# New Innovations of Improving Agriculture

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## Introduction

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India.

## Problems in Agriculture

"Slow agricultural growth is a concern for policymakers as some two-thirds of India's people depend on rural employment for a living. Current agricultural practices are neither economically nor environmentally sustainable and India's yields for many agricultural commodities are low. Poorly maintained irrigation systems and almost universal lack of good extension services are among the factors responsible.

Farmers access to markets is hampered by poor roads, rudimentary market infrastructure, and excessive regulation. With a population of just over 1.2 billion, India is the world's largest democracy. In the past decade, the country has witnessed accelerated economic growth, emerged as a global player with the world's fourth largest economy in purchasing power parity terms, and made progress towards achieving most of the Millennium Development Goals. India's integration into the global economy has been accompanied by impressive economic growth that has brought significant economic and social benefits to the country.

## Technological Needs and Future Agriculture

It is apparent that the tasks of meeting the consumption needs of the projected population are going to be more difficult given the higher productivity base than in 1960s. There is also a growing realization that previous strategies of generating and promoting technologies have contributed to serious and widespread problems of environmental and natural resource degradation. This implies that in future the technologies that are developed and promoted must result not only in increased productivity level but also ensure that the quality of natural resource base is preserved and enhanced. In short, they lead to sustainable improvements in agricultural production. Productivity gains during the 'Green Revolution' era were largely confined to relatively well-endowed areas. Given the wide range of agro-ecological setting and producers, Indian agriculture is faced with a great diversity of needs, opportunities and prospects. Future growth needs to be more rapid, more widely distributed and better targeted.

Responding to these challenges will call for more efficient and sustainable use of increasingly scarce land water and germplasm resources. New technologies are needed to push the yield frontiers further, utilize inputs more efficiently and diversify to more sustainable and higher value cropping patterns. These are all knowledge intensive technologies that require both a strong research and extension system and skilled farmers but also a reinvigorated interface where the emphasis is on mutual exchange of information bringing advantages to all. At the same time potential of less favoured areas must be better exploited to meet the targets of growth and poverty alleviation. These challenges have profound implications for products of agricultural research. The way they are transferred to the farmers and indeed the way research is organized and conducted. One thing is, however, clear – the new generation of technologies will have to be much more site specific, based on high quality science and a heightened opportunity for end user participation in the identification of targets. These must be not only aimed at increasing farmers' technical knowledge and under standing of science based agriculture but also taking advantage of opportunities for full integration with indigenous knowledge. It will also need to take on the challenges of incorporating the socio-economic context and role of markets. With the passage of time and accelerated by macro-economic reforms undertaken in recent years, the Institutional arrangements as well as the mode of functions of bodies responsible for providing technical underpinning to agricultural growth are proving increasingly inadequate. Changes are needed urgently to respond to new demands for agricultural technologies from several directions. Increasing pressure to maintain and enhance the integrity of degrading natural resources, changes in demands and opportunities arising from economic liberalization, unprecedented opportunities arising from advances in biotechnology, information revolution and most importantly the need and urgency to reach the poor and disadvantaged who have been by passed by the green revolution technologies.

**The most advanced agricultural technologies employed today**

**1. Tractors on autopilot**

Thanks to GPS tractors, combines, sprayers and more can accurately drive themselves through the field. After the user has told the onboard computer system how wide a path a given piece of equipment will cover he will drive a short distance setting A & B points to make a line. Then the GPS system will have a track to follow and it extrapolates that line into parallel lines set apart by the width of the tool in use. These systems are capable of tracking curved lines as well. The tracking system is tied to the tractor's steering, automatically keeping it on track freeing the operator from driving. This allows the operator to keep a closer eye on other things. Guidance is great for tillage because it removes human error from overlap, saving fuel and equipment hours.

