

Transforming agriculture

with data-driven insights

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Agriculture forms a major fraction of the GDP of our country. Large parts of this ecosystem are yet untouched by technology that could significantly boost productivity while reducing cost. India is a country of small land-holders. Small farms often pose challenges in making affordable personalised assessment possible at different stages of cultivation from pre-sowing to post-harvest. Fortunately, in the last few years, several forces have helped shape the agriculture ecosystem to make a lot possible.

Key words: Agriculture, Digital farming initiative, Technology

RAPID strides in technology have created an environment where there is a multitude of data sources from satellites to devices on the ground that sample the environment at regular intervals. Advances in machine learning with deep learning have made it possible to derive a lot more value from the generated data. Moreover, aggregation of land holdings through farmer producer organisations (FPO) is helping on two fronts – affordable gathering of data through shared technology and delivery of insights for the larger aggregated region which could help drive both agri-input supply for cultivation and post harvest collection.

Are things really that simple? Not at all. Given the sheer diversity of crops and their varieties along with the large number of external factors affecting each one of them such as diseases, pests, and deficiencies due to air, water and soil-borne elements, the dimensionality of the challenges on the farm to minimise risk and get the best crop value simply explodes. Compounding the problem is the reality of climate change. No rains in rainfed areas, unseasonal rains, cyclones, and global warming in general are playing havoc with crop

cycles, disturbing the entire equilibrium. Accurate information to help time the markets for best price realization is non-trivial. Further, the farm to fork journey for each crop is fairly distinct and guided by the manner in which it is processed and consumed. So, there is a sizeable variability both on the farm and beyond it in terms of how data-driven interventions can be carried out to impact the ecosystem and more importantly make Indian Agriculture sustainable in the long-term.

The Tata Consultancy Services (TCS) Digital Farming Initiatives (DFI) program was started in 2007-08 in response to farmer distress with the objective to see how technology could bring about a positive change in the farming scenario. Realising constraints associated with deploying technology for small farms, DFI started by supporting the digital empowerment of FPOs and even creating a few experimental FPO's to fast-track the process. The *mKRISHI*® platform from DFI when injected into an FPO, is converted into a PRIDE (Progressive Rural Integrated Digital Enterprise), a vibrant digital entity that is connected to the farming ecosystem

consisting of input, post-harvest players with support of government and research institutions. The study focused to offer data-driven digital services for food crops (such as potato, rice) largely covered by PRIDE's and plantation crops (such as grapes, tea) that are usually grown over large contiguous regions in organised and semi-organised setups have been bearing fruit. They have brought about a visible difference in the life of the farmer and how the support ecosystem players such as procurers and input providers interact with the farmer.

Yield loss due to pests and diseases is one of the major pain areas across crops as noted earlier. One of the TCS earliest work towards this is effective forecast of the deadly Late Blight disease of potato in Uttar Pradesh by micro-climate monitoring with sensors [2]. This involved strategic placement of sensors on the ground to regularly report ambient parameters where the forecast was validated with our mobile-based participatory sensing model that was used to report incidents. While accurate forecast is essential, it is non-trivial to achieve this in practice often due to unavailability of sufficient data at the right resolution (which can be

expensive) and changing climatic conditions in a region coupled with variability in pest movement and behaviour. Early detection of pests and diseases from crop images can be quite effective in such situations to combat the situation and take measures before it aggravates. We have worked on advanced machine learning models that help convert image data from farm incidents to actionable insights, which are instrumental in taking timely action both on the field and in mobilizing the movement agri-inputs to the necessary regions.

A macro-view of agricultural regions is paramount in helping various planning activities from pre-sowing to post-harvest in alignment with crop seasons. From assessment of net-sown area early in the season to detection of crop-health issues and prediction of end-season yields, imagery from the sky through satellites and drones have made significant progress in helping generate insights at regular intervals to drive action on the ground. In the recent years, numerous new satellites that operate in optical and other bands have made rich contribution to the quality of data that is being leveraged to deliver the right value at

the right time to the agricultural ecosystem. The TCS work has been as diverse as in-season assessment of rice growth stages in Andhra Pradesh coupled with warning for unseasonal cyclones to estimating extent of stubble burning in the Punjab region – a major source of pollution. Even soil moisture could be estimated to certain extent to understand the broad effects on crop growth in a region.

Innovation lies in the details. While a macro-view addresses many issues across crops, a deep-dive into operational aspects and peculiarities associated with each crop and the related industry unearths so much more value that can be derived with highly contextual data. For example, the TCS have developed insights from wearable devices that have helped distinguish between sub-activities of tea-plucking. This could go a long way in imparting specific training to tea workers to reduce variability in quality of tea and maximise yield [5]. To carry out a detailed analysis on factors affecting specific crops of interest towards pest and disease forecast, irrigation scheduling, systematic study of symptoms associated with diseases and deficiencies, and many other

aspects, we have created demo farms with a pervasive deployment of sensors covering over 14 parameters above and below the soil. The TCS took, for example, Cabbage and Capsicum as the crops in one demo farm for *Rabi* of 2017-18 and achieved significant improvements in yield[6].

The study have presented here only a glimpse of how deep value from rich data – the cornerstone of artificial intelligence (AI) – can touch various facets of the agriculture value chain and bring about a lasting effect. From mechanisation in farms to process automation in factories, advancements are on in many pockets. While Blockchain is digitising trust and establishing a tamper-proof chain of custody as the crops move from farm to fork, intelligent systems are assessing quality of the product at each link of this chain. At the heart of the digital forces impacting agriculture lies big data, and in unlocking the potential of this data with AI lies the secret to transforming agriculture as we see it today.

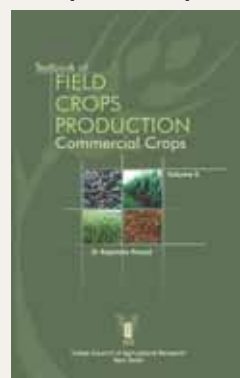
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Textbook of Field Crops Production – Commercial Crops

(Volume II)

Availability of high-yielding varieties/hybrids and increased irrigated facilities have resulted in the development of production-intensive cropping systems in several parts of India, and this has catalyzed further agronomic research based on the cropping-system approach. Many changes have also taken place in the crop-production technologies. And this necessitated the revision of the earlier publication brought out in 2002. The revised textbook is in two volumes: First is covering Foodgrains and second is on Commercial Crops.

The discipline of Agronomy has no longer remained mere field trials without application of discoveries emanating from the related disciplines of Genetics, Soil Science and Agricultural Chemistry, Plant Biochemistry, etc. The future Agronomy Landscape will face challenges of climate change, transboundary issues, TRIPS and other trade-related barriers, biotic and abiotic stresses, consequences of biotechnology and genetic engineering and increased market demands in terms of quality assurance, customized food crops, global competition, ecosystem services on land and social equities etc. The Agronomy must measure up to these futuristic challenges with well-defined metrics and methodologies for performance. The advent of hydroponics, precision farming, bio-sensors, fertigation, landscaping, application of ICT, GPS and GIS tools and micro-irrigation is in the horizon. This revised edition in two volumes covers fundamentals of the subject and at the same time will inspire and prepare teachers and students for the emerging frontiers.



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