

TRANSFORMING INDIAN AGRICULTURE THROUGH DIGITAL INNOVATION

Panel Moderator: *Marshall Bouton*

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Panel Members

Ashok Dalwai	Chairman, Committee on Doubling Farmers' Income & Chief Executive Officer
Anil Jain	Chief Executive Officer, Jain Irrigation Systems Ltd.
Rohtash Malawi	Chairman, EM3 AgriServices
Purvi Mehta	Senior Adviser & Head of Agriculture, the Bill & Melinda Gates Foundation

Panel Moderator

Marshall Bouton

President Emeritus, Chicago Council on Global Affairs

That was an excellent overview of Indian agriculture today. And I am delighted to be back at the World Food Prize and to have this great privilege of moderating this panel. I want to thank Ken Quinn, my good friend, number one, for what he has done to make the World Food Prize and the Borlaug Dialogue the best global gathering of global food and agriculture anywhere in the world. And I know you all agree with me on that point. And I'm so pleased Ken has given us this chance to bring India into focus at this remarkable forum.

I also want to express my very deep appreciation to the two other organizations apart from my own that have been absolutely critical to putting this panel together, thinking through how we wanted to approach it, and supplying the structure and the advice, i.e., McKinsey and Pradeep's colleagues in Mumbai and elsewhere in the world or in Seattle and so forth, have all been enormously helpful. And the other is the Chicago Council on Global Affairs, my former organization, which is also a wonderful partner. And both organizations are leaders in thinking about global food and agriculture.

We are joined today by four superbly qualified panelists, all of whom have come either directly from India or from some other very far away location to be with us today to help us delve into these issues a little more deeply. To my immediate right is Ashok Dalwai, the chairman of the Committee on Doubling Farm Incomes in Delhi. Purvi Mehta immediately to his right. Purvi Mehta is the Head of Agriculture for Asia at the Bill & Melinda Gates Foundation. Anil Jain, the CEO of Jain Irrigation Systems, which is, despite the name, not only does irrigation, supplies irrigation to millions of Indian farmers, but also is in commodity processing. And last but hardly least, Rohtash Mal, who is the founder and Co-Chairman of EM3, which you saw listed

in Pradeep's slide there, which actually supplies farm mechanization services also to hundreds of thousands of farmers. We regret that Andhra Pradesh Minister Nara Lokesh who was originally on the program could not be with us today. Minister Lokesh had to attend to cyclone relief duties in Andhra Pradesh, obviously very important. And we miss his presence but understand entirely and wish him well in those important responsibilities.

So we're going to begin by asking our panelists to talk a little more broadly in tune with the presentation you just heard about the transformational opportunity that exists today in Indian agriculture. And then we'll turn to deeper dive on some of the potential digital solutions in Indian agriculture and especially as they apply to a variety of challenges for Indian agriculture.

And I'd like to begin with Ashok Dalwai and ask him about this shift to a focus on farmer incomes. This was announced almost three years ago by Prime Minister Modi's revolutionary at the time, because for decades India has focused entirely on increasing production in order to assure its own food security. So shifting the focus to farmer incomes is enormously important, and we all salute it. And that is now the responsibility of figuring out how that is to be accomplished has been the responsibility of this committee, that Ashok Dalwai has pushed here. So I'd like to ask him to tell us more about the drivers behind this shift to increasing farmer incomes and what you see as the potential of it and also some of the obstacles.

Ashok Thank you very much, and let me begin by thanking Ambassador Quinn for putting India on the stage here. And I would also like to begin by saluting the village boy from Cresco, Norman Borlaug himself, who was a harbinger of change in India in the 1960s. And the new revolution that the Prime Minister of India initiated is actually carrying the baton from Norman Borlaug that began in the 1960s.

All along in India agriculture has been welfare centric. What started as a response to the food deficiency in the 1960s, it actually traveled very well. It not only conquered hunger in India and achieved a status of food sufficiency, but we are not at a stage we are able to export any quantity of food that the world may require.

As they say, success is its own enemy. So we're now at a stage where the high production resulting in surpluses across several sub-sectors 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 we see the scenes where the farmers who are not able to get good prices because of excess surplus have now begun to protest on the streets by pouring out the milk on the streets of Uttar Pradesh, or potatoes on the streets of Banjara in Andhra Pradesh, or dance out in Maharashtra.

So the story is that we now need to bring an equilibrium between the demand and supply. And as we do this thing, we have to keep the markets in mind. 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. So in this process, what you call income revolution – that means we now take a step away from green revolution or the white revolution that refers to milk and talk of 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.

So the basic tenets of all of this would be that we would now like to diversify and fulfill those deficiencies where the farmers are able to get better prices. We diversify such that the sustainability factors are taken into account. We then reduce the supply of those commodities where due to gluts in the market the current model works and the farmers suffer from low prices.

