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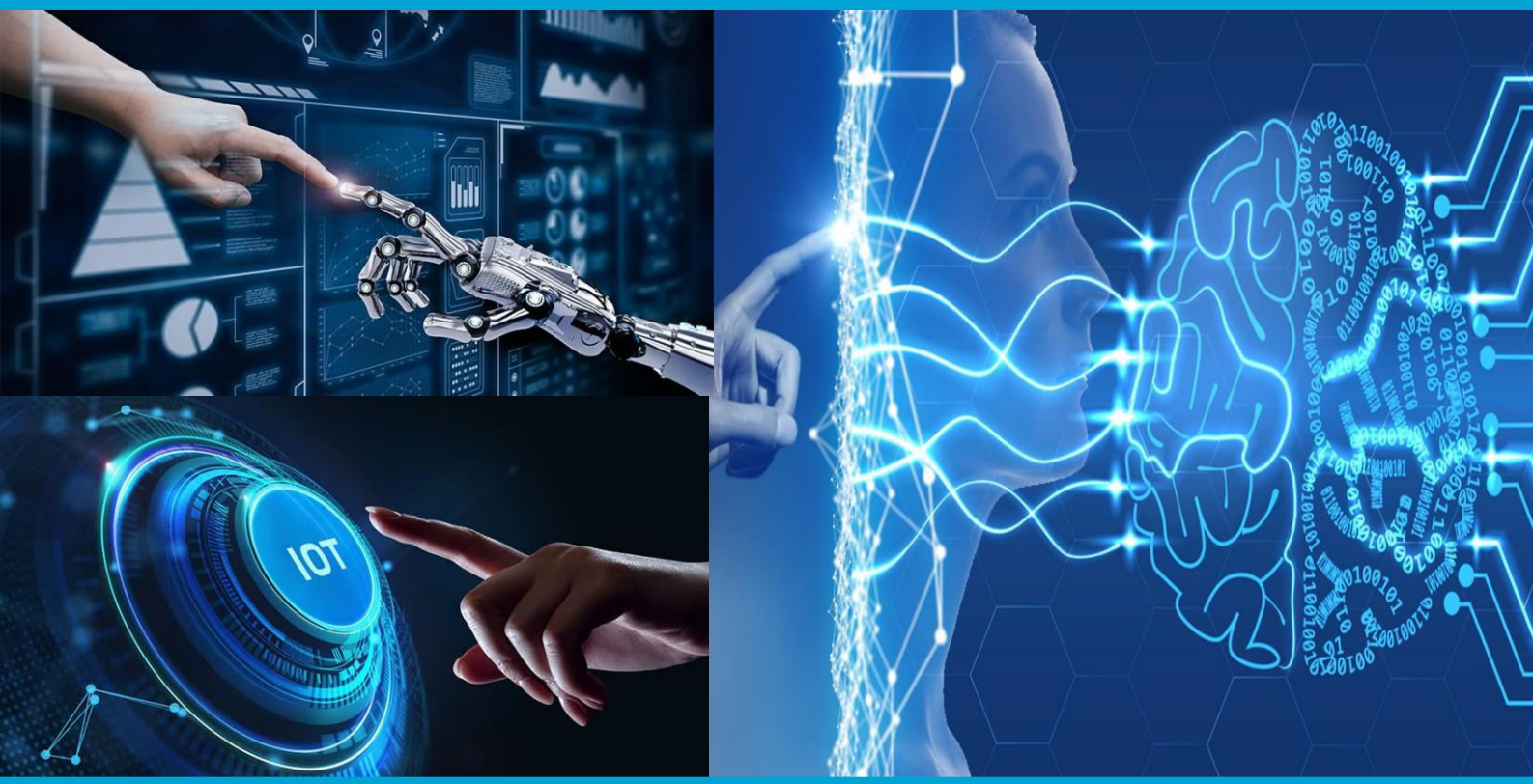

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Impact of Adoption of Innovative Technology on Agricultural Farmers in India

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ABSTRACT

It is imperative to mainstream innovative technologies and processes in India that can help farm output, farmers' livelihood and food security despite erratic and excessive rains, a climate trend that may only reoccur in future! hile the Scientific American termed India's 2019 monsoon floods as the world's deadliest disaster that year, a related observation is both 2019 and 2020 saw above-average monsoon rains with erratic intensity, i.e. dry spells in July followed by an absolute deluge in August and September.

India last saw such heavy downpour in 1994 and 1976, almost twenty years apart; but this time it struck in successive years. And this was after a drought in 2018.

Climate change is undoubtedly accelerating India's monsoon mayhem; and it is no wonder Indian activists like Licypriya Kangujam are following Sweden's Greta Thunberg to red-flag the climate emergency!

