



INTELLIGENT FARMING

The future of precision and sustainable agriculture

Context

Kondagorri Pentaiah is a 38-year-old, third-generation cashew farmer from Sannaiyiguda village in Srikakulam district of Andhra Pradesh. He has an orchard of nearly a hundred cashew plants on a small, 1.5-acre tract of farmland, which he does not own. The Andhra Pradesh Government has given his family this land under the D-Patta system¹. Like Pentaiah, there are about 120 million smallholder farmers in India, who make up nearly 70 percent of the country's farmers and produce over 40 percent of all agricultural produces, but own only 33 percent of the total cultivated land.


For years, Pentaiah's cashew crop has suffered from flower drop and flower burn caused by fungal infestation and prolonged drought-like or fog-like conditions. Competitive market forces and increasingly unpredictable climate combined with lack of access to the right farming advice at the

right time are the key reasons why smallholder farmers like Pentaiah have poor yield, pushing them further into poverty. "My cashew leaves had different colours like green, yellow, brown, dark spots on leaves, etc. I was unaware why it happened or what pests and diseases attack them. Some years, it's so bad that I had to go to look for work under the Government of India's Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) or gather some forest produce to sell in the local market," he says.

Despite several efforts by public, private and non-governmental stakeholders to make good and scientific farming advisories available to the smallholder farmers, the agriculture extension mechanisms in the country have often failed to communicate effectively with them. This

¹D patta is conditional land, prohibits transfer of assigned land and only inheritable at present. Conversion is permissible for non-agricultural purpose.

Digital Green



I now understand the causes of nutrient deficiency, am able to identify pests and diseases that can affect cashews and know about the measures for controlling pest infestation. I can also differentiate nutrient deficiencies from pest infestation. I have applied different natural farming nutrient and pest management advisories in my cashew orchards. Now, my orchards are brimming with fully green leaves, flowers and fruits.

- Kondagorri Pentaiah, a 38-year-old cashew farmer

is largely due to the content, which, in spite of being scientifically accurate, is presented in a generic, top-down manner that sometimes is not only difficult for the farmers to understand but also to which the farmers are not able to relate with. Savara Kitchayi, another cashew cultivator from Ullimanuguda village in Srikakulam adds, “Earlier, people from NGOs or the government used to visit us once in three or four months and tell us about good farming practices. Sometimes it was difficult to understand exactly what they meant. At other times, they told us about important practices for other crops, like rice or chilli, but not for cashew. I needed information that I could use, like information about managing flower burn and flower drop in cashew crop.”



Cashew farmer in north coastal Andhra Pradesh spraying organic pesticide as per community natural farming (CNF) practices to protect their crop from pests and diseases.

Integrating and hyperlocalizing data to develop customized agronomic advisories

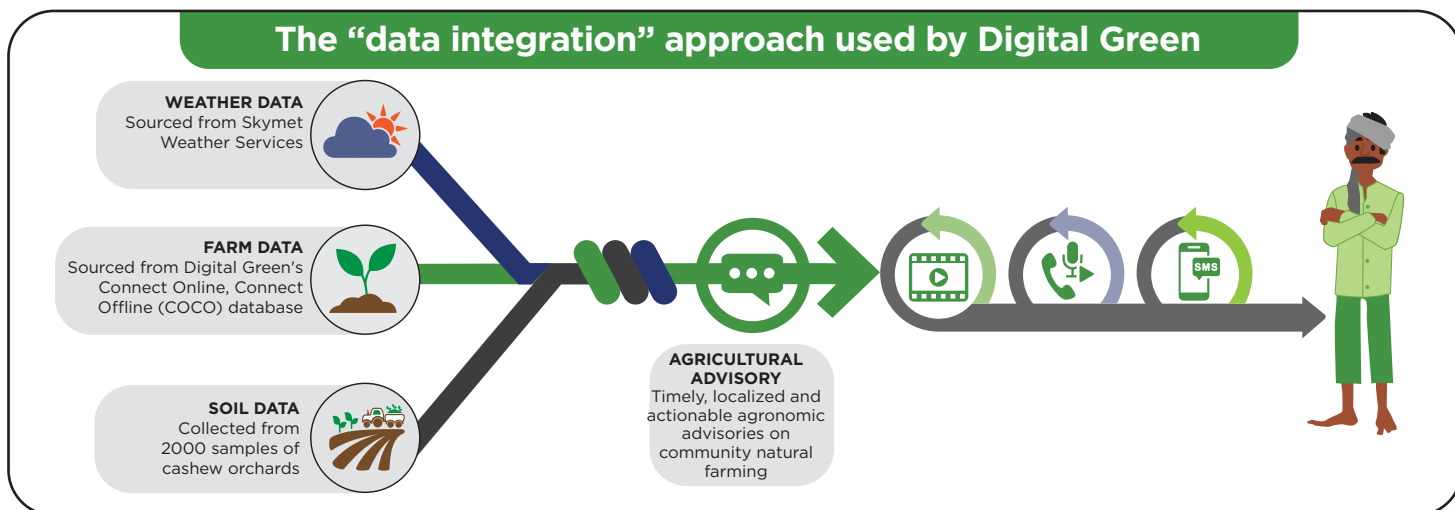
Digital Green, supported by Walmart Foundation, has come up with a much easier solution to overcome these obstacles with the help of robust algorithms and predictive analytics. Digital Green uses three sources of data -