So we are now talking about income revolution, or increasing the farmer's income. What we essentially are meaning now is the farmer should be able to realize better purchasing power, improve their welfare. And we are convinced that the welfare of the farmers, or any community for that matter, is in realizing higher income so that their dependence on government reduces over a period of time. And the welfare centrality of agriculture, which was looking at consumers so far, and the farmers themselves were a component of this consumer class, has to now be farmer centric, that the farmers have to be entrepreneurs. So we would like to shift the production basis to the enterprise class.

If we want farmers to become entrepreneurs, then they must realize net positive returns, and the net positive returns will come based on three variables: increase the productivity per unit of land, per unit of cattle, per unit of fishbowl, and view that as cost efficiency, because that's very important. And the third most important is – how do you monetize this thing. So these are the three variables that our country and government have been working on to improve the incomes of the farmers and also to improve the welfare of the farmers.

As we do this, we also have learned the lessons of the Green Revolution. That the revolution was based on a technology that was extracted by nature has to be also addressed. So sustainability is very important. When we talk of sustainability, we would like to have natural resource management practices that has to resource the sufficiency of soil, water and other factors. And various initiatives the government has already taken are all towards this. And all this new technologies which are machine-based are being linked to digital technology; because unless we have digital technology linked to the machine-based technology, we would not be able to scale it up, we would not be able to have real-time data and real-time advising.

So finally I think I'll end up by saying risk management is so important, agriculture being a biologically driven process is risk-prone at the production stage and because certainly it is in the post-production and it is highly market disoriented. And therefore technology, digital technology is required for the production stage and the post-production stage. And that's where we begin the income revolution. Thank you.

Marshall Thank you very much. Purvi, I'd like to ask you – How is this shift to a focus on farmer incomes from production, how important is it to smaller, marginal farmers? We've heard that 80% of India's farmers operate holdings of under, roughly four acres. So does this matter to them? And if so, how?

Purvi So I think from a farmer's perspective, this is the shift that they've been waiting for for a very, very long time. Farmers in India or farmers in any country don't farm because they are interested in country's food security. They farm because they are interested in income and the profitability. And India, as we all know and you're

paying tribute to Norman Borlaug for that as well, you know, having shifts and transformative reforms in agriculture is not a new thing for the country. We have had several of those reforms. Many of them have really transformed the country and its food production basket, Green Revolution being one, taking up of a very large number of R&D centers and extension networks and education institutions. There have been several reforms.

But if you look at the history of all these large agricultural reforms in India, they have all been farm centric or production centric and have focused on genetic gain and not necessarily on income gain for the farmers. So Green Revolution focusing on food production, bringing that food sustainability and surplus, as you mentioned, Dr. Dalwai, was extremely important at that time. But as we look at the shift, this is the right shift at the right time, and farmers have been waiting for it.

When you said doubling of farmer income by 2022, what does it mean to a smallholder farmer? The average farm income right now is \$1480 per year in India. We are talking about basically taking that to \$2900 to \$3,000 U.S. dollars per year. Where will that come from? That will not necessarily come only from increasing production or productivity and efficiency on the farm, it will essentially come from realizing better prices. Because again there is a distinction before farm income and farmer income.

So the farmer income will come from better price realization. And our systems are set up very well for, or predominantly for production-centric initiatives within agriculture. What is really going to be needed is a shift from a production-centric infrastructure to a market-centric infrastructure and giving that right market access to smallholder farmer. So I think that the shift is very welcome. It of course is something that the farmers have really, really welcomed. But with that shift we will also need shift in the business as usual and making that shift to very, very market orientation and shifting from agriculture being a welfare sector to a business sector.

Marshall Excellent. Thank you. Anil, I'd like to then ask you from a private sector perspective and with the broad sweep of your experience in Indian agriculture, your company's experience, what do you see as the principal both opportunities and challenges of this shift to a focus on farmer incomes? If it's going to work, and I don't think any of us is holding the prime minister to the "doubling farmer incomes by 2022." That was an inspired suggestion but very difficult to achieve but absolutely the right change of emphasis. What do you see as the challenges and opportunities?

Anil I think it's a very big opportunity as a country. But first when we talk about India and then agriculture or farmers' income, 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. And there are other farmers who grow lots of fruits, vegetables and so on, and their income levels are quite high. To double those farmers' income who are already doing well is not going to be that easy. But with right infrastructure return policies, the farmers who are just growing crop and doing staple crops, their incomes can definitely be substantially increased. And there you should be ambitious to actually more than double the farmers' income, not just double, because their base level of income is quite low.

