy shall have to be strong enough for it to occur

Four major challenges the Agritech start-ups were facing during the pandemic crisis are:

1. Maintain the supply of healthy food to protect immune systems
2. To prevent the transmission of Covid19 among the stakeholders
3. Food security concerns arisen due to lockdown
4. Maintain the supply chain in the era of pandemic

Role of Agritech start-ups in reinventing supply chain

Supply Chain, Big Data, Market linkages, FaaS, IoT, etc. are some of the prime domains where agritech start-ups will flourish. From predicting weather to monitoring through drones and from procurement of inputs and renting of equipment to online selling of vegetables and from farm mechanization to protected agronomy, evaluating and classifying, these start-ups are transforming agriculture in India. India's agritech start-up ecosystem has flourished in the last couple of years and the funding for this sector has also flourished. Currently, there are

hundreds of Indian agritech start-ups operating at different levels. Most of them use artificial intelligence, machine learning, drone technology through Geoinformatics, etc, to tap big data for greater productivity and comprehensiveness. In 2021, agritech start-ups raised US $ 684 Mn across 47 deals. The cumulative funding for agritech between 2014 and 2021 has traversed the US $1 Bn mark [3].

Farming-as-a-Service (FaaS) enabled Start-ups

Renting of equipment and methods involving caring of crops are areas most expected to have a grip on the market. FaaS aims to offer inexpensive technology resolutions for effective farming. It alters static prices into flexible charges for farmers, thus making them reasonably priced. The amenities are accessible on a payment-based-on-usage basis into three types. "Farming as a service (FaaS)" was first presented in India by EM3 Agri Services, which offered these facilities and rents to farmers on subscription basis. A few of the leading agri equipment rental and farm amenities start-ups include Ravgo, FarMart, Goldfarm and Oxen Farm Solutions.

Engineering based Innovation Start-ups

India is the largest global producer of tractors; but still then just over 1 percent of the country's farmers are machine dependent. Rural India is facing severe shortage of labour and farmers suffer the most. Certain agritech start-ups offer low cost and affordable mechanisation answers to these farmers to tackle scarcity of technology and increased labour costs. Kamal Kisan, Kheyti, Drip Tech fall under this category.

IoT equipped Start-ups

Precision farming techniques will eradicate inadequacies and improve production. Information on rainfall, crop harvests, rainfall, pest invasion and soil health will advance farming methods over a period of time. Low capital expenditure for principally software-based resolutions is the major highlights in these cases. Fly Bird Innovations and Fasal are some examples

Miscellaneous Agritech Startups

Certain start-ups are providing state-of-the-art explanations in evolving agro-based goods, improved dairy farming, poultry or fish farming approaches, delivering one-stop solutions for farmers practising secondary agriculture, etc. Cattle Mettle, Happy Farmer Labs and Suma Agro are some of the prominent start-up examples.

The tabular representation below shall further clarify the above.

Table 3: Demarcation of agritech start-ups on the basis of value-chain resolutions

Big Data/Farm Analytics	Farm information can be used in the following key areas • Solutions for farm management • Forecasting and risk extenuation • CRM • Compliance and tracking
Supply Chain/Market Linkage	Equips farmers with current knowledge of market prices and general scenario • Create platforms for agri inputs markets • Providing current resolutions to farmers • Agriculture info reorganized • Check price and quality • Enabling Farm to Fork chain of supply
FAAS	Inexpensive technology answers for effectual farming • Timely harvesting • Payments via digital route • Easy availability of technology for farmers • Access to required agricultural equipment
IoT	IoT devices for isolated and real-time tracking • Monitoring results for vertical farming • Monitoring humidity, air temperature through hydroponic farming ecology • Structure for aeroponics

Engineering-led Innovation	Engineering alternatives for inexpensive farming • Availability of machinery • Accessibility of technology for marginal farmers
Urban farming/Hydroponic farming	Hydroponic farming helps in • growing food in closed environment, where the demand is high, and helps in reducing the pressure on the traditional farmland, increase the utilization of modern technology to meet the demand for food and reduce the pressure on farmers
Miscellaneous	State-of-the-art answers to enhance income of farmers • Growing agro-based goods • Advancing secondary cultivation

According to Inc42 Plus report (2021) [10], despite the lockdown due to pandemic crisis, the Agritech start-ups sector made remarkable growth and pushed the farmers towards modernization, especially by adopting the digital platform for getting access to the market place.