- Existing farm-level data from its Connect Online, Connect Offline (COCO) database, like, who and where are the farmers, how much land they have, what they grow and their feedback on existing programs to develop large scale dynamic farmer profiles;
- Village-level weekly weather forecast data (rainfall, temperature and humidity) from Skymet Weather Services, which is matched against certain conditions to trigger the advisories; and
- Soil information, from samples of 2000 cashew orchards, collected by Digital Green in its

first use case area in north coastal Andhra Pradesh. These were tested in state and district agricultural testing labs, and the soil nutrient levels of nitrogen, phosphorus and potassium in them were matched against the optimum ratio for the cashew cultivation.

Digital Green’s technology team facilitates the “data integration” by fusing hyperlocal data on weather, soil quality and the crop under cultivation to enable timely, localized and actionable agronomic advisories to smallholder farmers. The agronomic content on community natural farming (a package of practices for preparing and applying natural inputs for organic fertilizers and pesticides), weather-appropriate crop care and infestation management, and soil nutrient management for cashew cultivation are developed with subject matter experts from the Department of Agriculture and Cooperation and the Department of Horticulture in Andhra Pradesh. Explaining the foundational idea behind the approach, Pritam Kumar Nanda, State Head (Andhra Pradesh and Telangana State), Digital Green says, “It is important for a farmer to know when it will be dry, when it

The “data integration” approach used by Digital Green



will be foggy and when it will rain. Weather data can also predict diseases. If the farmers can get this information accurately and in time, they will be able to make meaningful decisions.”

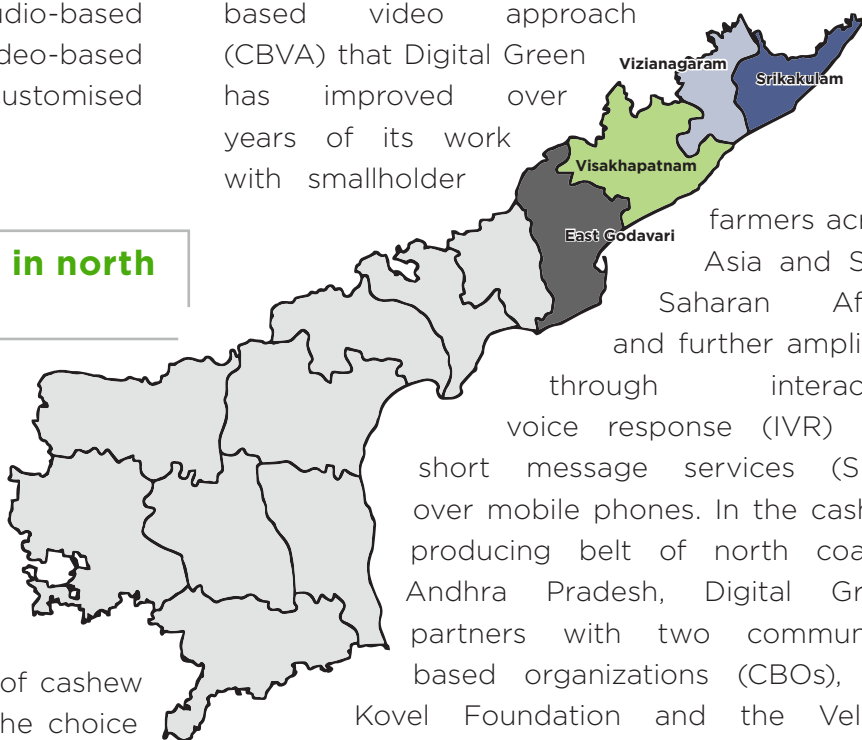
The final content is produced as videos and audio messages in the regional language, tailored to be locally relevant and easy to comprehend, while still maintaining scientific accuracy. The use of video-based advisories has three components - natural farming for agricultural development, video in agricultural extension and human mediation for effective training with video. The audio-based advisories are used to reinforce the video-based advisories and delivering hyper-customised advisories to individual farmers.