Now, this can be achieved, and this we have seen in our experience three or four ways:

One, through increasing the total amount of production. For example, using our products and technologies. Farmers who used to grow 30 or 40 tons of sugar cane, let's say, per acre now are growing 80 tons of sugar cane. And that extra 40 tons of sugar cane from the same amount of land with less water gives them substantially higher amount of income. And the same goes with cotton, bananas, mangoes, and so many other products.

The other way is that the value chain where you take these farmers produce to the end consumer, today and traditionally, is that, if whatever the farmer is producing, by the time it is in consumer's hand, the total value given to the farmer was hardly 15, 20% compared to the price at which it is being sold to the consumer. I think one need to clear that structure that at least 50% of the value is retained by the farmer of anything that is sold to ultimately to the consumer. And then that could automatically also increase the return that the farmer gets. And I give you an example where we worked with farmers where we have given them knowledge of seeds or irrigation technology, and we agreed to buy back whatever they grow. And we try and ensure that they get at least 50% of the finished goods price, what we sell. And it has been very successful. These farmers now have a nice home, maybe a motorcycle; their kids are becoming engineers. That level of transformation has happened literally with thousands of farmers where they are properly connected into a right value chain.

Coming back to the larger scenario in terms of challenges to double the farmer's income. If we really think, in India that we have 114 million hectares of land under cultivation and about 120 million cultivating that. Half of those farmers are growing only, let's say, one crop based on one single rainy season what we get in the monsoon. Now 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, which requires like orchards or whatever else. Now, that would substantially the income of these farmers because their land remains fallow today.

The second part is that the farmers who have access to, let's say, water to do a second crop or perennial crops, they're not growing that efficiently. They do just flood irrigation. They just throw the fertilizer. That is not what is called "precision agriculture." And with the introduction of precision agriculture technologies, I think those farmers can improve their productivity quite a lot and therefore their income.

The third part is the infrastructure where, because of lack of storage infrastructure – transportation, logistics, and lack of market connectivity – a lot of farmers lose their produce or do not get the right value for that produce. And if you can adjust that part or solve that issue for the logistical and infrastructure solutions, I think you would be able to also create additional income. So there are three different ways you can ensure the doubling of farmers' income. It's possible, and it will happen.

Marshall Okay. Rohtash, your company as well as your company..., the enormous success of private sector success in Indian agriculture, and in your case built from the ground

up, literally, as well as figuratively. Could you share with us what it takes today for a private sector enterprise to be successful in Indian agriculture, why we hear often that private sector investment in Indian agriculture has been sluggish at best. Why is that? What are the special barriers? What do you think can be done to get more private sector investment and involvement?

Rohtash Huh, so firstly a comment to a comment. I think our prime minister undershot the doubling farmers' income. It depends on the definition. If you're talking about net farmer income per square meter, you could well double it and quadruple it. But a mere small increase on the topline, a mere compression of the middle line yields doubling or tripling at the bottom. Right? So we may well surpass this doubling farmers' income story.

But to your point, look, there are two reasons. Number one, money seeks money. Private sector seeks profit. There isn't a sector as complex as agriculture, particularly Indian agriculture... Now in a situation where in any case you are under-technologized, your lands are fragmented, 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. A) It's complex, and B) it's complex because of the ground level management situation.

But even while that is changing over the last couple of years, and I think the government has been making the right sounds, the right imperatives to make that happen. Second, in a country where there was at one point of time in the very recent future, very past, almost an under-saturation in every area. If you talk software or cars or anything else, money found its way there – right? – because the returns were better and there was an ease of doing business and so on. Now that a lot of other sectors are also flattening out their growth spurts, we are moving towards agriculture as... In fact agriculture, education, etc. are major opportunities, and agriculture is finally finding its place.

The third is the political imperative. There is only so many decades that you can talk about volumes of production. Eventually, when the working population, 60%, of that population says, "We are looking for fattening our own wallets," that the political imperative and the political dialog also changes in that direction.

Now, all of these factors put together, we are seeing a situation for the last few years that's it's becoming easier so to speak to draw money, draw technology, draw talent – the toughest being the last one in Indian agriculture.

Marshall Excellent. Thank you. I'd like now to shift our focus to digital innovation. We've all decided that we want to think about how these tools can be applied to solve some of the problems of increasing farmer incomes and to open new vista for farmer incomes.

One of the areas in which this has begun to happen is in the marketing sector as farmers seek better prices for their products, more efficient ways of getting their products to market. And I'd like to start again with you, Ashok, and that is to ask you to speak about the prime minister's announcement of a new proposal for an electronic national agricultural market, a very radical, visionary approach to this,

which, despite it seeming that way, has been a focus of a lot of attention and certainly the government's attention. And this is in a context in which 70% of Indian farmers today market through informal intermediaries, whether at the village level or on up into established marketplaces. Can you tell us a little bit more about the so-called eNAM approach and what it's comprised of and the success it has had and what obstacles it has encountered?