They proved to be the unexpected relief during the pandemic, and the recent farm laws promulgated in 2020 could have given them a fresh impetus through provision of a legal structure to collaborate with farmers through FPOs and co-operatives. We shall now deliberate on how certain start-ups in the promotion domain are boosting farmers and small agribusiness operatives and providing customers with more attractive options [9]. Covid-19 seems to have unleashed the potential of agritech start-ups by making farmers aware about the need for technology as they became more open to innovation and digitisation. Between January and August this year, agritech start-ups in India raised $426 million, across 38 deals, over three times more than the same period last year, according to data from analytics firm Tracxn. They had attracted $127 million in January-August 2020. This includes seed, early and late-stage deals. In the face of the pandemic, India's agriculture sector has piqued investor interest. With singular digital access to farmers, significant reforms and exceptional government support, agritech has empowered rural India by increasing income levels and market penetration and linkages. As one of the least digitised sectors in the country, agriculture offers a huge untapped market that is projected to grow to US $ 30-35 billion by 2025. And that's just a fraction of the US $370 billion Indian agricultural sector, which is sitting at an 'inflection point', says a recent Bain & Company report.

One of the latest tendencies is that of several models of collaboration. Ninjacart, which started out as a consumer-centric venture subsequently branched out to a more business-focussed alternative (F2B from F2C), appreciating the requirement to tackle issues that provoke the agri-food ecology to attain far-reaching gains. Dehaati Beej Se Baazar Tak is an example of an agri start-up that participates via B2F and F2B options by utilizing data, agricultural science and analysis to foster a blossoming ecology of entrepreneurs and organized purchasers. Crofarm is a F2B digitized hoarding chain which takes care of logistics and supply of fresh produce from farms to retail chains like Big Bazaar, Reliance Retail, BigBasket and Blinkit.

In the current extraordinary scenario, the agritech space has been witnessing a steady, if not astronomical, influx of funds. With a cumulative capital of US $ 162 million since 2014, Dehaat was able to raise US $ 115 million alone in October 2021 – supposedly one of the biggest fund generations in the domain of agritech; thus, raising the valuation to USD 158 million by January 2022. Ninjacart generated funding worth US $ 222 million since March 2016 and was valued at US $ 503 million as of October 2020. With an overall funding of US $ 16.9 million since July 2016, Crofarm was evaluated at US $ 24.4 million as of July 2021. Similarly, Otipy has generated capital worth US $ 12.7 million, with US $ 10.2 million raised in July 2021.

The Indian agritech start-ups have now started to have a growing footprint. Karnataka, Maharashtra and Delhi NCR have become significant centres for agristart-ups. With over 6,50,000 farmers across 1,890 centres, Dehaat is widely present in the states of Bihar, West Bengal, Odisha, and Uttar Pradesh. Ninjacartis known for sourcing fresh produce from farms and providing to retailers, restaurants and kirana stores, and is functional across 11 cities. With a farmer network of over 10,000, Crofarm caters to more than 1 lakh customers and 5,000 businesses. Otipy, with over 10,000 resellers (of which 70% are women) across Delhi NCR, Uttar Pradesh, HP and

Gujarat, has arisen as one of the more prevalent platforms with nearly 2 lakh customers and more than 8.25 lakh mobile downloads.

The start-ups have left a noticeable impression. Through a demand-driven fruitage timeline, Ninjacart was able to diminish waste to 4 per cent in comparison to 25 per cent through old-school methods. Deliveries through efficient maximisation of logistics in reduced time have reduced costs by 1/3rd. As a result, farmers are taking home more than 20% of what they were earning earlier. Dehaat has succeeded in increasing the farmers' income to 50 per cent due to savings in inputs, increase in efficiency, and exploring better market rates.

E-commerce platforms hosting agritech start-ups have the ability to shift from government-controlled agribazaars to demand driven digital marketplaces. But the scalability of these schemes will be crucial over a long period. There is a likelihood of significant upheaval – numerous firms may collapse whereas others will strengthen via Merger and acquisition. On the distribution side, the platforms– also known as 'Farm-to-Fork' model, manage the revenue generation by directly linking the farmers and sellers. This resolves the burning issue of price realisation as the price hoarded by the middle men is now spread amongst the farmer and the seller only. Enhanced price realisation implies more revenue for acquiring superior seeds and capitalizing in upgraded amenities across the supply chain. With the agrarian ecology embracing a market-dependent and liberal outlook, these agritech start-ups have created an opportunity to revolutionize ground-breaking and technology-supported answers to age-old glitches across numerous phases of the chain to tackle matters that have previously maligned this segment.

