

INDIA'S AGRITECH SECTOR ADDRESSING UNIQUE CHALLENGES

Authors

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In collaboration with INDO-CANADIAN BUSINESS CHAMBER

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ABSTRACT

Employing close to 43% of the Indian workforce, in 2021, India's agriculture sector remains one of the most significant contributors to the GDP. Post the green revolution, technology revolutionising agriculture has been long pending. The current report provides an overview of the agriculture and Agri-Tech market, a brief analysis of India's Agri-Tech market, its challenges, possible opportunities, existing technologies and start-up ventures, policy interventions, the need to integrate multiple sectors and the critical elements to building a solid Agri-Tech ecosystem in India.

1. AGRICULTURE ECOSYSTEM IN INDIA- BACKGROUND AND CONTEXT

The Indian agriculture sector is the lifeline of the economy; close to 40% of the country's labour works in the Agriculture sector. It is still one of the biggest employers, employing around 43 per cent of India's workforce (World Bank, 2020). Agriculture as a sector is a support system for various others such as consumer package industry, retail chemicals, and e-commerce are primarily dependent on the agricultural produce, thus giving agriculture a significant stance in the economy.

The sector has been seeing sharp growth over the years in terms of market size and dynamic innovation. "India's agricultural sector has shown its resilience amid the adversities of COVID-19 induced lockdowns. The Agriculture and Allied activities clocked a growth of 3.4 per cent at constant prices during 2020-21 (first advance estimate)" (Economic Survey, 2021). The country's total food grain production estimated a record of 296.65 million tonnes, which is higher by 11.44 million tonnes than the production of food grain of 285.21 million tonnes achieved during 2018-19 (PIB Ministry of Finance, 2021). This news needs to be rejoiced on transforming a once agri-dependent nation to a self-sufficient producer and net exporter of agriculture and allied services.

With an increase in population and average income, global demand shifts affecting India will increase demand in quantity, quality, and food variety. This shift is already observable in the market and is expected to rise. The pressure on the limited land available for cultivation to produce more quantity, quality and diverse food demand will increase.

Technology integration through AgriTech inventions and adoption proves the dynamic nature of the industry and its stakeholders. India is witnessing a contraction in the digital-divide and growth of the digital ecosystem. Affordability and availability of high-speed internet is on the rise. The convergence of this digital ecosystem with agriculture presents India with a significant opportunity to boost overall agriculture potential.

"India's National Strategy on AI (Artificial Intelligence) also aims to realise the potential economic and social benefits that this technology offers. Further, the National Strategy on AI recognises agriculture as one of the priority sector areas for implementing AI-driven solutions." (NITI Aayog, 2019)

1.1 THE PLIGHT OF THE PRIMARY STAKEHOLDER

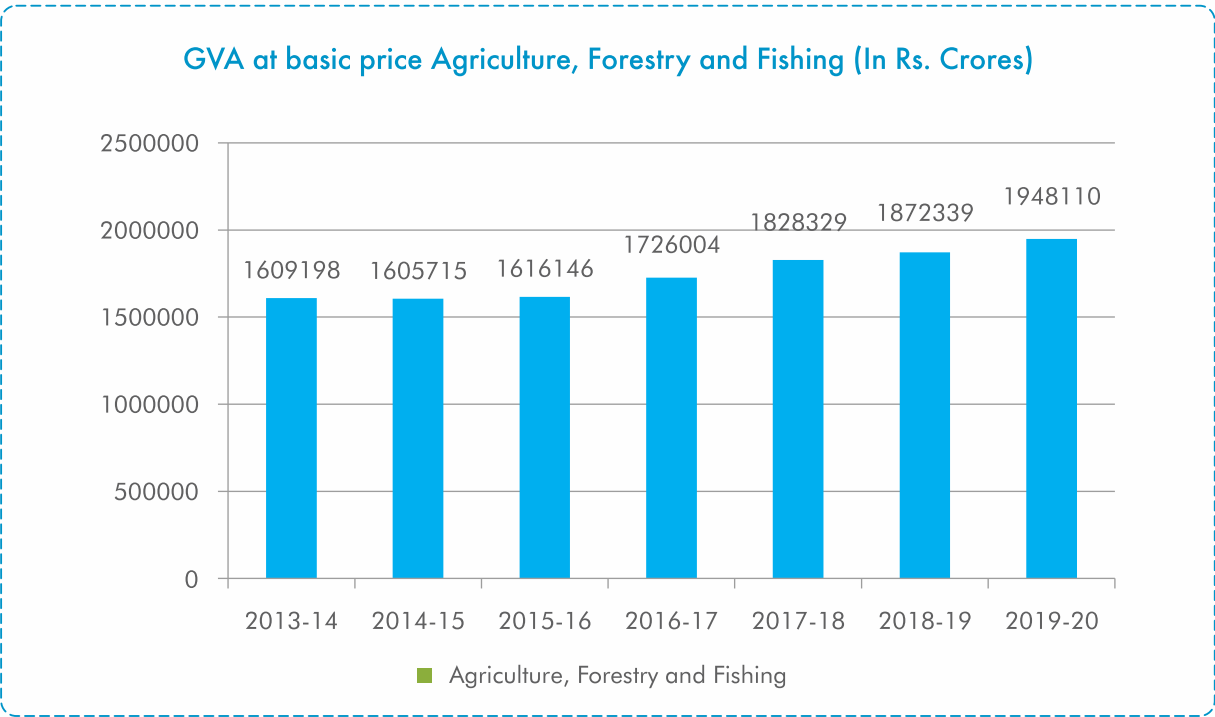
There has been a considerable policy focus on technology in agriculture. It seems like a logical and a rather needed step, as policy measures over the years have failed to address the agrarian crisis. However, progress is made in the sector; as mentioned, it also comes with a cost. The grassroots' conditions are neglected quite often, which leads the primary stakeholder to take such extreme measures in the hope to pull the attention of the citizens, the government to the real issues.

Farmers from the state of Tamil Nadu demonstrated in the country's capital over lack of drought relief measures and rising farmer suicides in 2017. The year after, in 2018, saw over 50,000 farmers taking to the streets, to voice their concerns and advocate for the passage of long outstanding sectoral reforms outlined in the MS Swaminathan Report, 2005 (National Commission on Farmers, 2006) (Economic Times, 2018). And now the farmers are protesting in 2020 against the newly passed farm laws by the Parliament.