Ashok Yeah, I think I should start by saying there are certain structural weaknesses that even agribusiness suffers from and apart from the smaller marginal holdings that Indian agriculture is defined by. But yet still holds a challenge of scarce economy. Marketing is not a very important structural weakness. And as you yourself have said that intermediaries have been doing the markets. Since '60s we introduced the reforms and set up organized markets called APMCs, Agriculture Produced Market Committees. Unfortunately, these have been wholesale markets, and we never understood that the small, marginal farmers who produce small lots could not access the wholesale market by themselves, apart from being at a distance of nearly 50 to 60 kilometers from the farm gates.

So now what we have been focusing is to construct a new market architecture whereby we'll have the foundation of the retail agriculture markets within the proximity of five or six kilometers from the farm gate. Then they feed the wholesale markets called APMCs, and thereafter we also link up with export markets, because surpluses have to be evacuated from Indian territories.

But what is more important is classical market economics, all these talks about integrating the markets. The physically disposed markets have been degraded, unfortunately, in India, constitutionally. Agriculture, including agriculture markets are the State subject. And therefore just as lands have been divided by density of population, Indian markets' face has been divided by these APMCs. So now the only way to integrate these physically disposed markets that caused a huge territory in India is to virtually integrate them, using the electronic technology. So the Electronic National Agriculture Market (and for short, eNAM) tries to integrate the physically disposed markets such that the universe of players increases.

What we have seen over the last 50 years since the APMC came into existence is that the traders or the commission agents working within a particular APMC had developed monopoly practices that catalyzed themselves. Though the access that we need to physically and transparently disclose the prices of farmers produce, the catalyzed such that the farmers were not getting benefit of transparent pricing.

So now with the virtual integration of one market and another, I don't think in the state or across the state within India. Then the universe of players increases, the players begin to transparently pay for the lot, and this is what is eNAM. However, just as the APMCs became monopolies in the name of eFarms, we do not want eNAM to be also a monopoly. We have therefore said both public sector organizations and private sector organizations can set up their alternate marketing channels. There can be any number of alternate online pay platforms. It is the government that is taking the initiative of promoting this eNAM, but validly there's one private sector market channel working on other states. And we want such

alternate channels to come up. When the markets start getting integrated, then we will see that the price discovery happens.

And I'm happy to share with you that over the last two years since we introduced this, out of 2,780 AMPCs that we have in the country, as many as 600 markets are already onboard onto the platform, and 150 markets on the alternate private sector marketing channel. And now we are targeted another 400 markets to be on board within the next two years. So we have a thousand markets on board. We are already seeing that catalyation has begun to break down, and that is the key performance indicator is, how many bits] are made for every single lot of the farmer. We have seen an average in the country today wherever onboarding has happened, the bits have increased from 1.8 per lot to 4.8 number of bits per lot. That is when there is competition, the price is certainly going to be better and to the advantage of the farmer.

Now, going a step forward, we want to now bring this electronic integration to the retail agriculture markets, and we hope for the next 5 to 10 years to set up 22,000 number of retail agriculture markets in the country. We already have traditional, conventional markets, we have periodical markets. We would like to use this particular space to set up organized retail agriculture markets, and then they become the foundation. And incidentally, it was the Royal Commissioner in Agriculture in 1928 which talked about assembling once for the smallholder farmer. And it has taken so many years for us to think and do that. I guess every idea has got its own timeframe.

Marshall Rohtash, I'd love to hear your thinking about the eNAM proposal and whether you think it can succeed and what are its potential pitfalls as well as its promise.

Rohtash So eNAM... Firstly, a very laudable objective, and it's been very well executed. Compliments to the government on that. It has to face a few challenges. The gridlock that exists as the farmer, in spite of these markets, is not exactly free to sell where he wants to sell. Let's remember that this farmer is in debt to the local money lender. The unstated rules of business is that the money lender needs to be sold the produce to, and then the produce is practically in control of the money lender. The money lender wants price opacity, whereas the system wants price transparency. So there's already a tension built in, so to speak. Not to take an iota away that the power structure is being chipped at almost on a day-to-day basis, and this is the right way to go.

Now, the second challenge that we are going to face is – Having the transaction fulfilled, once the deal is struck, the goods have to move. Once the goods move, the money has to move – right? And on the ground we are still facing problems. Like just last week I was in the apple-growing area of Himachal Pradesh. Now, while on the ground and the plains, a lot of this is happening for the commodities and for a crop which is absolutely valuable, like apple. I didn't see a single piece of evidence that stranglehold of the trader having gone down by even a fraction of 1%. The prices at the farm gate and the orchard gate was 8 rupees a kilo for finest variety of apples, and it reaches my table at 118 rupees a kilo – right? Somebody's chewing up that value in the middle. So, a) excellent initiative; b) it's on the right track; c) penetration has to happen; and d) in order to break that nexus between money, the

money lender and so on, another major initiative of microcredit, which digital will help solve, and it is beginning to appear.