**2. Swath control and variable rate technology**

Building on GPS technology are swath control and Variable Rate Technology VRT. This is where guidance really begins to show a return on investment. Swath control is just what it sounds like. The farmer is controlling the size of the swath a given piece of equipment takes through the field. This video is a great visual representation of how swath control works. The savings come from using fewer inputs like seed, fertilizer, herbicides, etc. Since the size and shapes of fields are irregular you are bound to overlap to some extent in every application. Thanks to GPS mapping the equipment in the field already knows where it has been. Swath control shuts off sections of the applicator as it enters the overlap area, saving the farmer from applying twice the inputs on the same piece of ground. VRT works in a similar fashion. Based on production history and soil tests a farmer can build a prescription GPS map for an input. By knowing what areas of a field are most and least productive the application rate of an input like fertilizer can be tailored to increase or decrease automatically at the appropriate time. This is a big benefit for farms. Instead of applying a set rate of fertilizer over the entire field (many times a high rate to help those low producing areas) an operator can now apply a rate most effective for a particular section of ground.

**3. Your tractor is calling**

Telematics is being touted as the next big thing in agriculture. This technology allows equipment to talk to farmers, equipment dealers, and even other equipment. Imagine you have a problem in the field and have to stop working, with telematics your dealer can access the onboard diagnostic system of your tractor. Depending on the problem they might be able to fix your equipment right from dealer. No waiting on a mechanic to drive out to wherever you might be. You're back to work, and the dealer saved a trip too. Farmers will be able to keep track of what field equipment is in, fuel consumption, operating hours, and much more. Usually it was noticed farm as it become more technologically advanced the downtime is often caused by electrical, software, or hardware problems as opposed to mechanical. Tractors can even communicate between themselves. The best example is a combine and a grain cart. Grain carts pull up next to harvesting equipment so the harvester can unload on the move without stopping. Telematics can tell the grain cart operator when a combine is filling up with grain.

**4. Your cow is calling too**

And it's not saying "Moo!" Collars developed for livestock are helping producers keep track of their herds. Sensors in the collar send information to a rancher's smartphone giving the rancher a heads up on where a cow might be, or maybe she's in some sort of distress, or maybe just in the mood for some mating. I suppose you could say it's kind of like telematics for cows. RFID tags are also a handy device for livestock management. The information kept on a tag helps producers keep track of individual animals, speeding up and making record keeping more precise. I recently read about RFID tags placed in to hay as it is baled. Data such as moisture and weight can be stored in the tag to be scanned later.

**5. Irrigate via., smart phone**

Mobile technology is playing a big role in monitoring and controlling crop irrigation systems. With the right equipment a farmer can control his irrigation systems from a phone or computer instead of driving to each field. Moisture sensors in the ground are able to communicate information about the level of moisture present at certain depths in the soil. This increased flexibility allows for more precise control of water and other inputs like fertilizer that are applied by irrigation pivots. Farmers can also combine this with other technologies like VRT mentioned earlier to control the rate of water applied.

**6. Sensing how your crop is feeling**

This is taking variable rate technology to the next level. Instead of making a prescription fertilizer map for a field before you go out to apply it, crop sensors tell application equipment how much to apply in real time. Optical sensors are able to see how much fertilizer a plant may need based on the amount of light reflected back to the sensor. I haven't seen one of these systems in operation yet, but I'm keeping a close eye on them. It's fairly new and pretty expensive, but I see huge potential here. Crop sensors are going to help farmers apply fertilizer in a very effective manner, maximizing uptake and reducing potential leaching and runoff into ground water.

**7. Field documentation**

Because of onboard monitors and GPS the ability to document yields, application rates, and tillage practices is becoming easier and more precise every year. In fact farmers are getting to the point where they have so much good data on hand that it can be overwhelming to figure out what to do with all of it. And of course, every farmer's favorite form of documentation is the yield map. It sums up a year's worth of planning and hard work on a piece of colorful paper. As harvesting equipments rolls through the field it calculates yield and moisture as it goes tying it in with GPS coordinates. When finished a map of the field is printed. These maps are often called heat maps. I liken then to weather radar maps. Each color on the map relates to a certain yield range. Now the farmer can see what varieties had the best, worst, or most consistent yield over varying conditions. Maps like this can tell a farmer how well a field's drainage system is working.