We see that the sector as a whole prospers and even a few from the farmer community but not all of them. The conditions of the small and marginal farmer, landless labour and women are bleak. These sections comprise the majority of the sector's population that is dependent solely on agriculture, and they seem to be carved out of the gaining side. Unreliable market linkages and access to inputs, fluctuating commodity prices, low returns, and high indebtedness are contributing factors that make farming a high-risk proposition (Anita & Deepti, 2019).

2. MARKET INSIGHTS

The share of Indian agriculture in the gross domestic product (GDP) has reached around 20 per cent for the first time in the last 17 years, making it the outperformer in GDP during 2020-21 (Economic Survey, 2021). GDP From Agriculture in India averaged 4282.93 INR Billion from 2011 until 2020, reaching an all-time high of 6364.44 INR Billion in the fourth quarter of 2020 and a record low 2690.74 INR Billion in the third quarter of 2011 (Trading Economics, 2021). The Agri sector has seen various developments in terms of rising penetration of the organised sector, growth in contract farming, agriculture becoming more mechanised, use of AgriTech, comfortable loan facilities, the rise of exports, use of agrochemicals and high yielding seeds, and an increasing role of the private sector in processing, branding, and marketing, etc.



(RBI, 2020)

Gross Value Added from the Agriculture and allied sector has been on a rise over the year.

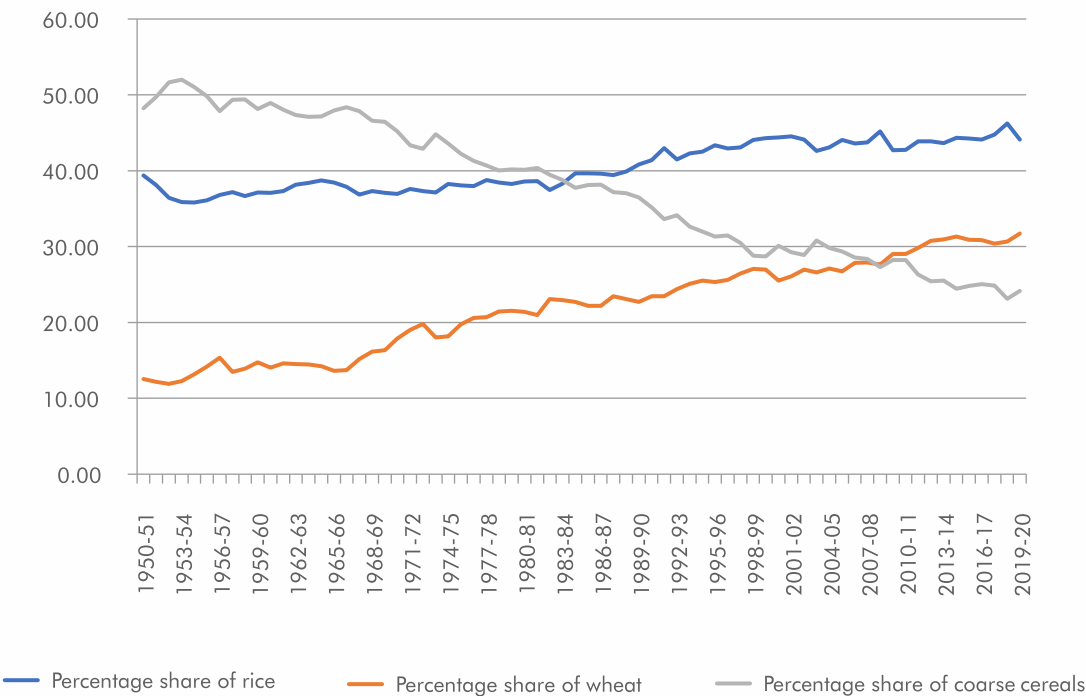
Area under Cultivation of Foodgrains in India



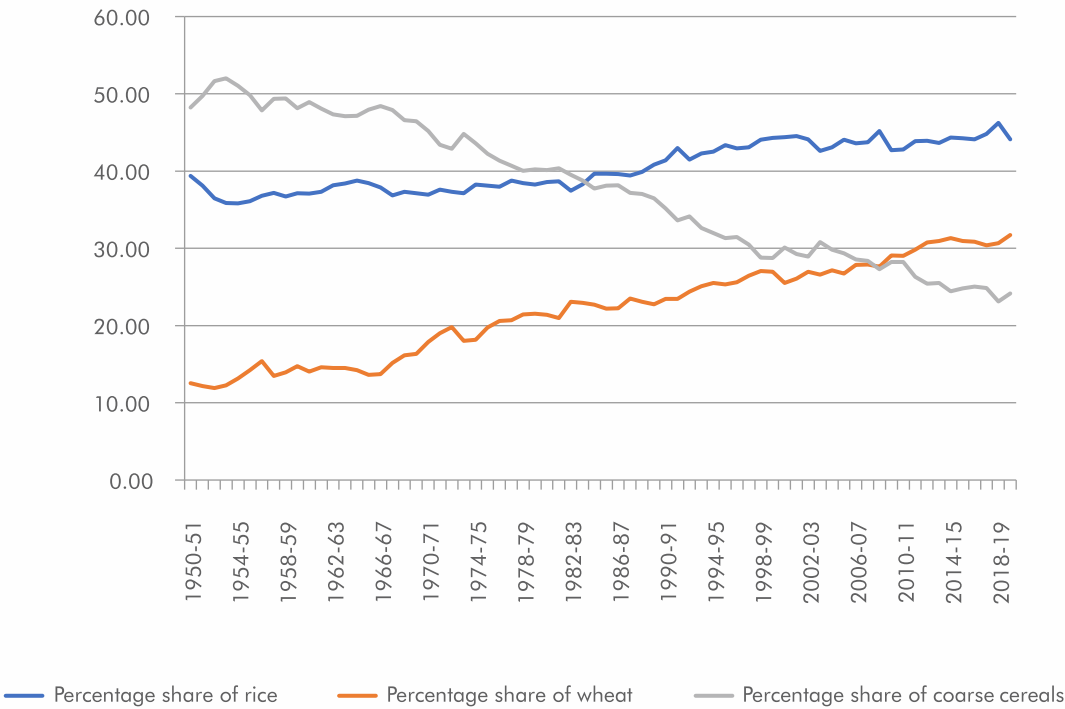
Area under cultivation of food grain in India (RBI, 2020)

The graph above represents the pattern of foodgrain production in India over the years. The total foodgrain production has risen from 973 lakh hectare in 1950-51 to 1276 lakh hectare in 2019-20. The total area under cultivation remains the same, but there are changes in the usage of the land.