Until a few forces like that come in, we might not see the acceleration we want to see, but overall in the areas that it has gone, the number of markets on board, it's a great achievement. But now the intensity of creating has to come in order to benefit the real, the real guy, and the farmer himself.

Marshall Thank you, thank you. Now, Purvi, I'd like to turn to another area where the effort and digitally enabled effort is to give farmers more transparency, more market power, not only in selling their products but also potentially acquiring inputs and so forth, and that is a producer organization, known in India, the acronym is FPOs, Farm Producer Organizations. And a number of these are starting to come up, and they seem to be quite promising. Could you tell us more about your perspective on that as a mechanism, especially with the digital enabling that could work over time and spread?

Purvi So, yeah, as you said, Farmer Producer Organizations, they have witnessed some amazing growth in the last four or five years, Marshall. The number of FPOs, the Farmer Producer Organizations' growing is almost at the rate of 18% per year in India right now. FPO basically means aggregation of farmers, on an average 1200 farmers coming together and forming an organization. And therefore, rather than acting as individual farmer whose scale they always complained about, we now have 1200 farmers, which essentially means about 1500 hectares of land coming together as one unit. And smaller the farmer, less advantage the farmer, including women farmers, for example, they are getting attracted more towards the Farmer Producer Organization.

It has shown a lot of very, very interesting lessons but mainly benefits. The way it changes the entire dynamic for the private sector and for any others is, rather than one individual farmer going out there in the market, buying half a bag of *uria* and taking, say, 20 kilos of their produce to the market, we now are having farmers going out there and buying one truck of *uria*, which means they have better agency, better negotiation, prices. The input cost is coming down to as low as about 30 to 40% saving because of that negotiation power. And when they are producing, they are taking anywhere between 100 to 150 tons of produce to them, which means again the price realization goes up. In our experience in some of their fields that we have in a place like Bihar, the price realization, rather than going individual farmer to FPO has gone anywhere between 28 to 33% higher price realization just because of the scale. So suddenly that smallholder farmer with half an acre of land or one acre of land becomes a serious player in the market. And that gives a huge advantage and huge agency.

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% of India's Farmer Producer Organizations are selling their produce now through electronic trading platforms. So for example the National Commodity Exchange or eNAM or so forth. About 70% of the FPOs are getting credit, you know, the farm credit for their produce through digital services. So fascinating things happening.

And one of my favorite examples of that is... And again it just shows how the revolution, the cell phone revolution and how cell phone is becoming one of the most important farm equipment. And this is in a matter of five years that it has changed that dynamic. My favorite example – and I've written about it, so some of you may have read about it – are women goat holders in Bihar, the poorest of the poor farmers, clicking the pictures of their goat with their little cell phone, uploading them on eBay-like Indian site, OLX, and getting their price realized as high as more than double for the goods.

I mean, it's fascinating what is happening. What is important now is how fast we, as a development organization or public sector or all of us sitting here can tap into it.

Marshall Anil, I know you've been dealing with some Farmer Producer Organizations or their analog in your own company. What is your experience of their success and their challenges?

Anil I think in terms of success, while it's still nascent, the whole process, and while the total number is quite large among the FPOs, but the really successful FPOs are still, you can really major maybe about 100 to 200 only across the country. And some of them have done very well. Some of them are actually exporting their produce also and so on. Where they get a stronger leader and organizer who can help them to bring together all their thoughts and different ideas. And if they can circulate and manage better, it is providing good solutions. But if it does not, then it becomes an amalgam of people wanting to come together with right intention, but they don't have good outcome. So I think it's very important that they get this professional help in one, buying things or negotiating on how to sell.

But also, In India this whole cooperative moment where people come together usually has been thought process as the okay you're going to have elections, somebody is going to get elected and so on. And then politicking starts, and you lose all the major focus on economics. And I think having professional supporter, somebody who will manage them, is what is going to create the big solutions. In terms of our own experiences, we have actually worked with the farmers to create kind of somebody who can come together to create a platform that they can use as they get this digital knowledge, all of them on their cell phone, they know how much they produce, how much they have sold, how much has been come under cultivation, and what level or steps they are. And when you have that sharing of the knowledge and they can see all the data in their own language on a cell phone on a real-time basis. I think that is when the change starts taking place. That's when you start feeling, yes, it is doable.