The excessive and erratic monsoons were most destructive on the agriculture sector. Both years saw floods damage the standing crops. Excess rains during the crops' growth stage, trimmed their size at places. Temperature variation increased pest attacks, destroying output. And the lack of storage and drying facilities rotted the perishable harvest that had high moisture content.

KEYWORDS: innovative, technologies, agriculture, farmers, India, livelihood, trend, sector, crops, harvest

I. INTRODUCTION

In agriculture, India is a land of contradictions. The country produces 11 percent of total global agriculture and, at the same time, is host to the world's largest number of malnourished people. Agriculture provides livelihoods for about half of the Indian population, most of whom are smallholder farmers, yet a majority of government agricultural subsidies are used by medium- and large-scale farmers. Parallel to India's tremendous successes in the modernization of agriculture, smallholder farmers have been marginalized. The average debt of a farming household has risen fivefold in a decade, while increases in farm incomes have not kept up, and more than 300,000 Indian farmers have committed suicide since 1995[1,2]

Given the complexity of Indian agriculture, no single policy change or technology shift will move the country toward its dual goals of raising income for smallholder farmers and continuing to strengthen the competitiveness of Indian agriculture, but the digital transformation of agriculture occurring worldwide holds some promise for progress. This article presents reflections on the topic from four leaders in Indian agriculture. They offer insights illustrating fundamental changes in the structure of the sector and raise questions about whether smallholder farmers will benefit from digital innovation in the same way that larger farmers will.

Ashok Dalwai, who has chaired the Committee on Doubling Farmers' Income and is CEO of the National Rainfed Area Authority for the Ministry of Agriculture and Farmers' Welfare, Government of India, describes India's move toward an "income revolution" in the agriculture sector. Purvi Mehta, head of agriculture for Asia at the Bill & Melinda Gates Foundation, explains how digital innovations are supporting moves toward higher incomes for smallholder farmers. Rohtash Mal, chairman of EM3 AgriServices, elaborates on challenges and questions about how these innovations will be monetized to have an impact on smallholders. Anil Jain, managing director of Jain Irrigation, discusses the need to pair digital innovation with physical infrastructure.[3,4]

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Starting with a response to the food deficiency in the 1960s, India has not only conquered hunger and achieved a status of food sufficiency, but also we are now at a stage where we are able to export any quantity of food that the world may require. So, we're at a stage where the high production resulting in surpluses across several subsectors of agriculture and certain segments of agriculture commodities has actually resulted in a distinct flip of the markets, where the supply is more than the demand and farmers are not able to get good prices. The story is that we now need to bring an equilibrium between the demand and supply. We need to focus on markets. We would like to liberalize agriculture, make it more market friendly, so that it is the demand and the prices that become the incentive for the farmers to produce what the global markets demand or the domestic markets demand.

That means we need take a step away from the Green Revolution, or the White Revolution that refers to milk, and talk of an "income revolution" that is able to capture the entire value chain right from research up to the stage where the farmers are able to realize money in their pockets. If we want farmers to become entrepreneurs, then they must realize net positive returns. As we do this, we also have learned the lessons of the Green Revolution—that sustainability and natural resource management practices are very important.[5,6]

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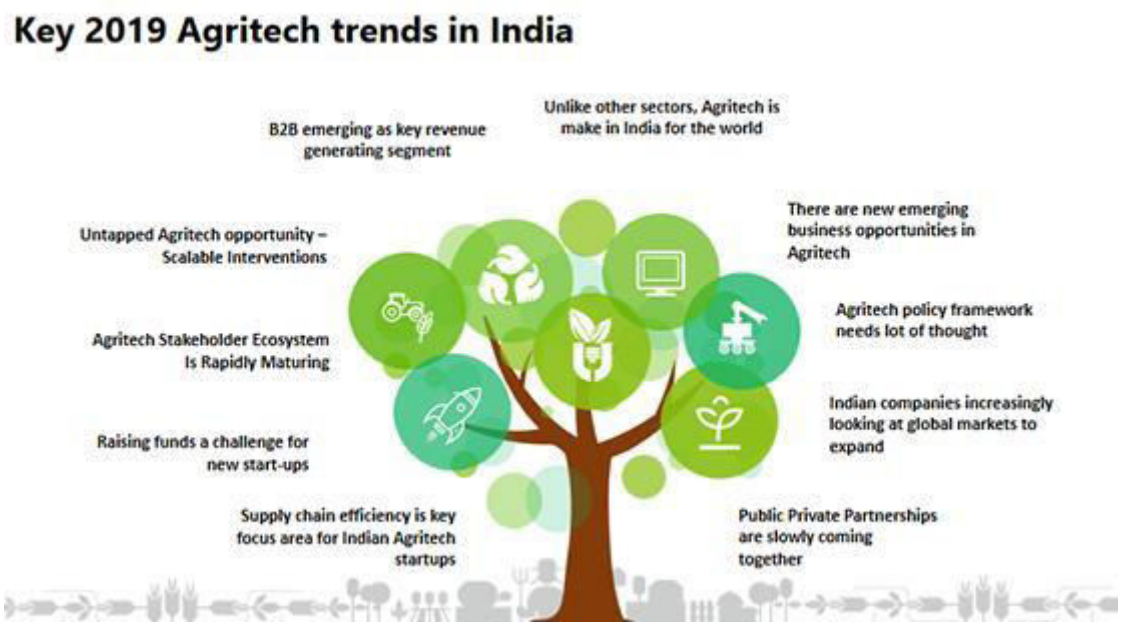