As discussed previously, India's agritech sector has the potential to grow manifold over the coming years. With a current gross revenue of US $ 204 million, which is just below 1% of its market potential, this segment is just getting ignited. The revolutionary influence of agritech is visible at every stage of the agriculture business: from acquiring inputs, to upgrading cultivation procedures, to logistics of harvest to postproduction dispensation and ultimately to vending and funding - every point has the possibility of revolution.

Responsibility of State Governments

Every state has an important part in encouraging the start-up environment. Prior to the unveiling of "Startup India" by the Government of India, only four state governments were keen on supporting them. The country-wide movement to promote start-ups was disjointed and there was an urgent necessity for uniting these isolated attempts. Simultaneously, other states needed to be convinced to implement these new efforts. Thankfully, with the urgency coming from a national level, it gave rise to a widespread drive across the country and currently twenty-two states have their own start-up guidelines, while the remaining states and UTs are in the process of drafting their respective procedures. In this expedition towards formulating a favourable start-up ecosystem, it is vital that states and union territories converse and implement best approaches. The graphical representation herewith provides an insight into the conducive environment (state-wise) for establishing start-ups.

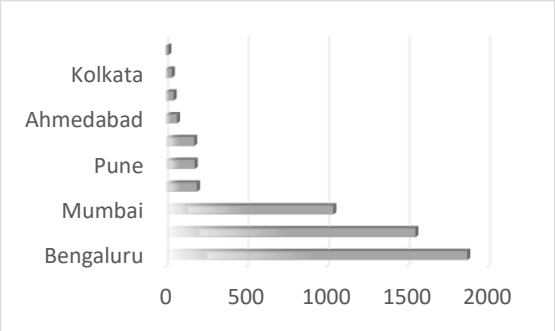

Fig 3: Top-10 start-up Hubs in India (Source: Startuptalky)

Department of Industrial Policy & Promotion, Government of India, has now conceived a ranking system with the key objective of encouraging States and UTs to provide hands-on support for strengthening the upcoming start-up ecosystem under their dominions. Action points (38) were broadly distributed into 7 flagships (start-up policy/implementation, incubation hubs, seed funding support, angel and venture funding support, simplified regulations, alleviating public procurement & awareness and outreach). This was done to enable a strong rivalry between states to observe and adopt best approaches. Independent evaluation specialists from the start-up environment undertook an elaborate valuation of replies across different criteria. Some questions targeted receiving response from recipients. Answers were recorded

even in local languages to elicit accurate feedback and get an actual pulsation at the operational area. The results are mentioned in Table 4.

Table 4: Ranking of States and UTs for support towards start-up ecology (Source: Dept of Industrial Policy & Promotion, Government of India)

Flagships	***States with model performance in respective categories (in alphabetical order)***
Startup Policy and Implementation	Andhra Pradesh, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Odisha and Rajasthan
Incubation Hubs	Andhra Pradesh, Delhi, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Odisha, Telangana and Uttar Pradesh
Seed Funding Support	Bihar, Gujarat, Jammu & Kashmir, Karnataka, Kerala, Odisha, Rajasthan and Tamil Nadu
Funding Support– Angel & Venture Funding Support	Chhattisgarh, Gujarat, Jharkhand, Karnataka, Kerala and Rajasthan
Simplified Regulations	Andhra Pradesh, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Odisha, Telangana, Uttar Pradesh and West Bengal
Easing Public Procurement	Chhattisgarh, Gujarat and Odisha
Awareness and Outreach	Andhra Pradesh, Chhattisgarh, Gujarat, Karnataka, Kerala, Odisha and Telangana

Government authorities are stepping up efforts to create consciousness about being new-age entrepreneurs among students. Hundreds of initiatives have been arranged by numerous state governments under this scheme. Over 340 districts across the country have now set up hundreds of entrepreneurship initiatives, and this in turn plays a crucial role in fostering the philosophy of novelty within youngsters, who can use these ideas for promoting trainings and workshops. For a long-term approach, the Centre-State axis needs to cumulatively construct desired structure, devoted framework, group of like-minded people and monetary awareness across all demographics.