And otherwise farmers are very productive. You know, they're entrepreneurs they are business owners – they don't want to give up their land, they don't want to give up ownership of the land. And that's when there's a really unique example where small farmers are bringing about a big change. And it's not going to change, and they won't always have a large number of small farmers, but still they can be very profitable, productive and progressive, all three put together.

And in terms of learning about technology, accepting digital innovation, we have found the farmers who are illiterate or not educated are not really going out of their

way willing to learn to use the cell phone perhaps, and so on and so forth, and they're ahead of , if you want to compare them to city folks sometime.

So in terms of challenges, it's about provisionalization and getting the right type of management structure around these – when you come together as an organization, that's a challenge. But this is the only way Indian farmers can move forward, because I don't think... The time has gone where a usual farmer wanted to do it, because then they're not going to say why. And this is the way they can say why we do well. And it's happening, but this is going to take some more time.

Marshall Thank you very much. I'd like to shift now to productivity. We've focused a lot on the marketplace and the commodization of farmers' produce, but let's back up to productivity issues, because they're also potentially very important. Digital applications, to improve productivity and particularly again Ashok, I'd like you to briefly if you would talk a little bit about some of the technologies that your government has been supporting to improve productivity, such as accessing technology and monitoring soil health, helping farmers manage weather risk. Could you tell us a little bit more about some of the initiatives in that area? And then I'm going to turn back to Anil for a brief comment on that.

Ashok Yeah. I think India is very, very clear that digital technology is the present and the future. We have a competency policy called Digital India, which addresses all sectors of the economy. And there's one particular pillar of this policy, called NEGPA, National Electronic Governance Program for Agriculture. And in NEGPA the focus is to begin with basic ICT and hear what different segments in regard to people who access the digital infrastructure – that means they can access the websites and eb portals. Then we have got people with a large number of smartphones so that we have mobile applications. Or the third category of farmers who have basic phones, and therefore they can access the advice only through the short] messaging services, SMS. And the poor do not have as yet access to the telephoning. They can access the services through what is called toll-free numbers, or in India we call it Kesan service, Kesan call center. The farmer call centers. So these are the four avenues through which we are able to reach all the farmers.

And I must share with you that a large number of digital technologies have actually been scaled up. In a country with 130 numbers] and 1300 million population with 48% dependent on agriculture, when we talk of scaling up, what we mean is that when you are able to achieve, let's say, 200 million numbers within two or three years, I think it's a great tribute to the technology and the technology purveyors. Like for example, there is the soil health. . As far as productivity is concerned, one of the ways that we now try to bridge the ease gap between the technical and economically feasible ease and the farmers ease, we have realized there is a gap to be bridged. We would like to do it with cost efficiency, and that means that, particularly the soil and water, which are the basics of the natural resource management, have been used efficiently.

So India has now drawn up and has rolled out one of the most massive soil health management system of anybody in the world. All the farmers in the country today get their soil samples tested once in two 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. And then he's able to now add, take up balanced nutrient management, whether it is agrichemical fertilizers, organic manure, or soil amendments like gypsum. All of that it does according to the nutrition demand. And we have found, a study conducted already has shown wherever the farmers have taken the advice seriously, the reduction in the fertilizer consumption has come down without compromise of the productivity. In fact, the cost of cultivation on account of good soil health management has been to the extent of 8 to 10%, and the productivity has simultaneously increased by 10%. And this shows that in every crop segment now, where they have this evidence-based soil health management, the farmers are going to benefit.

So likewise, it is only with the weather forecast, for example, we have now rolled now... There are a few states in India have article rolled the large scale weather forecasting. And one thing in the study shows that wherever the weather forecast advisories were shared and utilized by the farmers, compared to the country farmers, they were able to reduce the risk and the risk-associated loss by 5 to 10%. And Karnataka is an outstanding example, which is one of the eighty capitals of the country. And we now are coming, for the coming season we will be taking up what is called "price forecasting." We realize that one of the ways to negotiate the risk on the marketing side is to advise the farmer on the price and demand forecasting. And the price forecasting based on the statistic of the variant model, is possible. We can have as good correlation as 95% between the forecast price and the actual market price. And for the coming next season, the next year season, we will be graduating from the uni-variant to the multi-variant model. That is the weather that can be brought in. The pest and disease data can be brought in. So along with the market price forecasting, the multi-variant forecasting could actually help the farmer to take the production decision. If a farmer can take a production decision, then I think you would be able to bring that industrial mechanical process of controlling the supply. And then assuming his supply along with the demand that is expected. So I think there are lots of opportunities. And we actually are now looking forward to using a large number of digital technologies both at the production phase as well as the post-production stage. And for the third one, most important, is the pre-production stage. That means the weather forecasting, given the climate change implications where the plain, which is the food basket of India, is expected to experience a temperature rise of 1 degree Celsius. When in fact the beef price, we need to have very strong forecasting of weather, and we are going to base on that.