This income revolution transition of moving from a focus on productivity to income of farmers doesn't leave the productivity out, though. From achieving higher productivity, you release land and resources that can be shifted to higher-value crops like fruits and vegetables, and to livestock. You need efficiencies in productivity and reduced costs of production, but you also need effective monetization of farm produce. Within this transformation, we are seeing digital innovation enable critical shifts. India is very, very clear that digital technology is the present and the future.

For example, we are transforming the extension system so that our manpower-based system is augmented by information and communication technology (ICT). We had a robust extension system in the 1980s to 1990s, but it has gone weak now—manpower extension needs to be strengthened. With smart use of ICTs, we can drop the cost of the extension system and make it more efficient and effective.[7,8]

We're also improving our market-led crop insurance scheme with digital innovations. We're using geotagging, satellite data, and drone technology to verify crop-cutting experiments and improve intelligence on the area insured. Crop-cutting experiments used to be manual. We are now using geotagging and geoimagery to build these data, and hence the credibility of data for the insurance agency has gone up substantially. Similarly, area disputes are being settled using satellite images and drone technology. Digital tools are increasing the reliability of the data and making the settlement of crop insurance faster and easier.

Marketing in India is another very important structural weakness that is being changed through digital innovation. In the 1960s we set up organized wholesale markets called APMCs, Agricultural Produce Market Committees; marginal farmers who produced small lots could not access them without depending on intermediaries. We have seen over the last 50 years since the APMC came into existence that the traders and the commission agents working within a particular APMC had developed monopoly practices—they have cartelized, such that the farmers were not getting the benefits of transparent pricing.[9,10]

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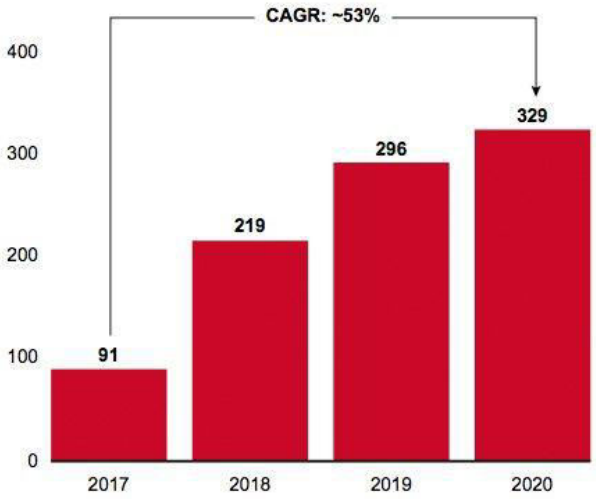
Investments in Indian agritech have increased over the past few years; this trend is expected to continue

Private equity/venture capital investments in agritech in India ($M)



$30B–$35B market with e-sales of produce, inputs, and digitally enabled logistics as key segments

		FY19	FY25	Growth
Online offtake	Online grocery buyers (M)	~30	~150	**5x**
	Average spend per consumer ($)	~65	~130	**2x**
	Online offtake market ($B)	~3	16–18	**6x**
Online farm inputs	Farm inputs ($B)	~85	~150	**2x**
	Online sales penetration	Limited	5%	
	Online farm input market ($B)	<1	7–8	**Nonlinear**
Digital logistics	Agri-logistics ($B)	~50	~100	**2x**
	Digital penetration	1%–3%	8%–10%	**3x**
	Digital logistics market ($B)	~1	7–10	**Nonlinear**

Sources: Tracxn; Bain PE deals database; Bain analysis

Now we are constructing a new market architecture whereby we'll have a foundation of retail agriculture markets (within the proximity of five or six kilometers from the farm gate), which will feed the wholesale market APMCs, and also link to export markets. But what is more important than increasing the direct reach of these markets is their integration. We can virtually integrate these physically dispersed APMCs by using electronic technology. The Electronic National Agriculture Market, eNAM (see box), integrates the physically dispersed markets, the universe of players increases, and traders begin to transparently bid for the lots of produce. We have seen that where eNAM is used, cartelization has begun to break down. As a metric of success, the number of bids per lot has increased from 1.8 to 4.8. When there is competition, price discovery is better and to the advantage of the farmer.[11]