The way ahead

Even though the last few years have seen significant fund inflow into this sector, the market infiltration is still moving at a snail's pace (<1 per cent). However, this makes us strongly believe that the unexplored trade capability and prospects shall spur long-term progress in this sector. With the maturity of the agritech ecology, we expect some instances to emanate. There is a scope for existing and upcoming stakeholders to broaden horizontally across agritech segments to take complete ownership of end-to-end relations with farmers. Some ambitious e-commerce giants may swell their existence by retrograde amalgamation in this segment. Also, some food-processing enterprises could buyout agritech firms to have a leash on quality and operational control. Eventually, we may observe a growth in novel segments such as finance solutions, precision agriculture, quality control and M&E, considering the untapped scope and magnitude of cash influx they can offer. The idea for these start-ups is to establish attainable commercial opportunities with higher unit economics and empowering rather than ousting old-style value chain contributors to be successful.

Here are some openings for agritech start-ups:

- Increased collaboration amongst agrotechnology start-ups and finance enterprises will encourage farmers to avail investment via authentic outlets instead of procuring high-liability loans from non-institutional moneylenders.
- Amalgamation of financial solutions with agri-finance start-ups can be bettered by digitalisation and admission to agri supply chain info
- Government to launch India Agristack – a Unified Payments Interface for agritech within 2025 by aggregating shared information substructure of all farmers with land archives. This would be a multi-pronged agri data arrangement comprising of geo-tagged statistics

on farmers and their physical/financial ownership, including existing agronomy/environment details, and corresponding relevant market/pricing data. This will enable private stakeholders to filter required data and offer customised goods to farmers such as protection coverage and investment.

Indian agri yield still endures sub-standard quality and tracking information because goods pass through a cloudy supply chain, thereby leading to losses for buyers as well as sellers. Solutions are emerging by utilizing spectral analysis and cost-effective advanced data grab techniques like IoT sensors and blockchain at farm level which ensure efficient trade, yield, storage and sale at premium prices, both locally and internationally, thus growing farmer's incomes.

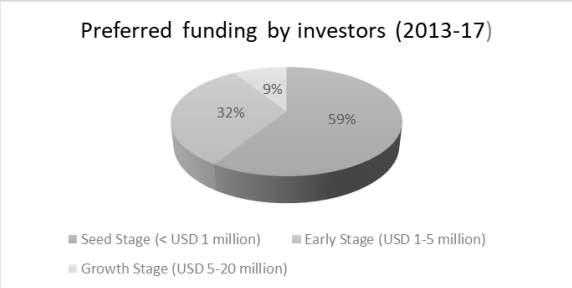

Fig 4: Graphical distribution of agritech start-ups based on investor funding preferences (Source: NASSCOM 2018)

The start-up-FPO collaboration can be reinforced by appealing FPOs under central govt's scheme of adding 10,000 new FPOs by 2024. The grid of agritech start-ups, incubators, accelerators and investors need to work in close proximity with policymakers, academic world and the government to grow a finer understanding of the agritech undercurrents. If policies and partnerships can sustain the current thrust, the start-up ecology will definitely be the upcoming technological upheaval in the agritech sector [1].

While presenting Union Budget 2022-23, Finance Minister Ms. Nirmala Sitharaman announced that agritech start-ups and companies will be engaged in public-private partnerships (PPP) to deliver state-of-the-art technology solutions to farmers and handhold in implementation. The Government of India shall set up a devoted grant for agritech start-ups. Additionally, a fund with merged capital through co-investment, would be enabled via NABARD to finance start-ups for agriculture & rural enterprise, relevant for farm produce value chain. The activities would include support for FPOs, machinery for farmers on rental basis at farm level, and IT-based support. The government would also look to pay INR 2.7 lakh crores worth of MSP directly to wheat and paddy farmers. Additionally, the government is also keen to install "Kisan Drones" or "Agricultural Drones" for monitoring, crop assessments, digitisation of land records and spraying of insect pesticides. Furthermore, for the upcoming financial year, an estimated INR 6.75 lakh crore shall be provided for PM-Kisan Yojana, INR 15,500 crore for crop insurance schemes, INR 7,183 crore for Krishi Unnati Yojana, INR 10,433 crore for Rashtriya Krishi Vikas Yojana and about INR 1,500 crore for scheme-price support scheme through market interface. These encouraging steps further strengthen our beliefs that the government is gung-ho about promoting agriculture technology and will hopefully ease procedures and policies as it identifies agritech start-ups as an immensely promising and pro-people initiatives in the foreseeable future. NITI Aayog is teaming up with IBM to provide artificial intelligence solutions to develop crop-yield protection simulations.