Marshall Thank you. I'd now actually like to pose this same question to both Anil and Rohtash, whose companies are on the ground all over India in various crops and various regions. So what are the challenges facing scalability? Chairman Dalwai as you said at the outset that a couple hundred million may not sound like anything but scale in the United States, but in India it's, you know, maybe. But what are you seeing as the practical obstacles to achieving scale with digital innovations?

Anil I think in terms of scale, right, in India everything is the large numbers. The mobile revolution has been very big, and I think that's going to help to scale this up quickly and fast enough. And we have seen using — you've talked about productivity — using precision agriculture whether the right irrigation, you want fertigation or nutrition if you provide to the plants it results into high level of productivity. And it has

worked structurally well, but this digital innovation, digital inputs, they need to go along with the physical infrastructure. And 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 the farmer would like to get done. And where you are able to create both, so for example the incentivized individual [?] project, integrated irrigation project, where we are putting radio telemetry wireless sensors. Where one example, to see the level of moisture under the soil and then accordingly decide to irrigate, farmers have great higher level of productivity, and because everything is structured in that, let's say, 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.

Other, as well, when farmers decide to get together and get that information – and it's not merely information because a lot of people are just sending SMS's or whatever – but farmers are unable to link that information and convert that into knowledge. And I think once you are able to back up digital inputs along with knowledge transfer to the farmer where that information becomes knowledge, and that's the, I would say a challenge that the faster we do that, then we'll have faster the implementation success.

Rohtash I'm going to echo what Anil is saying, but in a minute. So a couple of challenges first and foremost. I think the devil is in the details when we talk about numbers of cell phones and penetration and so on. If you're going to segregate that into farming sector and non-farming sector, rural this that and the other, the penetration of smartphones is actually quite low in the rural area. It's increasing. It's increasing very rapidly as the price of instruments is going down, but that is a challenge. And we may spend two, two and a half, three years, to your point, Ashok, that that is going to happen.

Second, what is it that you are writing on the air waves? Right? Information? What does information do? To your point, it has to reach a decision. It has to... You know, you said knowledge. I'm thinking, what's the decision he's going to take? Third, the transformation of content and information into local languages, meaningful, not to a state, not to a district, but to that local area. Right? It has its own microclimate. It has its own crop. It has its own complexities. So are we giving 30,000 foot knowledge or 100 feet knowledge? I think that's a major challenge.

And lastly, I think we are really talking about... I like to use the word monetization. Look, this is expensive business to reach all this to the farmer. Right? Who's going to pay for it? So far, unless this rides on other paid services... Go back to the cell phone era, right? The price you were paying for, but some apps came free with it. So there has to be a monetizability, so to speak, of a lot of this stuff, of this knowledge and practices and so on and so forth.

And to me, the last one is the most crucial one. Who's paying the bill? It costs a huge amount of money (a) to get the apps going; b, to get the information going, put it into local content, make it into the vernacular, and then getting people used to deliver it.

But there's a ray of hope, and that is as follows: If penetration is low, you will find every village with at least two or three smartphones. Now, the smartphone gets it, but the word of mouth gets it across, inaccurate as it may be. So as I say, the devil's in the details, and the jury is out as to how long it will take, at least in my head.

Marshall So, Purvi, continuing on this theme, I wonder if you would share with us your thoughts about this question – whether, given all of this, given the history, given where it is today, given the very promising signs of a transformation in the offing, given that many of India's farmers have already taken advantage of these technologies, where is India along this path moving forward? Is it at the brink of what could become a rapidly accelerating process of change? Like digital technology at large in India where who would have predicted that at this point there'd be 1.1 billion Indians with a biometric identification. Right? And not to mention all the other digital penetration. Where is India's agriculture on this track?

Purvi I think anything you say about India's agriculture, the opposite also stands true. Right? So there is no single track. There are several tracks that are running really parallel to each other. And this is a country where you see a revolutionary thing happening. If you see, say for example, productivity data, the same variety of rice promoted by the Indian national organization like ICAIR in one village gives 3.6 tons a year. Right in the neighboring village it gives less than 1 ton per year. By the world potential would be 7.5 – right?

So it's very interesting how different trajectories move sort of together, and it's very difficult to generalize. But some of the sectors are really going to that brink world. And some of the sectors... You know, it's very interesting – most of these experiences that this panel has talked about or we talk about generally or the policies that are there, are basically by and large based on four or five commodities – rice, wheat, cotton, sugar cane, milk. What about the other commodities? The growth actually comes there. The income potential comes from there. The nutrition potential is coming there. And these experiences are not captured enough.