Discussion

A large number of digital technologies have already been scaled up. In a country with 1.3 billion people, with 48 percent dependent on agriculture, when we talk of scaling up, what we mean is that you are able to reach 200 million farmers within two or three years. For example, India has now rolled out one of the most massive soil health management systems of any country in the world. All the farmers in the country today get their soil tested once every few years on 12 parameters—on all the macronutrients, micronutrients, secondary nutrients, and physical and chemical properties—and the farmer gets advised of the nutrient status. We are now looking forward to using a large number of digital technologies, at the preproduction stage, in production, and in postproduction.

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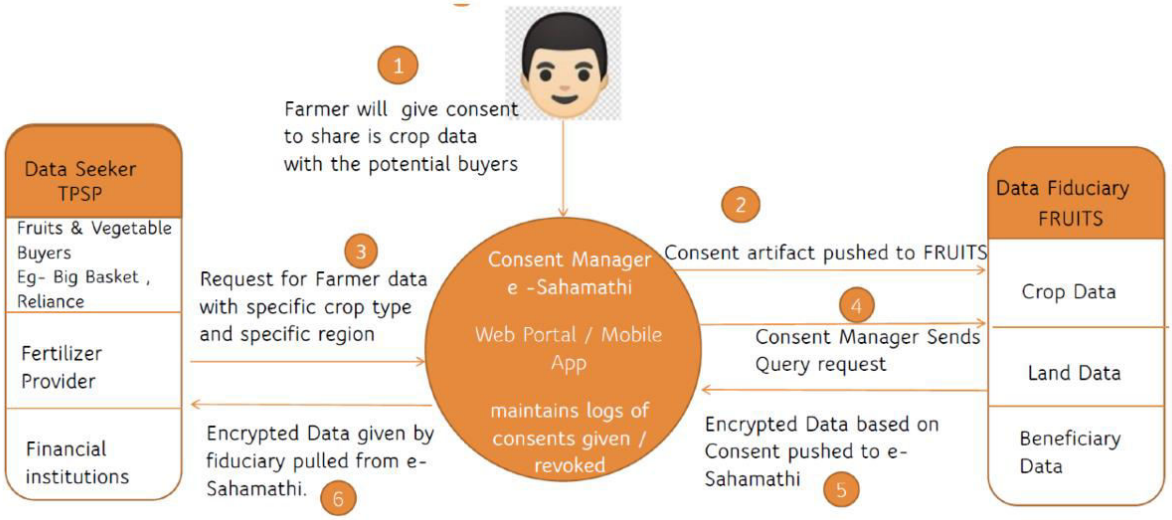

Indian agriculture is at a very interesting crossroads. Despite the complexities and diversities, we have a remarkable success story in agriculture. Production continues to grow, export markets for agriculture are strong, and domestic demand has become a huge opportunity. We also have an excellent foundation of institutions and one of the largest forces of human resources working in agriculture. The agriculture sector has progressed. But here is the challenge—the majority of farmers have not. The biggest question right now is how to give opportunities to the smallest of the smallholder farmers.[12,13]

Farmers in India or farmers in any country don't farm because they are interested in a country's food security. They farm because they are interested in income and profitability. But if you look at the history of large agricultural reforms in India, they have been farm-centric or production-centric and have not necessarily focused on income gain for the farmers. These reforms were extremely important at that time. But our systems are still set up predominantly for production-centric initiatives within agriculture. What is going to be needed is a shift from a production-centric infrastructure to a market-centric infrastructure and giving market access to smallholder farmers. This is the right shift at the right time, and farmers have been waiting for it. It will require moving away from business-as-usual and toward market orientation for agriculture—from agriculture as a welfare sector, to a business sector.

In terms of digital innovation, India, like elsewhere in the world, has seen the mobile phone transform the lives of rural households. Twenty years ago, only 10 percent of the population had any kind of telecommunication. Now, we have close to 80 percent of households with access to a cellphone. This technology revolution has been driven by the people themselves, and it is especially benefiting smallholders and the poorest of the poor. As one example, think about farmer-driven uses of digital platforms like Whatsapp. In Bihar, for example, 98 percent of the goat rearing is done by women, and these are the poorest of the poor because they can't even afford half an acre of land. Instead, they graze their goats. We know that they are using their cell phones now to upload photos of their goats on eBay-like sites to increase their potential market, where buyers can now be up to 700 to 800 kilometers away. They are fetching anywhere from 20 to 47 percent more per head for their goats. This is an illustration of how the new digital innovations, which we primarily think of as having created efficiencies for larger farming operations, have been also benefiting the very poorest farmers.[14]