of consultations with the cashew farmers in the four districts. A lot of their farming decisions anchors on instinct and guesswork. They neither had access to the weather forecast for their village nor the knowledge on soil quality of their orchards. This was the just the right case for us to test our approach.”

DigitalGreen employs a multi-channel dissemination strategy for enhancing the reach and coverage of the advisory. The agronomic advisories are communicated through participatory, community-based video approach (CBVA) that Digital Green has improved over years of its work with smallholder

Use case: Cashew cultivation in north coastal Andhra Pradesh

Digital Green, through its FarmStack project, provides the customized, farm-level agronomic advisories, based on the integrated data, in Visakhapatnam, Vizianagaram, East Godavari and Srikakulam, the four north coastal, cashew producing districts of Andhra Pradesh, the second largest producer of cashew in India. Explaining the logic behind the choice of cashew cultivation, Pritam shares, “During the early, exploratory stage, we held several rounds



farmers across Asia and Sub-Saharan Africa and further amplified through interactive voice response (IVR) and short message services (SMS) over mobile phones. In the cashew producing belt of north coastal Andhra Pradesh, Digital Green partners with two community-based organizations (CBOs), the Kovel Foundation and the Velugu Association, which, in addition to enabling the rapid rollout of on-ground implementation, builds

on local, traditional knowledge and practices in agriculture. The advisories are woven into a novel system that maximizes the impact of agriculture extension workers and adds the critical element of community engagement and participation throughout the process.

About once every two weeks, the extension agents hold village level meetings with the farmers in small groups of 8-15 people, where they screen the agronomic advisory videos using portable, battery-operated pico projectors. Biddika Yellaiah, a 53-year-old smallholder cashew farmer from Chinnagorapadu tribal habitation in Srikakulam District shares, “We would meet every week and watch video screenings on natural farming methods for cultivating cashew. I understood what was being said. Whenever I had any doubts, I used to ask Raj Kumar (the field facilitator) to clarify them.”

Interactive voice response (IVR) and short message services (SMS) messages are drilled down to farm-level based on farmer profile from Digital Green’s COCO database, soil data from the cashew orchards and layered with village-level weather data. The IVR and SMS also go out to the extension agents at regular intervals to not only reinforce their own learning but also remind them to share the advisories on cashew cultivation and crop protection. K. Archana, Deputy State Head, Andhra Pradesh / Telangana state Digital Green says, “The advisories on IVR and SMS are short recorded messages, often less than a minute, which are delivered 2-3 times every week. We use these supplementary channels to improve reach, recall and uptake of messages delivered through CBVA.” **An independent evaluation of FarmStack by IDinsight reported that farmers found supplementary IVR and weather IVR were highly relevant and easily understandable.**

The value addition of IVR and SMS based advisories becomes more pronounced during the COVID-19 pandemic, which restricted congregation and mobility. “We had to stall our group video