And so if you say for example livestock, while the agriculture struggles to be actually 3.2, 3.5% growth in general, livestock sector consistently – which by the way gets less than 10% of the government money allocated – and yet consistently, since 2014, has been growing at the rate of 4.8 to 5.5. So there are sectors which are going to that brink. There are sectors and commodities that are running at a slower pace.

So it's very interesting. It kind of continues to remain on that crossroads, but I think the biggest revolutionary thing will come from making agriculture attractive. And agriculture will be attractive not because of its potentials 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.

Marshall Excellent. I would like to close in our remaining time with a question about a very big issue. And that is climate change-induced weather, volatility and variability. And we know from the IPCC reports that India is projected to be hit very hard, especially certain sections of India, regions of India, by climate change or the weather results. And so in our four minutes remaining, I would like to ask each of

you for a one-minute answer on how much of a challenge this poses to the kind of transformation we've been talking about. Is it going to make a difference at scale, so to speak, in Indian agriculture? How concerned are you about it? What do you think, if anything, could be done? But just a minute each, and then we will conclude, and those who remain can go get some lunch, too.

Ashok Yeah, the climate change poses a big challenge to India, because agriculture is monsoon dependent, and we know there are already signs of changes in the rainfall patterns, not in the quantum of rainfall but in the rainfall spread, and of course the temperature rises. And both these two parameters are going to change the seasonality, and therefore we will be now called upon to change our agronomy practices, our ITs, etc., etc.

And the second important one is that there are already areas which are extremely monsoon dependent, and based on the IPCCs value parameters, of the 700 districts we have identified 151 districts as particularly prone to draught. And now our emphasis would be to develop draught-proofing systems so that the coping mechanisms are an option with the farmers. So it is going to be a challenge and therefore as a part of our doubling farmers' income, sustainability and a response to the climate change is also one of the important factors that we have to take into account.

Marshall Purvi.

Purvi I think, yeah, first of all it could be very naïve to underestimate how climate change is going to be impacting. The smaller the farmer, more vulnerable the community that will get affected more, and therefore our responsibility towards that, of course, increases. My only thing is – these are new sets of challenges, and yet another set of challenges, and it will require more and newer tools in our toolboxes to address these challenges. And I think the approach of taking on a new war with an old sword won't work in terms of climate change. And therefore, I think the Vermont discussion yesterday was intriguing. We do need tools, no matter where they come from, what technology they come from. I think we need to be willing to bring in more tools to adjust this and to basically bring in more efficiency into the system.

Marshall Anil.

Anil I believe climate change is there, and one is seeing that through the differences in weather and the delaying monsoon or less or more or difference in the heat or cold, etc. The farmers are already in process of adapting, but they just do not know; because it's like a moving goalpost – right? Things are changing every year. Every season you see something different.

Technologies do exist already on how to address this. For example, as the heat rises, the wheat is expected to be 20 to 30% lower productivity. But you can actually create microclimate through irrigation or whatever else so that that heat impact can be taken out. So these solutions do exist. One has to just see – how do you reach out to all these farmers to make it a viable and cost effective solution. That's the challenge.

Marshall You have the last word, Rohtash.

Rohtash] Don't leave yet. God will do what He will do, and then we've got to do what we can do. And the first thing is these 151 districts, for example, how do we get water out? Technologies are now being made. Magnetic resonance technologies remain to be seen, which define exactly where the water is under the ground, and pumping it—right? We have to invest in that. Now, that's for the areas which are draught intensive. What about the areas that have surplus monsoon and therefore kill crops—right? Insurance has to kick in, in a very huge way. I think we've barely scratched the surface. Insurance has to kick in, because if our focus is not on the farm but on the farmer, we've got to make sure that his efforts don't go in vain.

Thirdly, factorial technologies are coming in where early warning signals are available. For example, usually farmers used to wait for crops to come to full color, so to speak, before harvesting. But if you know that a storm is approaching, you better get that off the field. More importantly, don't leave it as a mountain on the field. You harvest it, you sort, grid, pack and get it out of there as quickly as you can.

So we've got to find ways and means, and there are possibilities right in front of us, to be able to apply on a lot of these solutions. We can't avoid the effects of climate change. More importantly, the violent changes in climate that we are beginning to see, but measures are available, and more and more are going to be available. I think both private sector and government have to go out and seek these and make sure that they're implanted on the ground, not at a national level nor at a state level but literally at the district or the sub-district level. There will be different solutions for small areas.

Marshall Excellent. Well, I want to thank all of you for a superb panel and a superb discussion. And I want to let those in the room know that we will be putting out a publication based on this panel's discussion and some interviews we had with the panelists prior to coming here to Des Moines, and that will be out sometime, I would say in the next six weeks or two months. Meanwhile, I will ask all of you to join with me in thanking the panelists for their time and contribution.