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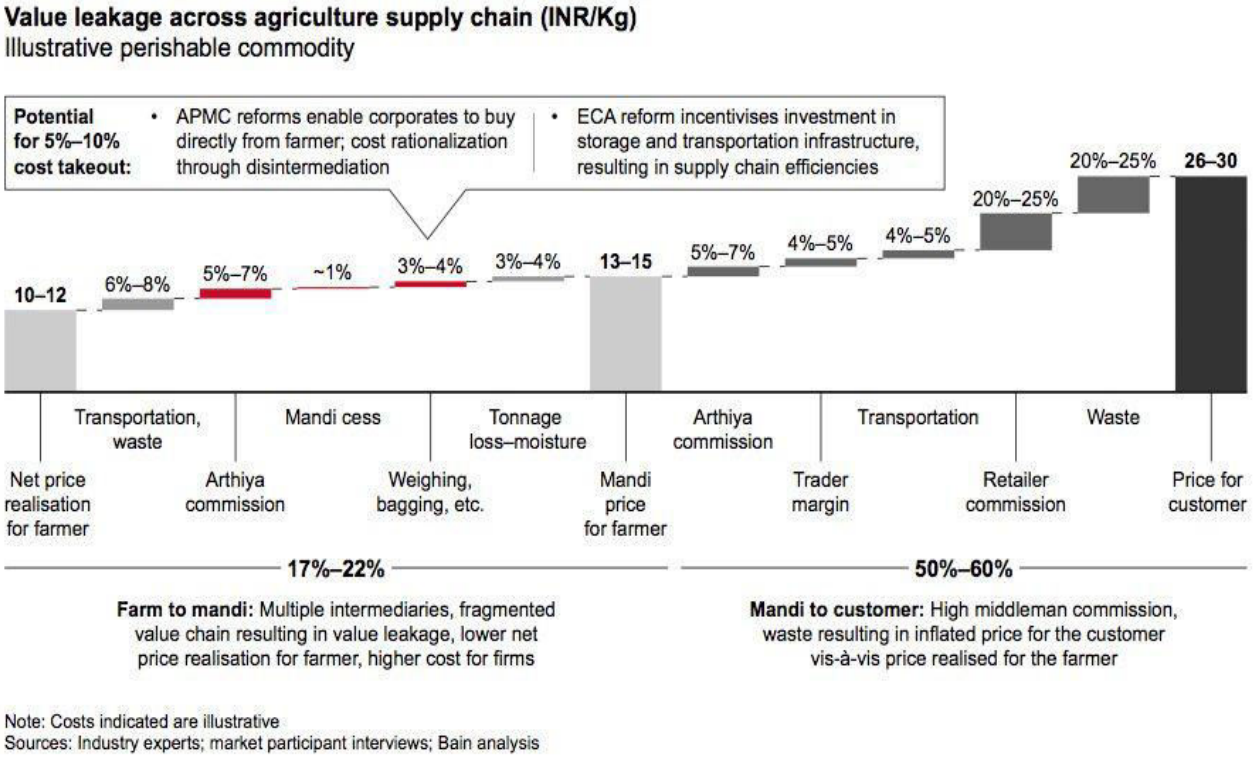

Note: Costs indicated are illustrative
Sources: Industry experts; market participant interviews; Bain analysis

As a second example, important impacts of digital innovation are being seen in the use of data to inform decision making, policy making, and operational efficiency of governments at both federal and state levels in India. Historically, most of the emphasis was on data collection, not data utilization, with a focus on production data. So, state-by-state, we have a tremendous amount of data, but we have gaps, and we aren't using what we have well. We have a lot of crop-cutting data, for instance, but we often don't know how much the farmer is earning. Ideally, we would have the data to understand a potential income gap, not just a potential yield gap. But in general, we are being more intentional about the data we need and how we use it to make good decisions. We are making the shift from "what data" to "data for what."

Farmer Producer Organizations (FPOs) have also witnessed some amazing growth in the last four or five years, in part building on digital innovations. The number of FPOs is growing at nearly 18 percent per year in India right now. This basically means farmers are realizing the benefits of aggregation—better access to inputs, better market-price realization. One of the biggest challenges of this kind of aggregation of farmers was lack of transparency within that group, and digital has kind of solved it in a way. We have fascinating examples of about 30 percent of India's FPOs selling their produce through electronic trading platforms.