**8. Biotechnology**

Biotech or Genetic Engineering (GE) isn't new tech, but it is a very important tool with much more potential yet to be unleashed. The form of GE most people have probably heard of is herbicide resistance. The other would likely be insect resistant traits. Crops can be made to express toxins that control particular pests. Many employ Bt toxin that is the same toxin found in some organic pesticides. That means a farmer won't have to make a pass through his fields to apply pesticide, which not only saves on pesticide, but fuel, labor, and wear on equipment too. New biotech's coming online right now are things like drought resistant traits and nitrogen use efficiency. What does that mean? In short it means that crops are going to be able to protect more potential yield in drought conditions. Another way to look at it would be that farmers who irrigate their crops can cut back on water use and not see yields suffer.

**9. Don't forget to flush**

Ray Prock dedicated a whole blog post on how he manages cow manure on his California dairy. I'm sure most people know that manure makes good fertilizer, but it's the method Ray uses to collect it for use that is so cool. An automatic system uses water to flush manure away from the cattle into a holding area where all the solid matter dries up. After it dries the solid manure can be picked up and further processed. The liquid manure continues on into another area. From here it can be pumped out and used to fertilize Ray's crop or it can be sent back in to flush out more manure. A metering device lets him know exactly how much liquid is used so that just the right amount is placed on the crops. Excess nutrients are at risk of reaching groundwater, but Ray is all over that too. Irrigation runoff is captured in ponds and is recycled over and over again in the system.

**10. Ultrasounds and more for livestock**

They aren't just for checking on baby animals in the womb. Ultrasounds can be used to discover what quality of meat might be found in an animal before it goes to market. DNA testing helps producers identify animals with good pedigrees and other desirable qualities. This information can then be use to improve the quality of the herd which helps the farmer improve his bottom line.

**11. There's an app for that**

Mobile tech is big in agriculture and it's getting bigger all the time. Farmers and ranchers are using all the social media sites for all types of reasons. Some are using apps like foursquare to keep tabs on employees. You might even catch me on a twitter chat tweeting away right from the tractor cab. The tractor is driving itself and my hands are free so why not? Apps can control irrigation and grain storage systems. Want to load grain into a truck without getting out of the cab? Load Out Technologies has you covered. I can't tell you how many times the flashlight app on my phone comes in handy. Even the camera can be put to work on the farm. If you think you might forget how something goes back together after you take it apart take a picture of it assembled. On my phone I have apps that show me soil type via GPS, agricultural news and markets, insect pests, calculations for mixing herbicide solutions, and one that tracks growing degree days. GDDs are an index based on temperature that gives a grower an idea of how mature a crop may be. If you plan on visiting the National Farm Machinery Show in Louisville, you won't have to carry around a map all day that shows vendors booths and event schedules. There's an app for that too.

### 12. Smile for the camera

Putting up cameras around the farm is a trend that's catching on. We have a rear-facing camera on the back of the combine that shows up on a monitor in the cab. I can think of all kinds of places to put cameras on large pieces of equipment to help eliminate blind spots. Our grain cart is wide enough that you can't see around it so I'd like to have one out back to I know if I'm holding up traffic when driving from field to field. Another idea would be to have a camera or two looking at the implement behind the tractor. Craning your neck around left and right all day to look behind you gets a little painful after a while. Livestock managers are wiring up their barns, feedlots, and pastures with cameras that send images back to a central location like an office or home computer. They can keep a closer eye on animals when they are away or home for the night. Val Wagner told me she is setting up cameras to monitor cows during calving season. Her hope is that by being able to watch the cows during this critical time they can lessen the chance of calves being born outside on those well below zero North Dakota nights. So now you're up to speed on some of the latest and greatest things going on in agriculture. It's all about more data, efficiency, and precision. Farmers and ranchers have a lot of awesome stuff to help them produce a bountiful harvest. So long as Mother Nature chooses to play along. She'll come up with at least one monkey wrench each year no matter what you do, but that goes with the territory