The agritech start-ups have a growing footprint in India with the states of Karnataka, Maharashtra and Delhi NCR being major centres. The impact has been immediate, with an increase of almost 50% in farmers' income due to savings in input costs, growth in farm output, and better price returns. In the union budget for the year 2022-23, Govt. of India has announced that agritech start-ups and companies will be engaged in public-private partnerships (PPP) to provide backstopping for implementation of the latest technological solutions. These initiatives open up a huge avenue for the agritech start-ups to spread its wings in the country and revolutionize Indian agriculture.

In June 2020, the Central Government moved three ordinances to revolutionize agriculture marketing in India; which were subsequently followed by the introduction of the three farm bills, that were cleared in September 2020.The Farmers' Produce Trade and Commerce (Promotion and Facilitation) Bill, 2020; The Farmers (Empowerment and Protection) Agreement of Price Assurance and Farm Services Bill, 2020; and The Essential Commodities (Amendment) Bill, 2020 were targeted to introduce

a radical upheaval. Yet, while introducing reforms with such widespread inferences in any democracy, continued intercession and cooperation of multiple stakeholders is mandatory. While the three farm bills, hailed by the agritech industry, were pushed away due to concerns raised by non-corporate stakeholders – agritech companies in India shall continue to prosper, supported by advancement in technology, innovations and funding.

In 2016, the figure for global agritech investment was US $ 3.23 billion. India continues to be among the top six countries, with the highest number of deals in agritech. By 2017, within global investments, Indian agri food-tech start-up firms contributed US $ 10.1 billion, covering 994 deals from 1,487investors, ticking 29 per cent YoY growth. From this, US $ 2.6 billion went to agritech itself.

Recommendations

- Minimal use of smart phones by farmers leads to limited use of start-up amenities on mobile-based apps. Thus, there is an urgent requirement to curate training programs to teach farmers and make them proficient in adopting new technological progressions
- For a start-up to be successful, it is essential to build a singular platform for farmers to explore new products by developing technology-enabled distribution channels
- More entrepreneurs to be attracted by government through lucrative grants/schemes, reducing the maturity periods and setting up agritech-focused incubators. Also provide incentives for effective post-harvest avenues like storage, cold chain and refrigerated transportation
- Start-ups require to focus more on marginal farmers who represent the mainstream of Indian agriculture

CONCLUSION

Agritech start-ups are successful in improving supply chains, but the progress is slow. Thus, the government should come forward to encourage and facilitate the entrepreneurs by providing necessary facilitations like infrastructure, financial support and proper rules and regulation. This will give confidence to the entrepreneurs in developing truly innovative business models for managing food value chains and creating real value. They are already developing innovative business models in managing food supply chain and where an opportunity for future entrepreneur lies. In future, agritech start-ups will have to deeply look into intrinsic matters like land-holding size, lengthier maturation eras, low return on savings, cheaper accessibility amongst targeted clusters, and information loopholes among farmers while formulating business representations. Getting farmers to obtain the desirable skillset to implement, these knowhows will involve tremendous efforts.

Agritech start-ups are managing the data and information system effectively through data analytics and helping the farming in taking right decision. By using blockchain technology they are successful in introducing quality management and traceability in agriculture sector. In addition to this, they helping the farmers by providing service in managing inputs and output by providing end-to-end services. New business models in Agritech space are still evolving. Further, there is a high possibility that in near future the Agritech start-ups will become an integral part of Indian agriculture. If the government's vision for making India the world's third largest economy by achieving a target of US $ 5 trillion by 2024-25 is to be materialized, the agritech segment's invaluable and ever-growing importance needs to be flagged optimistically. Indeed. expectations are high for exploring optimistic opportunities for agri start-ups in Indian agriculture.

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