Comparing different food crops over the years



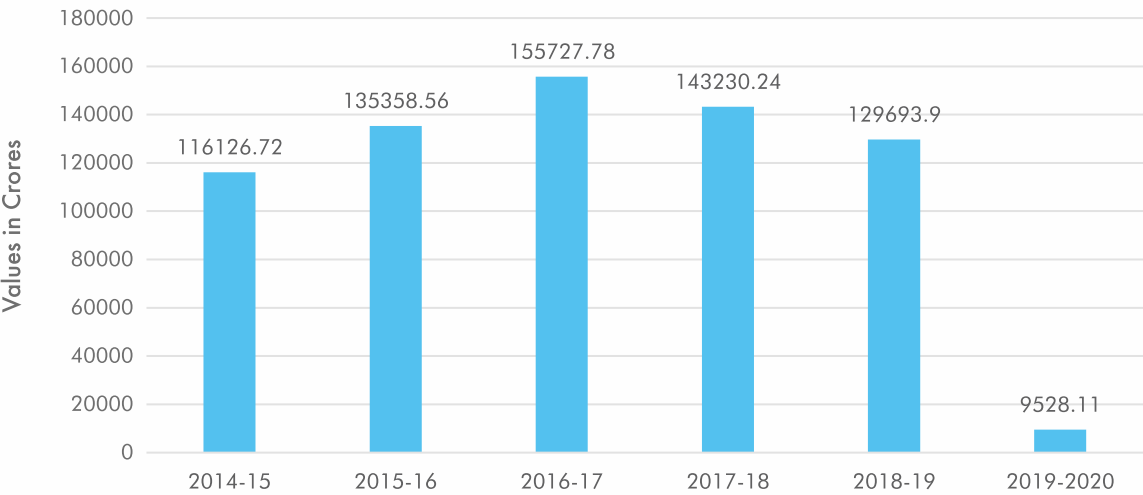
Comparing different food crops over the years



Comparing different food crops over the years (RBI, 2020)

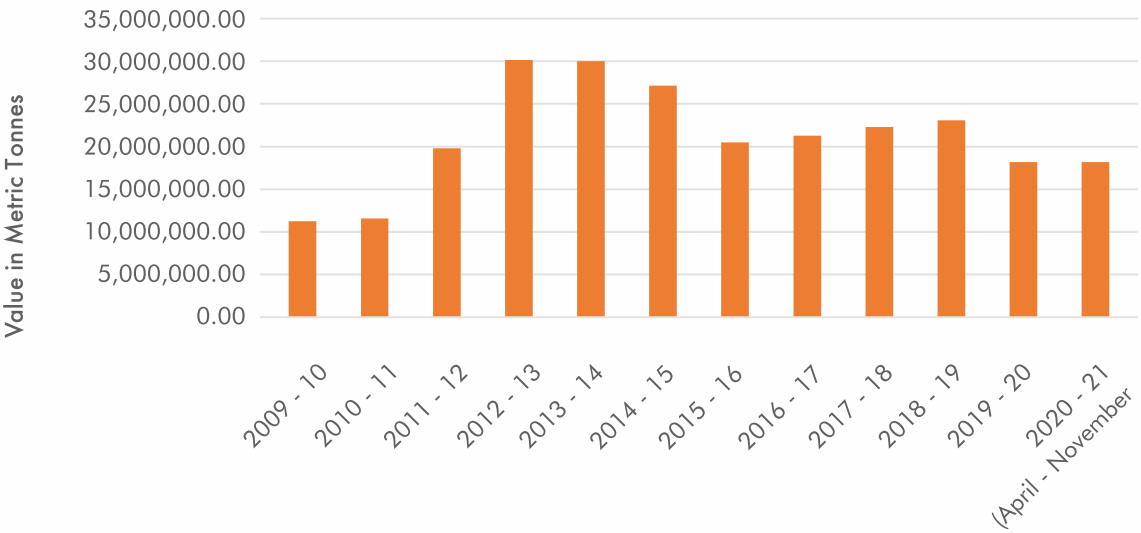
While looking at the cropping patterns over the years, we see a shift from coarse cereals to wheat and rice cultivation.

Import of Agriculture and Allied Products by India



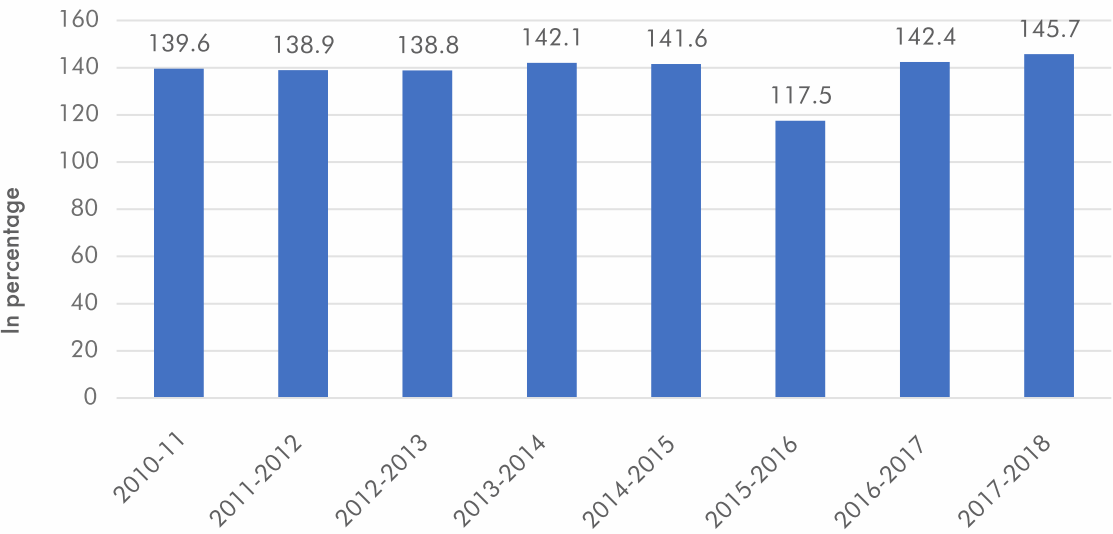
(RBI, 2020)

Export of Indian Agriculture and Allied Products



(APEDA , 2020)

Cropping Intensity in India



The above figures present the imports and exports of Indian agricultural products. There has been a significant rise in imports during the year 2016-17, and a rise in exports in the year 2014-15.

A possible inference that can be drawn from the cropping intensity data, in the year 2015 we see a dip in the crop intensity, and also a dip in exports in the same year.