Indian agriculture continues to remain on that crossroads, but I think the biggest revolutionary impact will come from making agriculture attractive. And agriculture will be attractive not because of its potential in the production and productivity or genetic gain; agriculture will be attractive because of the value it brings as a source of income for a very, very large number of Indian people for whom this is the only or a very important source of livelihood.[15]

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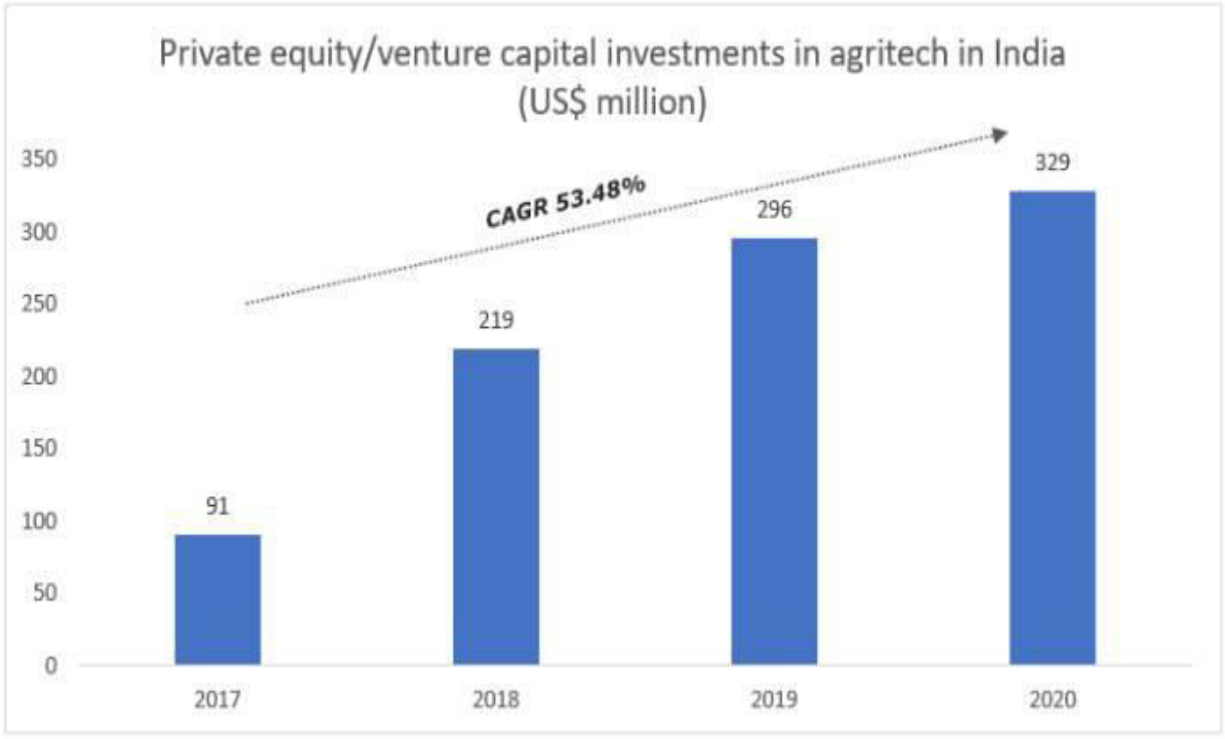

Source: Bain & Company

Results

There are several reasons why the doubling of farmers' incomes should succeed. In fact, I think if you are talking about net farmer income per square meter, you could well treble or quadruple it. The first reason is the private sector—seeking profits. Now, there isn't a sector as complex as agriculture, particularly Indian agriculture. In Indian agriculture, you are under-technologized, your lands are fragmented, and there's a strong nexus between economics and politics at the ground level. It takes bravery to jump in there and try and make some value out of it.

But this is changing. In the recent past, there was an undersaturation of investment in many areas of the Indian economy. Money found its way into software or cars or anything other than agriculture, because there was an ease of doing business and better returns. Now many other sectors in the country are flattening out their growth curves, and agriculture is finally finding its place. Another reason for success lies in the political imperative. There are only so many decades that you can talk about volumes of production. Eventually, when 60 percent of the working population says, "We are looking for fattening our own wallets," then the political imperative and the political dialog also change in that direction. Now, all these factors put together, we are seeing that in the last few years, it's becoming easier to draw money, draw technology, draw talent—the toughest being the last one—into Indian agriculture.