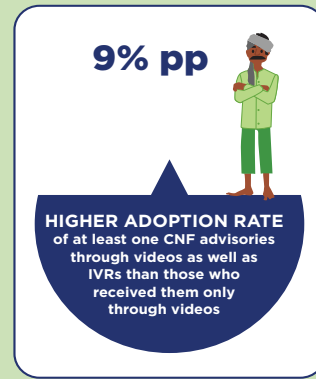
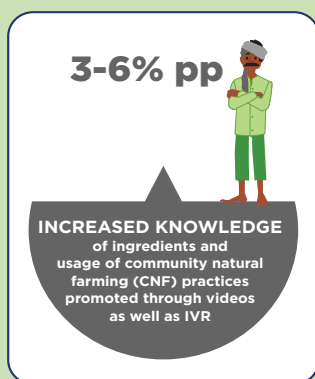
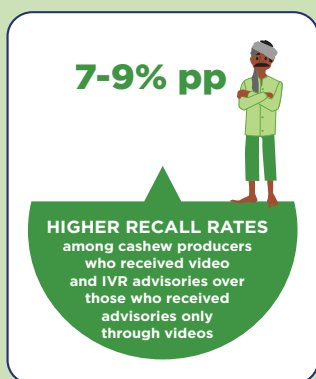
meetings when COVID-19 lockdown was imposed, and adapt rapidly to ensure that the farmers do not miss out on important agronomic advisories. We increased our IVR and SMS based advisories to the farmers on the most crucial of the best practices. We sent reminders on timely adoption of best practices, about government advisories, schemes and announcements, information when the nearest markets that are open, contact details of important local functionaries, and so on,” says K Archana, Deputy State Head (Andhra Pradesh and Telangana State), Digital Green.

The green shoots of change

Nearly 10,000 cashew cultivators from 332 communities in the four districts of Andhra Pradesh benefit from the customized agronomic advisories.

The adoption of FarmStack did not happen instantly. Disappointed by lack of proper guidance in the past, the cashew farmers and even some extension agents, were initially sceptical. Raj Kumar, a young extension agent, describing the change he has witnessed, says, “I initially doubted Digital Green’s approach. I was worried that it would only add to my workload. Now, I can say with confidence that the videos, IVRs and the SMSs have eased my work. When the farmers see the videos, they understand the messages better. The SMS and IVR helps in reinforcing the advisories that I have discussed using the videos. Now, I have to do less talking and explaining.”

Kunjam Manganna Dora, another cashew farmer from the Vedurlakoda village in East Godavari district adds, “Changing from how we used to cultivate cashew to natural farming methods requires us to change our mindset about farming. I have watched videos on different practices to improve cashew cultivation. I also get audio messages on my phone. It convinced me to change my conventional thinking and adopt organic



Source: IDinsight. *Digital Green FarmStack Evaluation Results: A Use Case for Cashew in Andhra Pradesh*. February 2021

practices. I have also tested some of the advisories they shared. This season, for the first time in many years, my cashew flowers did not drop!”

Nearly **30 percent** farmers reported lower incidence of infestation and **16 percent** cashew farmers reported less flower drop in the current season. The cashew yield increased **from 56 kg per acre to 65 kg per acre** in one season. Savara Kitchayi says, “I applied Neem oil and *Neemasthram* as a precautionary measure when the tea mosquitoes started attacking my cashew orchards. I could see a clear difference between treated and non-treated cashew shoots, leaves, flowers, nuts and fruits. The cashew nuts I had this season were of very high quality. I also had a bumper yield this season. I will be adopting more of the natural farming practices next season.”

Digital Green encourages its partner CBOs and FPOs to maximise the return on its advisories to the farmers by aggregating and negotiating a higher price for the produce. Sanjeeva Rao, Secretary, Velugu Foundation shares, “This year we aggregated nearly 120 quintals of high-quality cashew nuts. This, in spite of the work and mobility restrictions due to COVID-19, was by far the highest yield in several years. We were able to get much better rates from the traders because of the quality and quantity we had. All the cashew farmers in our area are happier this year!”

The most significant impact is the community’s sense of empowerment through exposure to new information, new skills and new technologies. Adoption of natural farming practices based on the hyperlocal agronomic advisories coming from data integration has resulted in better quality, higher yield and better return on yield for the farmers. This, in turn, has also enhanced their social standing within the community. The smallholder cashew farmers are being seen as role models and are inspiring many others in their villages. Yellaiah reflects, “Before I started working with Digital Green, I was just another farmer. Now, everyone in my village knows me. They come to talk to me not only about their cashew crop, but also if they are growing any other produce. They listen to me attentively. They follow what I advise them to do!”

Seeds of success

At the core of success of this initiative is hyper-localizing the data. Farm level agronomic advisories built on village-level weather data and analytics on a field-by-field basis helps farmers make informed decisions that lead to better crop output throughout the year. This further helps improve the quality of life for farmers as the information they need as well as solutions are available via IVRs and video enabled advisories. “Our solution combines traditional knowledge of natural farming, soil and

weather data to provide farm-level, hyper-local insights,” P Krishnan, Country Director, Digital Green says.