3. AGRITECH

3.1 DEFINING AGRITECH

Considering the bewildering possibilities of deployment of technologies in agriculture, a universal watertight definition of AgriTech cannot be arrived at; it is defined in multiple ways by different stakeholders.

The description, which comprises of an overall view is that, AgriTech is an ecosystem of companies that are leveraging technology to provide products or services for increasing overall performances (yield), efficiency (time/cost) and profitability (revenue/ROI) for farmers across the agricultural value chain. It includes applying technologies such as data digitisation, data platforms, analytics, Artificial intelligence (EY, 2020).

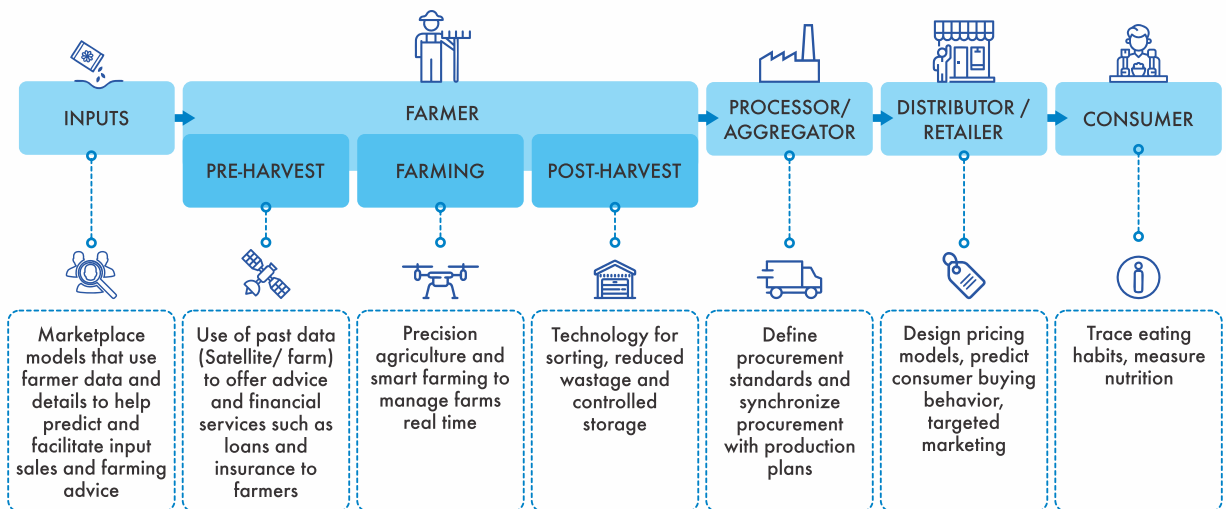


Illustration by Zephyr Peacock (YourStory, Agritech trends: Use of data science in agriculture, 2020).

The overall presence of technology/ Data science applications in the agriculture space is illustrated above.

For time immemorial, farmers have used their tacit knowledge of responding to agronomy challenges with their crop and piece of land. They applied their acquired knowledge to tackle issues such as weather, pest attacks, and other factors.

But with the expansion of crop variety due to the shifts in consumer demands, unpredictable weather conditions due to climate change, the complexity involved in decision making for the farmer only based on his/her experience started to increase. In light of the new crops, depletion of natural resources (water, soil fertility...) required for farming as inputs-and-sustenance leaves no choice to the farmer, but to turn to technology, resulting in precision farming.

Below is an illustration of the agri- spaces and a few of the existing agri-tech start-ups in India.

Space	Agri-Tech Startup	Services Offered
		One-stop advisory channel for farmers - Package Crop Advisory Bharat Agri of Best Practices; Queries on the disease, pest attack, weather and market information
Crop Agronomy	Fibsol	Building innovative Agri inputs - nano fertilisers etc.
Farm Management	Arogyam Organics	End-to-End services for production, certification and marketing of organic crops
	TraceX, Source Trace, Cropin	Crop Monitoring and traceability solution
	JeevaBhumi	Farm Management (trackability and traceability) as a solution with BlockChain connected nodes
	Stellaps	End-End digital platform for milk producers - cattle management, traceability and analytics
Financing	Samunnati, JaiKisan, FarMart, Bijak	It provides Digital financial inclusion to farmers - for inputs, farm machinery purchases, market linkages etc.
	Intellectap	Digital financial inclusion for Agri Value Chains
	Mastercard Farmer's Network	Insurance and banking solutions to farmers through a platform approach
Inputs	AgroStar & BigHAAT	A "direct to farmer" m-commerce platform providing relevant agri-information for farmers

Space	Agri-Tech Startup	Services Offered
	Gramophone	Bringing timely information, technology and the right kind of inputs to achieve better yields for farmers
	Unnati	Offers support services to farmers to improve yield. It also connects them to local retailers to procure agri-inputs such as sugarcane, corn, paddy, soybean, wheat and vegetable
	Agronxt	AgroNxt provides farmers access to agri-innovations – going directly from research labs to farms
	Kisan Kart	e-commerce platform for farmers, traders, retailers, farm workers where they can buy/sell/rent/lease any Agri products or assets
	Krishi Trade	Online marketing platform & supply chain services
Market Linkages	DeHaat	A physical infrastructure + mobile app-based-model to provide market linkages to farmers
	Technifybiz, Procol, INI, Crofarm, Agribolo, Gram Unnati, KrishiHub, Agrigator, Kamatan	Facilitating market linkages to farmers
	Ninjakart, Waycool, Leaf	Facilitating market linkages to farmers and connecting the produce to HoReCa
	AgriBazaar	An online Agri marketplace connecting farmers, traders & processing companies
Mechanisation/ Novel Farming	EM3 & FutureFarms	Building Custom farm machines and setting up Custom Hire Centres
	Kamalkisan	
	GoldFarm	
	Future Farms	Advances in Hydroponics - Hitech soil-less farming
Precision Agriculture	Bharat Rohan	Farm data analytics thru Drone, satellite and remote sensing techniques
	Cultivate	Smart irrigation to improve productivity and quality