But there are challenges. Let's look at eNAM, for example. It's a laudable objective that has been well executed. But in spite of the alternative markets, the farmer is not exactly free to sell where he wants to sell. We need to remember that the farmer is in debt to the local money lender, and this governs the sale of the farmer's produce. The money lender wants price opacity, whereas the system wants price transparency. Also, even after the deal is struck through eNAM, the goods have to move, and the money has to move. In many places there is still a stranglehold of the trader. So, even though it's an excellent example of digital innovation having impact, we need larger penetration to break the nexus of the money lender.[16]

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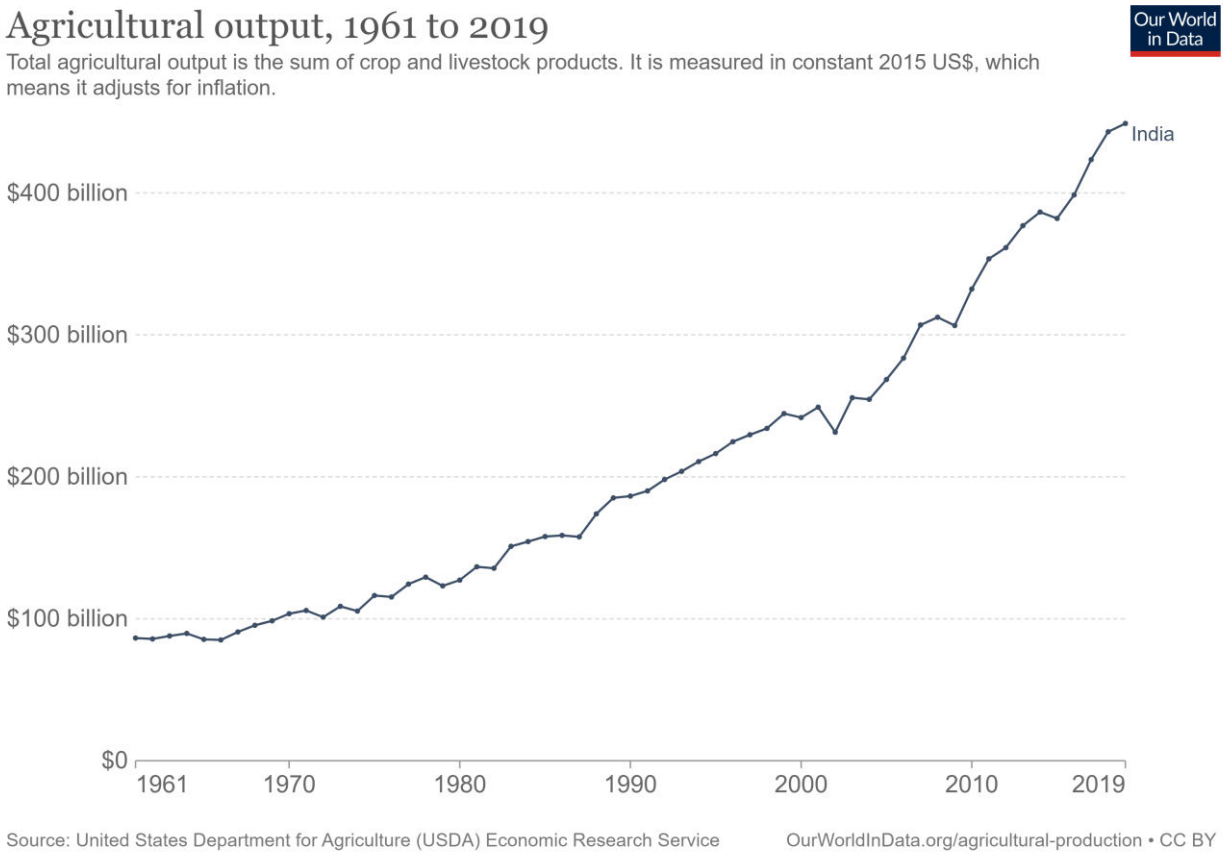

More generally, the impact of digital innovation on Indian agriculture will take time. Although we talk about mobile penetration rates on average across the country, the penetration of smart phones into rural areas is actually still quite low. It is increasing rapidly, but we may be several years away from scaling the types of services we talk about in these areas.

And there are other challenges. Consider our discussion about giving farmers better information for decision making. There are challenges in the transformation of content into local languages, and making it meaningful, not to a state, not to a district, but to that local area—for a particular microclimate or crop. Are we using digital platforms to give 30,000-foot knowledge or 100-foot knowledge? I think that's a major challenge. Also, there is the question of monetization. It is an expensive business to reach all of this to the farmer. Who's going to pay for it? This has to ride on other paid services. Go back to the cell-phone era: voice you were paying for, but some apps came free with it. So there has to be a monetizability. To me, this is a crucial question, Who's paying the bill? It costs a huge amount of money to get the apps going and to get the information going, put it into local content, make it into the vernacular, and then getting people used to delivering it.

But there's a ray of hope, and that is as follows: even if penetration is low, you will find every village with at least two or three smartphones. Now, the smartphone connects to the information, and then the word of mouth gets it out further.