The selection of the crop and target geography are all inextricably linked to the implementation partners. Partnerships with CBOs for agricultural extension is by no means a new approach to Digital Green. The approach had many named and unnamed partners. The science behind the advisories and the scientific accuracy of the video and IVRs were validated by subject matter experts from the Department of Agriculture and Cooperation, the Department of Horticulture, and the Cashew Research Station. Partnerships with the local organizations, namely Kovel Foundation and Velugu Association, that have an existing relationship with FPOs in the four districts ensured scale and reach of the interventions. Strategic partnerships with SkyMet Weather Services and Exotel helped integrate the agronomic content with soil health data and local weather data, and send out timely, targeted advisories based on an algorithm that combined the two data set.

The participatory, video-based learning approach, as demonstrated by Digital Green through its earlier interventions, are nearly eight times more cost effective than traditional approaches (\$3.20 vs \$24 per adoption). **The current approach of fusing weather and soil data with farm level data, and using IVR and SMS as supplementary channels is a marginal increment of US\$3.40 per farmer, making the approach more effective,** not only in terms of outcomes but also by cost, as demonstrated by Digital Green’s interventions.

The next level: Digitally enabling the data driven agronomic advisories

To further improve accuracy and run analytics in real time, there will be reduction in human intervention

in data integration. This use case lays the foundation for FarmStack, an automated platform that Digital Green is developing to integrate data from multiple sources for increasing accessibility of agriculture extension knowledge, improve interoperability among the systems and provide more relevant advisories at a single point for the smallholder farmers. Digital Green will set up a digital platform for agriculture that applies artificial intelligence, machine learning and advanced analytics to the weather, soil and farm data to provide valuable insights and automatically generate agronomic advisories for smarter decisions. More data will help improve accuracy of predictive analysis and generate more relevant, farm level advisories.

Building digital platforms for agriculture has some challenges that needs to be considered, like the lack of clean data. These data are often locked in closed systems due to lack of trust and fear of it being misused. Success at scale will need collaboration with data generators and data providers to build secure, open source, peer-to-peer data management protocols for sharing data on factors such as soil nutrients and moisture, irrigation quantity advised and achieved, weather, pests/diseases, crop yields, etc. for every farm.

This approach will be tested with various use cases and in different agricultural bubbles to assess (a) the comparative advantage of data integration over standalone data points, (b) whether any additional data sources are required and (c) the multiplier effect that communication technology can have in adoption of desired practices. While there are early positive indications of the social and gender impact of this approach, it is not yet conclusive. The social empowerment and gender dimensions of this approach needs further study.

Conclusion

Agriculture in India is the core sector for food security, nutrition security, sustainable

development and for poverty alleviation, as it contributes to nearly 14 percent of the country's GDP, with smallholder farmers contributing nearly 40 percent of it. The need to empower smallholder farmers by harnessing the collective power of technology and grassroots-level partnerships drives Digital Green's approach. The case study provides further examples of the tools and approaches that the organization has piloted and how they will lead to increased impact.

The future of agriculture is not only in Big Data but also in effectively communicating with the farmers. The current approach has shown the advantages over the conventional approaches by going hyper-local with weather data, soil information and crop profile to generate farm level agronomic advisories and then delivering them in local language through

easy-to-understand format unified through video-enabled approach and supplementary channels, like IVR and SMS. This is an ongoing effort, which has shown a lot of promise in improving the quality and yield of a crop in a single season, besides showing early positive indications of the social impact of adopting this approach.

This approach ushers in a new era data driven decision making in agriculture in which Digital Green and its partners can empower smallholder farmers with "better, cheaper and planet-friendly" techniques. It highlights valuable lessons for organizations working to empower smallholder farmers with data enriched advisories for improving crop yield and quality and improving their social and economic health.



Biddika Yellaiah showing the yield and quality of cashew nuts after adopting the natural farming practices

Digital
Green

Connect



About Digital Green

Digital Green is a global development organization that empowers smallholder farmers to lift themselves out of poverty by harnessing the collective power of technology and grass roots-level partnerships.

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