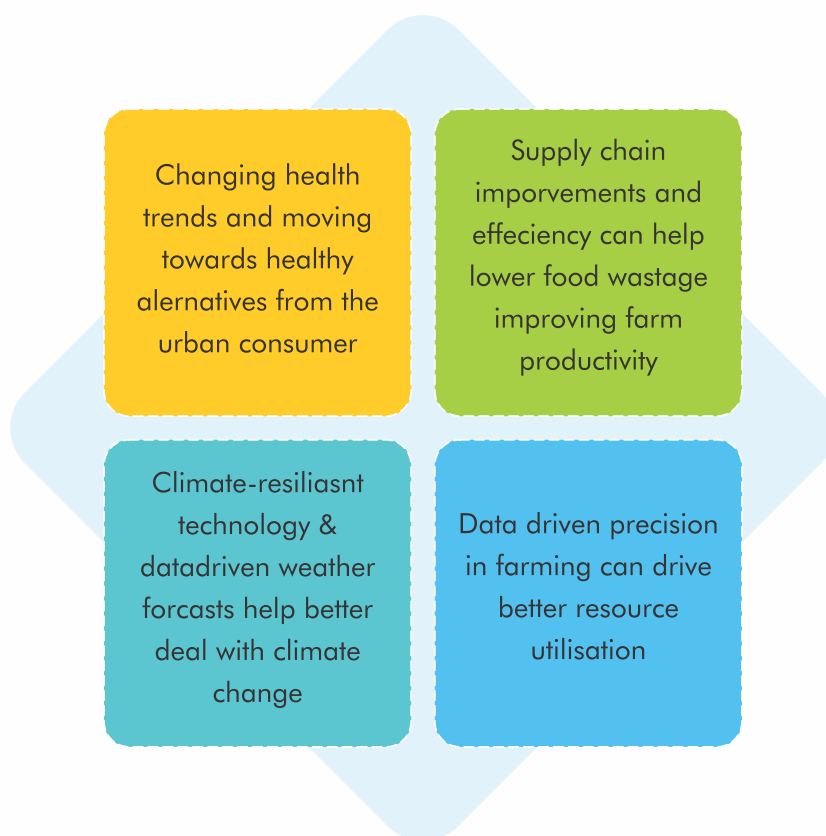
	Satsure, GeoBhumi, SkyMap Global PTE Ltd, VegaMx	Farm data analytics thru satellite and remote sensing techniques
	Plantix	Image Analytics to identify disease/damages to crops
	Mantle Labs & Prakshep	Farm data analytics through satellite and remote sensing techniques
	Kisan Raja Smart	irrigation technologies - controlling motor pump from mobile, and by employing sensors for detection of water level, rainfall, weather forecasting & soil nutritional analysis
	mKrishi	Provides service using satellite imagery for Crop health monitoring, Crop disease identification & Crop yield estimation
	Oorja	Develops solar-powered solutions like -irrigation pumps, cold storages and agri processing equipment
	Intello Labs	Rapid quality testing thru AI/ML and other innovative techniques
Quality Testing	Agricx	Rapid quality testing thru AI/ML and other innovative techniques
	Nebulaa Innovations	Agri produce quality estimation through image analytics
Weather Forecast	CustomWeather, OpenWeather, AccuWeather, Skymet	Weather Weather forecasting services - seasonal, fortnightly, daily and hourly

Source: (Sivakumar, 2019)

There are nearly 450 AgriTech start-ups in the country and are growing at 25 per cent yearly, estimates FICCI

4. DRIVERS OF AGRITECH IN THE COUNTRY

The AgriTech opportunity is the country presents itself in a big way in India in recent years. Innovations in agriculture are working both ways. One, changing how food is grown and distributed, and two due to its changing consumer demand, innovation and technology are coming into light.



5. DIGITAL AGRICULTURE

5.1 DEFINING DIGITAL AGRICULTURE

Digital Agriculture uses new and advanced technologies integrated into one system, enabling farmers and other stakeholders within the agriculture value-chain to improve food production, storage, valuation and quality. The digital generation of agriculture is termed Agriculture 4.0.

Digital agriculture 4.0 is a giant leap from Agriculture 1.0 (Manual Labour), Agriculture 2.0 (Using machines, fertilizers, and better seeds), Agriculture 3.0 (Farming integrating the usage of high-tech sensors, cloud computing, specialized software, and the Internet of Things). Agriculture 4.0 is putting a greater focus on precision agriculture, Usage of Bigdata, covering rural areas, Dealing with legacy technology Connected tractors, New measurement tools.

It applies precision agriculture principles. Farmers will be using systems and technologies that generate data in their farms, and that data will be processed to help them take proper strategic and operational decisions. In Agriculture 5.0, farmers will follow precision agriculture principles and use equipment for unmanned operations and autonomous support systems. Robots and AI are expected to play a significant role in Agriculture 5.0 (PwC-FICCI, 2020).

5.2 ANALYTICS

Digital analytics is the process of using computers to sort, compare, and contrast large amounts of data to find patterns, relationships, and insights that previously were too expensive or time-consuming to produce.

This information can markedly refine decision making and improve customer service (farmer). Analytics in agriculture helps to make a predictive and post-harvest analysis. It comprises various statistical methods from modelling, machine learning and data mining.

Data analytics refers to capturing relevant data from various sources and putting it together to translate it into actionable information to improve the business processes and solve problems efficiently and effectively.

One such Indian example in the analytics space is AgNext. Based in Chandigarh, this start-up is trying to resolve trust issues between the buyer and the seller. AgNext is solving the most significant concern in Indian agriculture: the lack of trust in critical transactions starting at the procurement stage. Traders or intermediaries assess vast amounts of farm produce by what they see and feel with their eyes and hands, based on which prices are determined. Over the years, this assessment mode has become a tool with which traders and intermediaries have exploited farmers.

AgNext has innovated technology that uses computer vision, spectral analytics, the internet of things (IoT), and artificial intelligence (AI) to analyse quality-of-produce in about 30 seconds. It solves the trust issue between the buyer and the seller across the agriculture supply chain and accelerates transactions. The benefits are immense because there is no human involvement. It is digitised, and users can access data. With the right technology in place, farmers can obtain accurate prices for their produce and greater incentive to improve their farm practices for better-quality crops.

For consumers, they ensure quality by accurately ascertaining whether the produce has contaminants or not. AgNext has also become India's first digital assaying company who provide their services to the government. In the area of food-grains, they work across seven states, impacting 1.5 million tonnes of procurement through their system (Doley, 2021)

5.3 MOBILE DEVICES AND DIGITAL SERVICES

The government has an extensive research and development infrastructure in institutions such as the Indian Council of Agricultural Research (ICAR), state agricultural universities, and public extension agents-networks. However, fewer than 10 per cent of farmers report receiving information about agricultural technologies from public extension agents. One potential alternative to costly individual extension agents going from village to village is to deliver farming information to farmers via low-cost information and communication technologies (ICT) like mobile phones (Cole, 2012)

The internet and smartphone penetration in India has been increasing over the last decade. It has proven to be an alternative to traditional agricultural practices to obtain agrarian information via low-cost technologies. Mobile phones are used to deliver information regarding land, crop, and usage and a array of financial services like payments, credits, insurance, and savings.