So, I would say, even though digital innovation offers many opportunities, the devil's in the details, and the jury is out as to how long it will take.[14]

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When we talk about Indian farmers' incomes, we need to remember that there are different types of farmers. There are farmers who grow one single crop in a year based on some staple agriculture crops like rice and wheat—their income levels are quite low. There are other farmers who grow lots of fruits, vegetables, and so on, and their income levels are quite high. We should be ambitious to more than double the incomes of even the staple crop farmers.

We can improve farmers' incomes in several ways. First, increasing the total amount of production will increase incomes. For example, using irrigation, farmers who used to grow 30 or 40 tons of sugarcane, let's say, per acre, now are growing 80 tons of sugarcane. That extra 40 tons of sugarcane from the same amount of land with less water gives them a substantially higher amount of income. The same goes with cotton, bananas, mangoes, and so many other products.

Maybe half of India's farmers are growing one crop based on one single rainy season—what we get in the monsoon. The government is spending a lot to create water infrastructure so that these farmers who have access to only rainwater can also get additional access to water in the second season so that they can grow a second crop or do a perennial crop. This will substantially increase the income of these farmers because their land remains fallow today.

Second, we can increase the efficiency of farmers. There are other farmers who already do have access to water, but they are not growing efficiently. They do just flood irrigation. They just throw the fertilizer. With the introduction of precision-agriculture technologies, those farmers can improve their productivity quite a lot.

The third way is to capture more of the value in the value chain for the farmer. Today, the total value given to the farmer is maybe 15 to 20 percent compared with the price at which it is being sold to the consumer. But you can increase the value retained by the farmer. For example, we worked with farmers where we have given them knowledge of seeds or irrigation technology, and we agreed to buy back whatever they grow. We try and ensure that they get at least 50 percent of the finished-goods price, what we sell. It has been very successful. At scale, changing how smallholder farmers engage in markets requires changes in storage infrastructure, transportation, logistics, and market connectivity. So, there are different ways you can ensure the doubling of farmers' income. It's possible, and it will happen.[15]

Digital will play a key role. When you create a platform that farmers can use to get this digital knowledge on their cell phone, when they know how much they produced, how much they have sold, how much has come under cultivation—when they can see all the data in their own language on a cell phone on a real-time basis—that is when the change starts taking place. That's when you start feeling, yes, it is doable. India will always have a large number of small farmers,

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but small farmers can bring about a big change. They can be profitable, productive, and progressive—all three put together.

The mobile revolution will help scale digital innovation, but we need the physical infrastructure to go along with the digital. That's where I think there's a little bit of divergence. Because physical infrastructure is not moving on as fast to support the digital innovations that the farmer would like to use.

For example, in one project in Karnataka, we had an integrated irrigation project, where we put wireless sensors measuring the level of moisture under the soil, supporting the decision to irrigate. Here you have both the digital and the physical infrastructure working together. These are often solutions that work when, let's say, you have 25,000 acres of one single area where you want to manage. But where there are small farmers all over the villages or larger areas, then it becomes that much more difficult to pair physical infrastructure with digital innovation. I would say, there are tremendous opportunities for digital ahead, but one just has to see—how do you reach out to all these farmers to make it a viable and cost-effective solution. That's the challenge.

Conclusions

In India, a digital agriculture mission has been initiated by the government for projects based on new technologies like artificial intelligence, block chain, remote sensing and GIS technology, use of drones and robots etc.
Modernisation of the agriculture sector will continue by infusing new technologies so that farmers can increase their income, according to Agriculture Minister Narendra Singh Tomar. His ministry recently signed an MOU for pilot projects with CISCO, Ninjacart, Jio Platforms Limited, ITC Limited and NCDEX e-Markets Limited (NeML).
Based on these pilot projects, farmers will be able to take informed decisions on what crop to grow, what variety of seed to use and what best practises to adopt to maximise the yield. The agriculture supply chain players can plan their procurement and logistics on precise and timely information. Farmers can take informed decisions about whether to sell or store their produce and when and where and what price to sell.
Any attempt to transform agriculture sector needs to imbibe an ecosystem thinking and a digital ecosystem. The agriculture value chain extends from crop selection to crop management and the market; it involves public and private players in agricultural inputs and services and logistics.
Establishing a digital ecosystem of agriculture needs to take a long-term view of aspects like interoperability, data governance, data quality, data standards, security and privacy, besides promoting innovation.
A significant requirement is adoption of a decentralized, federated architecture that assures autonomy to the service providers and all other actors and ensures interoperability at the same time.
Recognising the importance of digitisation in agriculture the department is creating a federated farmers database and building different services around this database so as to build Digital Ecosystems of Agriculture.
Federated farmers' database will be linked by the land records of farmers from across the country and unique Farmer ID will be created. So far, the database is ready with details of around 5.5 crore farmers.[16]

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