### 13. Nitrogen Modeling

Nitrogen N is the most important nutrient in agricultural systems, and it plays a significant role in the economic viability, long-term sustainability, and enhancement of cropping systems around the world. To meet the nutritional demands of over six and a half billion people and the world's continued population expansion, an adequate supply of this element in the rooting zone of cropping systems is required to maintain and boost yields. Nitrogen has been critical in maintaining agricultural production increases, yet nitrogen utilisation efficiency (NUE) is typically stated to be less than 50%. Farmers, consultants, and policymakers want effective tools to identify, prioritise, and learn about how nutrient management strategies affect economic returns and regional environmental quality. Combining computer models with GIS techniques can aid in the development of public policy that promotes a region's economic, environmental, and social well-being. BMPs that promote NUE are continually being developed and improved by researchers. It is impossible to undertake field plot or whole-farm studies that cover every possible situation due to the variety of geographical areas, cropping systems, management scenarios and weather. Computer simulation and decision support (DSS) models for soil-crop systems that emphasise the nitrogen cycle, particularly when combined with economics and geographic information systems (GIS), are viable options for evaluating different management scenarios and how they affect the recovery of nitrogen by a cropping system for a given set of conditions. These models are made up of a complicated set of algorithms and databases that can interact with a variety of settings and serve as mechanistic tools for evaluating various nutrient management scenarios and their impacts on NUE and system sustainability. These simulations may be used to create and apply the optimal management techniques for maximizing economic returns, improving NUE, and conserving the environment.

### 14. Electrical Conductivity Sensing

The ability of a material to transfer

electrical current is measured by its electrical conductivity (EC). Various soil qualities, such as soil texture and water holding capacity, are related to the EC of the soil. The EC of sandy soils will be lower than clay soils. Mapping the EC within a field gives you more information on the soil variability in that field, as well as year-to-year trends like salinization and compaction. Because the application efficiency of herbicides and nitrogen fertilizers is dependent on soil texture, this information can help with deciding on variable rates. In light-textured soils, for example, a split nitrogen treatment may be required. Other approaches for determining soil electrical conductivity focus on determining the EC of the soil-solution, and thus its salinity. The key difference between both strategies is the soil moisture level. Depending on the moisture level of the soil, the electrical conductivity of the soil-solution fluctuates over time. As a result, all EC measurements must be done at the same moisture content for uniformity. In precision agriculture, EC sensors are a helpful tool for better understanding soil variability and trends. This is notably true for soil EC mapping, and to a lesser amount for single soil sensors that are immobile.

## 15. Robotics

Many of the robots have been developed as a result of recent technology advancements. Machine vision technology is used in many agricultural robotic breakthroughs to avoid risks, recognise crops, and even decide when they are ready to be harvested. A camera or numerous cameras transmit information to the robot, allowing it to locate and access the crops surrounding it, which is known as machine vision. Robots can conduct jobs including weeding, growth monitoring, harvesting, sorting, and packing thanks to machine vision. Many breakthroughs in agricultural robots have also been made possible by satellite location systems like as GPS. GPS data is frequently used by robotic farm equipment to position and locate themselves on farms. Robotic ploughing trucks may employ a combination of computer vision sensors and GPS to navigate and act as the driver in autonomous field ploughing, seeding, or navigating tractors and equipment.

Machine learning is another technique used in agricultural robots. Machine learning is a sophisticated approach of determining collision paths that can assist autonomous cars in learning to adapt and avoid new or unforeseen hazards in their paths. It also allows picking and quality control robots to learn as they go, allowing them to develop the most effective strategies for detecting and carrying out their responsibilities.

## Conclusion

The development of agricultural food industry and integrated supply chains with globalization, technological and corporate advancements and environmental effects have all widened the scope of agriculture. Additionally, global financial crises in recent years have revealed a weakness in the implementation and sustainbaility of current growth models and agricultural policies. New sturcutral solutions are therefore required. Aside from these issues, modern growth theory considers technological change as the engine of economic development. It is often pointred out that the use of technology will contribute significantly to rural development and a decline in poverty. Developments in science, technology and engineering are main instruments to help reach these goals and to bring about the changes stated above.