Almost all AgriTech start-ups have a communication line with the farmer almost directly, thanks to the internet and smartphone revolution. India's Internet and Mobile Association says that rural India has more than 217 million active mobile users, more than 205 million (estimated) urban users (The Times of India, 2020).

A growing cohort of AgriTech start-ups have been working on several aspects of the value-chain in agriculture. One of them is providing smart solutions to farmers on their smartphones. One such start-up is the National Collateral Management Services (NCML), a post-harvest commodity management company. It hosts market intelligence platforms for crop monitoring, production forecasting and remote-sensor based agri-lending. NCML also has its android app 'EmktYard' for procurement which is active with around 50,000 farmers in Bihar, Jharkhand, and Uttar Pradesh (Sharma, 2020).

There is high potential for integrating an agribusiness model on mobile services such as mobile application and portals. The outreach provided by such integration changes the present manner of farming.

5.4 PRECISION AGRICULTURE

It is also known as Site-specific Crop Management System or Satellite Farming, this concept in farming relies on observation, measurement, and response to various inbound and outbound requirements in agricultural fields.

"The primary vision of precision farming is to optimise RoI (return on investment) and preserve resources by allowing farmers and landlords to take optimised and informed decisions from the available field data. Precision agriculture fosters an environment where farmers can zero-down precise locations in their fields for the spatial availability of several resources like water availability, topography, soil fertility, organic matter, nitrogen levels, moisture content, the presence of magnesium, potassium, and more" (Gupta S. , 2018)

5.4.1 Geographical Information Systems

GIS or Geographic Information System in agriculture is helping people to map and project current and future fluctuations in precipitation, temperature, crop output and much more. The remote sensing and GIS technologies allow in gaining reliable information of human-made or natural features or processed and interpreted appropriately of any phenomenon occurring over the earth's surface without making any physical contact. It provides the real-time analysis and forecasts of weather, floods and monitoring crop area sown, lost or damaged due to floods and rainfall.

"The use of GIS in agriculture is all about analysing the land, visualising field data on a map, and putting those data to work. Powered by GIS, precision farming enables informed decisions and actions through which farmers get the most out of each acre without damaging the environment." (Intellias, 2020) GIS is one of the most enabling technologies in this day and age. It is transformative and disruptive; the role of GIS in various aspects of the economy and especially agriculture is growing.

"Applications of GIS has helped in India's growth story so far. Programs like Direct Benefit Transfer, Swachh Bharat, Smart cities, and government initiatives in Infrastructure Development, Water Resources, Forest management, Mining, Electric and Gas Utilities, Telecommunications etc., have realised the benefits of GIS technology" (Kumar, 2020). GIS technologies is used for visualisation, monitoring, management, and potential development in various sectors.

The government has primarily used GIS technology in India, but with the growing access to cloud technologies and growth potential in businesses, the private sector is not far behind.

5.4.2 Unmanned Aerial Vehicles (UAV)

Drones are ubiquitously referred to as UAV's. The use of drones in Indian agriculture is increasing with multiple AgriTech start-ups and Agri input companies providing these services to farmers. UAV technology's intelligent use can help fight highly mobile invasive pests such as fall armyworm (FAW) and desert locusts more efficiently and effectively and reduce the cost of cultivation while maintaining agricultural productivity. The following are some broad applications of drones in agriculture :

- Crop health monitoring: Routine surveillance using high-resolution, geo-referenced, orthomosaic 2D maps, spectral imagery and visual imagery can capture the growth cycle and assess crop health, enabling the swift detection of any potential problems as well as an assessment of damage to contain crop losses. Site-specific crop damage reports are generated for appropriate action.
- Soil health assessment: Soil quality is monitored by soil moisture through remote sensing, which can help develop fertility maps and plan for more optimal crop rotation or irrigation.

Improved resource utilisation: Ascertaining areas within a field that are most fertile or that require additional water/fertilisers or chemicals can help farmers to optimise their resource utilisation (PwC-FICCI, 2020)

Aarav Unmanned Systems (AUS) is one of the few Indian start-ups that design drones to serve India's needs. They have large GIS (Geographic Information System) companies, financial institutions, insurance companies, governments as their clients. Gujarat, in 2017, witnessed one of its worst-ever floods. Over 200 people died, and more than 113,000 had to be evacuated by the Indian Army, Indian Air Force, Border Security Force, among other rescue teams. As human life was in peril, the crops destroyed in the calamity were, understandably, not in focus. Yet, for a state whose two-thirds population are engaged in agricultural activities, the extent of the damage had to be measured. With even the highways inundated, manual estimation was near-impossible. With AUS' drones, however, the data of damage was collected within a fortnight (Doley, 2021).

5.5 Genomics in Agriculture

Agriculture in India relies heavily on rain as a source of irrigation, this is especially the case with the small and marginal farmers. Fluctuations in weather and climatic conditions coupled with a pest infestation, diseases, post-harvest the yield is low. Combined with these constraints, the challenge posed by our expanding population necessitates the adoption of new, innovative and efficient means of increasing food production. Various crop- improvement programs have been put in place. Over the last few decades, the genomics approach has been used to understand plant/crop genetics for its improvement. The genomics approach is used in animal husbandry, horticulture, sericulture, and more to identify and modify genetics to produce better results. Modern genomics and genetic engineering technologies have emerged as powerful tools that can provide roadmaps to sustainable agriculture that can provide roadmaps to sustainable agriculture in the present

challenging times of drastically changing climate and market conditions. Each of these has been successfully utilised in different ways and have led to significant achievements like the development of high yielding varieties (HYVs), new hybrids, better quality products and transgenics in crops (Sheela, et al., 2015)

AgriGenome Labs works in this genomics space; it is a Kerala based company. They provide genome sequencing, editing and bioinformatics services for Plant, Animal & Microbial projects of the industry and academic and government institutions. AgriGenome Labs has completed genomes of several Indian spices, medicinal plants and livestock, some under its R&D program and the rest in collaboration with other groups (AgriGenome, n.d.).

6. KEY AGRITECH INVESTMENTS IN INDIA

Despite the weak economic conditions due to the Covid-19 pandemic, the AgriTech ecosystem's investment is estimated to be around \$300-350 million in 2020. Conversations with venture capitalists and other AgriTech investors reveal their optimism for the funding to rise in the AgriTech space in 2021. The AgriTech investments in India are generally on the rise.

