

# Technological Innovation in Agriculture: Solutions for the Future

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Agriculture is one of India's most critical industries. It accounts for 16% of the national GDP and employs more than 40% of the total workforce. Eight of every ten of these agricultural workers are smallholder farmers, which means it is no surprise that 70% of rural livelihoods are made in cultivation, harvesting, and selling produce. The importance of this industry, from the national to the grassroots level, makes its vulnerabilities all the more concerning.

## Challenges Facing Indian Agriculture

- Smallholder farmer reliance on traditional cultivation and irrigation
- Erratic weather, floods, and droughts
- Soil erosion and pests
- Logistical and supply-chain issues leading to waste
- Unequal access to credit and insurance
- Overexposure to chemical fertilizers

Smallholder farmers are particularly vulnerable to the challenges facing the agricultural sector as a whole. Most of these farmers, working small plots of land for food to sell at market and to feed their families, use traditional farming techniques. Similarly, many are reliant on groundwater, rivers, and rain for their crops, rather than more advanced irrigation techniques. As a result, shifting weather patterns and the droughts and floods that are becoming increasingly common in our changing climate can have devastating impacts on their lives and livelihoods, destroying crops, livestock, and infrastructure. Climate change has caused weather patterns to shift, soil to degrade, and attacks from pests like locusts to increase in severity, all of which directly impact smallholder farmers. All of this led to nearly \$10b in losses in 2018, and the Indian Council of Agricultural Research has reported that climate change could reduce total yields by 9% by 2040 if aggressive mitigation efforts aren't implemented.

Logistical issues and supply-chain inconsistencies further hold smallholder farmers back from accessing all of the potential capital in their land. Difficulties around transportation -- a fact of life, certainly, but again often exacerbated by erratic weather or floods -- are compounded by lack of efficient cold storage or other means of preserving produce until its sale. Unable to quickly get their produce to market and lacking the infrastructure to keep it fresh over longer transportation times, farmers see nearly 16% of fruits and vegetables and 10% of cereals go to waste each year.

While this seems like a dire situation, even without touching on other issues such as overexposure to chemicals in fertilizers or unequal access to credit and insurance, technological innovations are creating solutions and improving outcomes across the sector and, most importantly, for smallholder farmers.

## Promising Technological Solutions

- Digital platforms analyzing satellite and sensor-based data through artificial intelligence and predictive analytics
- Smartphone apps providing farmers with real-time information on what crops to plant and when and how much to water
- Solar-powered cold storage and dehydrators preserve produce and reduce waste
- Sensor-based micro-irrigation reduces water usage
- Nano-fertilizers reduce exposure to chemicals
- Drones can be used to monitor crops and protect from pests

In Jharkhand, a small state in eastern India with a long-marginalized rural population, farmers face poor market connections and access. With a lack of cold storage infrastructure and reliable electricity, their incomes suffer greatly from wasted produce. Swaniti is working hard to address this issue through improved technology, engaging with the State Department of Horticulture to roll out solar-powered cold storage as well as solar-powered dehydrators. While the refrigeration preserves fresh produce, drying certain vegetables and cereals before sale not only allows them to be stored longer, but can actually increase the profit-margin for smallholder farmers as well.

Combining this with initiatives to strengthen farmer organizations, connecting sellers and buyers, and building farmer capacity through trainings on the best crops to grow at certain times will continue to boost output and income.

Across India, other startups are creating digital platforms to improve efficiencies in the supply chain. This makes the entire process more traceable and transparent, reducing the likelihood that smallholder farmers can be taken advantage of by large buyers or corporations or connecting farmers directly to the end consumer. Much of the other new technologies aimed at improving farmer livelihoods are focused around smartphones and app-based systems as well.

Apps that collect data from GPS and GIS satellites as well as sensors in the soil, combined with predictive analytics and algorithms based on machine-learning, can take location, season, crops, and weather into account to create individualized, farm-level reports. Similarly, albeit at a broader level, the Indian government's National Strategy on Artificial Intelligence has prioritized agriculture, aiming to improve production, precision, and sustainability through AI and IoT-based technologies. Smartphone accessibility could help farmers use that information to make decisions about crop configuration, fertilization and cultivation practices that will help regenerate the health of the soil, and planting schedules that will adapt to changing weather. Beyond smartphone apps, sensor-based technologies can be used for micro-irrigation, which has been shown to reduce water usage by up to 90% in some cases.

Looking out farther to the cutting edge gives a view of even more exciting technological advances. Drones can be used to help spread pesticides and monitor crop health; in Rajasthan recently, they were even used to protect crops from an advancing swarm of locusts. Gene-editing technology can be used to create more productive seeds with more desirable traits such as disease or drought resistance. Nano-fertilizers may benefit soil and plants while offering farmers a means to avoid exposing themselves to harmful chemical fertilizers.

Of course, none of this will make a difference without training and capacity building programs dedicated to ensuring that even the most remote farmers are able to access data, have the tools necessary to understand these individualized reports, and the means to implement changes in planting, cultivating, and harvesting. It is easy, when looking towards these advances, things that once seemed to belong either to a far-off future or a work of speculative fiction, to get excited about the possibilities. It's exciting to focus on what we can make, on what our computers can do or how they can learn.





But we need to make sure that we do not forget the human aspect that all of this should be dedicated towards. In putting all of this out there, we need to recognize different human capacities, building where some may be lacking so that all of these advances can be put to use by those who need them the most. Technological progress that is not accompanied by empowerment of the most marginalized people is hardly progress at all.