Some Agri-Tech Investment Deals of 2020

Company	Investor	Investment (in \$ mn)
FreshToHome	DFC, Ascent, Iron Pillar	121
Waycool	Lightbox, FMO, LGT Lightspeed Aspada	35
Ninjacard	Flipkart, Walmart	30
Arya Collateral	Quona, Lightspeed Aspada, Others	21
DeHaat	Sequoia, Omnivore. FMO	12
Bijak	RTP Global, Sequoia, Omdioyar Network, Omnivor	12
Arya Collateral	Omnivore, LGT Lightspeed Aspada	6
Intellolabs	Saama Capital, Omnivore	5.6
Clover Ventures	Accel, Mayfield, Omnivore	5
Ergos	Chirate, Avishkar	5

Source : (Business Line, 2021)

7. POLICY PERSPECTIVE

7.1 Government Initiatives

The Government of India (GoI) has been proactive in lending support to the country's AgriTech space. Various policy initiatives have been taken up by GoI to support technology in agriculture and focus on boosting the environment for AgriTech start-ups. Some of the key initiatives and their salient features mentioned below:

Sr. No.	Name of scheme	Salient features
1	Startup India	<p>Startup India is a flagship initiative of the Government of India and aims to build a robust ecosystem to nurture innovation and start-ups, drive sustainable economic growth and generate large- scale employment opportunities in the country.</p> <p>Through this initiative, the government aims to empower start-ups to grow through innovation and design. The Startup India initiative is based on the following three pillars:</p> <ol style="list-style-type: none"> 1. simplification and handholding 2. funding support and incentives 3. industry-academia partnership and incubation.
2	Atal Innovation Mission (AIM)	<p>The Atal Innovation Mission (AIM), which includes Self-Employment and Talent Utilisation (SETU), is the Government of India's flagship program to promote a culture of innovation and entrepreneurship across the country. Its objective is to serve as a platform for the promotion of world-class innovation hubs, start-up businesses and other self-employment activities, particularly in technology-driven areas. It has two core components:</p> <ul style="list-style-type: none"> • promotion of entrepreneurship through SETU • innovation promotion - to provide a platform where innovative ideas are generated. <p>AIM provides a grant-in-aid package of INR10 crore to every Atal Incubation Centre for a maximum of five years, to cover its capital and operational expenditure in running the centre.</p>
3	NewGen Innovation and Entrepreneurship Development Centre (NewGen IEDC). Under the National Science & Technology Entrepreneurship Development Board (NSTEDB)	<p>The Government's NewGen IEDC start-up programme has been implemented in educational institutions. A maximum of 20 new projects are supported in a year and the government provides one-time, non-recurring financial assistance up to a maximum of INR25 lakh to the institution to meet the cost of its establishment, furnishing of cubicles for start-ups, purchase of PCs with printers, library books, journals, laptop, multimedia projector, 3D printers, etc.</p>

4	Dairy Entrepreneurship Development Scheme promoted by NABARD	<ul style="list-style-type: none"> • 25% of the project cost as back-end subsidy restricted to a maximum of 10 animals, subject to a ceiling of INR15,000 per animal for establishing a dairy unit (INR6 lakh maximum) • 25% of the project cost as back-end subsidy restricted to a maximum of 20 calves, subject to a ceiling of INR6,000 per animal for establishing a dairy unit (INR5.30 lakh maximum)
5	Venture Capital Finance Assistance (VCA) Scheme promoted by Small Farmers' Agri-Business Consortium	Capital assistance depends on the cost of the project, location and the promoter's status. It is in the form of interest-free venture capital assistance up to INR50 lakh or 26% of the promoter's equity, whichever is lower.
6	Aspire (MSME)	Aspire has been launched by the government to set up a network of technology and incubation centers, and to promote start-ups for innovation and entrepreneurship in rural and agriculture-based industries.

Source: (StartUpIndia, 2020) (AIM, 2020) (NABARD, 2021) (PwC-FICCI, 2020)

7.2 National Strategy on Artificial Intelligence- NITI AAYOG

Niti Aayog recognises the importance and potential of AI in agriculture. It also recognises the challenges the sector faces, identifies them and looks to solve them with AI support systems. These challenges include inadequate access to credit and information, decreased fertility of the soil, pest infestations, changing cropping pattern, wastage in the supply chain and an incompetent market discovery mechanism. It identifies significant areas where digital technology is applied. It delineates tech-enabled agri-extension, precision farming using IoT and remote sensing data, predictive pest management and real-time forecasting of yields as critical areas for immediate intervention.

Some AI-based platforms in agriculture supported by the Government of India are:

mKisan: KVKs (Krishi Vigyan Kendras), through the mKisan portal, provided SMS services to 612.95 lakh farmers on improved farming practices such as climate-smart agriculture, low carbon farming, and System of Rice Intensification (SRI) for various crops and allied enterprises as well as weather-based advisories and information on various Government schemes (PwC-FICCI, 2020).

Ekikrit Krishi Shiksha Takniki Ayaam: New digital applications have been developed to bring Indian agriculture in line with the Digital India theme. The Department of Agricultural Research and Education (DARE) launched the agricultural education portal Ekikrit Krishi Shiksha Takniki Ayaam (EKTA).

It set up an integrated online management information system with developed nine mobile apps for cultivation of mango, e-kalpa, oil palm (English, Hindi and Telugu), pomegranate, onion and garlic, black pepper and mushroom, and two other mobile apps Kisan Suvidha and Pusa-Krishi for the farming community (Kisan Suvidha and Pusa Krishi).

(NITI Aayog, 2019) (PwC-FICCI, 2020)

8. INFRASTRUCTURE DEFICIT IN INDIAN-FARMING

Infrastructure challenges lay open in the Indian agriculture space. While looking into the AgriTech segment of agriculture, certain deficiencies shall pose an obstacle for the optimal running of any tech-based idea in agriculture.

8.1 THE DIGITAL DIVIDE: The digital divide in India is rapidly decreasing with the increase in smartphone usage and internet penetration. India is among the top three global economies in its number of digital consumers (users of internet services), and the digital divide is narrowing fast in the country. Although the government is undertaking various enabling measures and programmes, digital literacy and technology adoption are still significantly at inadequate levels in rural areas. There has been significant penetration of mobile use and internet connectivity, but the use of mobile and internet services for practical farming is still nowhere substantial. The chances are that small farmers may be left behind, given that he/she might not have the resources needed for the outreach to learn about new and upcoming technology.

8.2 LACK OF AVAILABILITY OF QUALITY DATA IN AGRICULTURE: One of the significant challenges faced by the Agri community is that of the availability of quality and useful data sets. The AgriTech start-ups face the problem of data availability and accessibility as well. AI modelling relies on several input data points such as topography, soil, weather, seed types, cropping practices, diseases and pest patterns that all impact each other. Moreover, some of the data is not publicly available, and what is available needs a detailed review to satisfy the critical attributes required, such as volume, variety and veracity.

CropIn Technology a Bengaluru-based AgriTech start-up said "that many agribusinesses are yet to move away from traditional practices and switch to more efficient use of advanced technology. There is no data available to farmers to show the power of tech-enablement clearly. The existing solutions work on certain ecosystem levels and do not connect with the entire ecosystem, which becomes a burden on AgriTech providers. One of the important challenges we face today is ensuring farm-to-fork traceability of produce, especially when global markets are in question," CropIn CRO Jitesh Shah (Naik, 2020).

8.3 LAGGING BEHIND IN AGRI-FINTECH: One of the gripping problems of the Indian small farmer and agriculture is the lack of adequate and timely financing. For reasons such as droughts, bad harvest, or pest infestation, the small or marginal farmer would like to seek a quick loan, but this is far from happening, as interest rates are as high as 10 % per week (Shanti S, 2020). Financial inclusion levels have been low in the agriculture sector, which leaves the farmers out of the formal credit system. Financial lending institutions face credit risk assessment issues due to lack of historical performance and risk profile of their clients.

There is a dire information asymmetry due to lack of alternative data sources to verify the source data, and high-cost operations. The lending personnel have to check on every farmer loan physically (Naik, 2020).

Infrastructure deficit of Indian-farming and farm-produce-management in transforming from a subsistence and labour-intensive model to that of an agile market driven model supporting the smallest farmer to that of industrial farming.

9. NEED FOR FARMERS DIGITAL LITERACY, EDUCATION, AND ADOPTION

The digital ecosystem in present-day agriculture plays an indispensable role in disseminating information on farming's critical aspects. Digital literacy amongst the farmer community has been steadily improving but has not reached a critical mass. Mobile and internet penetration is not enough. The comprehension, practical use and adaptability shall be the turning point for the farmer and the agri-businesses. Low digital literacy among the farmer community impedes integrating AI and related technologies in agriculture.

10.AGRITECH INDIA CASE STUDIES



CropIn Technology Solutions

About CropIn's solution

- It offers farm management software and mobile apps to agri-business and data-led lending risk assessment to financial firms and banks.
- They also use remote sensing satellites to determine what crops are sown in a region, using crop signatures collected over a few years.

Products by CropIn

Product	Description	Segment it serves
SmartFarm	Complete farm management solution	Farming companies, Seed Production companies, AgriInput companies, Financial Lending institutions, Crop Insurance provider, Government and Advisories
SmartRisk	Risk mitigation and forecasting intelligence solution	Farming companies, Seed Production companies, AgriInput companies, Financial Lending institutions, Crop Insurance provider, Government and Advisories
SmartWare	Packhouse solution for traceability and compliance	Farming companies, Seed Production companies
SmartSales	CRM and input channel management solution	AgriInput companies

Impact of CropIn

- CropIn has digitised 13 million acres of farmland across six continents and touched over 4 million farmer lives.
- CropIn has worked on 3,500 crop varieties across climatic zones and predicted crop yields with over 90 per cent accuracy (Mitter, 2021).



Ergos Business Solutions Private Limited

About Ergos' solution

- They provide professional warehousing services to small and marginal farmers at their doorstep.
- Warehouses are located within the villages, approximately within a 5km radius from the farmer's farm.
- Provides easy access to scientific micro-warehousing at affordable prices, market advisory and forward linkages, access to finance against warehouse receipts and access to hygienically stored grains for house consumption.

Products by Ergos

Product	Description	Segment it serves
GrainBank	It provides doorstep access to end-to-end post-harvest supply chain solutions to small and marginal farmers. It enables farmers to convert their grains into tradable digital assets, avail credit against those assets through partner NBFCs and Banks, and get better prices for their produce.	Farmers

Impact

- Ergos supports more than 20,000 farmers on its digital platform and has a physical footprint in more than 60 locations
- There is an increase in the volume of sales, increased yield, increased market access, increased access to credit, reduced transaction cost, reduced production cost, and received higher product prices.
- Ergos mobile application increased technology adoption, improved information dissemination, increased labour demand, increased the need for agricultural extension agents, better support for extension agents (Raju, 2019)

Samudra Network

Samudra's Solution

- They provide FPO digitisation solution, including mobile applications and dashboards for the FPO / Federation / Co-Operative staff and directors. It helps to manage daily operations like Shareholder /Member tracking, Farm Input Sales, Stock & Inventory management, Farm Output sales and demands from buyers.
- They have an Agri Market Network to connect the FPOs to the broader ecosystem of wholesale buyers, Agri finance companies, inputs suppliers, logistics via market linkages and key partner relationships (Samudra Network, 2021).



Samudra's Products

Product	Description	Segment it serves
VarunaChain	It is a straightforward user interface powered by technology enablers like cloud, blockchain, artificial intelligence and machine learning algorithms.	It tracks the FPO operations in real-time, and various analytics-driven dashboards are available to share across with value chain partners to achieve supply chain efficiency, predictability and speed of process.
Samudra Network	It uses Android Mobile & Internet front end, back-end database technologies. Exploring blockchain for traceability & provenance.	Farmer Producer Organisations (FPO), Farm Co-operatives, Wholesale Buyers, Inputs Suppliers and other Value Added Service

Samudra Impact

- FPO Digitization solution is deployed with 15 Farmer Producer companies in Karnataka active in Kunigal, Gubbi, Tumkuru & Nagamangala taluks.
(NASSCOM, 2019)

11. SUMMARY

- The agri-tech industry is at a bleeding-edge stage in India. Both companies and farmers should both be formidable risk-takers in riding this upcoming wave.
- The peculiarity of the Indian agriculture sector (Farm Size, Labour practices, Economies of scale, non-commercial farming etc.) would demand that this technological forefront needs to work in a GLOCAL fashion to work.
 - Unless local peculiarities are taken into consideration and business cases drastically customised, the success and relevance of technology would be redundant.
- Integration of multiple sectors is still pending to make a seamless transition of the Indian farm from small scale self-sustenance modelled manual farms to that of a mechanised market-oriented farm reaping the benefits of economies of scale.
 - Integration of finance, logistics (storage, transport), banking have a long way to go.

The need is to build a more substantial AgriTech base with a focus on :



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