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Enhancing Capacities of Digital Extension and Advisory Services in Odisha, India

Ditty Maria Dominic, **Nimisha Mittal**, and **Rasheed Sulaiman V**
Center for Research on Innovation and Science Policy (CRISP)

Preeti Bharti and **Sheetal Sharma**
International Rice Research Institute (IRRI)

Abstract While several digital platforms and applications developed for farmers collect data and information, more is needed to know about their use by the Extension and Advisory Services (EAS) to provide more relevant advice or design a data-informed extension. This report discusses what needs to be done to enhance the capacities of EAS based on in-depth reviews of farmers' use of three digital farmer services available in Odisha and interactions with select stakeholders who are familiar with and are part of these services. We found that EAS stakeholders needed to be fully aware of the types of data and information available or how best they could be used. We identified that four specific types of capacities need to be strengthened coherently and systematically.

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Background

While several digital platforms and apps developed for farmers collect a lot of data and information, more is needed to know about its use by Extension and Advisory Services (EAS) to provide more relevant advice or design a data-informed extension strategy. This study attempts to find out primarily what needs to be done to enhance the capacities of EAS in using data and information available with Meghdoot, IRRI's Rice Crop Manager/WeRise, and Ama Krushi in Odisha. Before answering this question, we need to understand what type of data is available, in what form it is stored, and how it could be shared with others who can use it. We first reviewed existing studies, reports, and good practices available on this topic and then interacted with select respondents who were familiar with and are part of some of these services during the workshop organized by IRRI in Odisha in November 2022.

Insights from the Review

Digital agriculture

After mechanization, the green revolution, and precision farming, the agriculture sector is being revolutionized by digitization. This new era has been acknowledged by various terms such as agriculture 4.0, smart farming, etc. With the help of technology, digital agriculture has the capacity to drive and assist complex decision-making, both on-farm and along the value chain, by changing data into actionable knowledge. It has the potential to enable farmers to access on-farm, location-specific information, as opposed to previous sources of knowledge that were based on broad understanding and research studies (Poppe et al., 2015). In light of this, digital agriculture symbolizes a transition in agricultural resource management from generic to highly optimized, personalized, real-time, hyper-connected, and data-driven management (Van Es and Woodard, 2017).

The three pillars of digital agriculture are robotics, sensors, and big data analytics platforms. The scope and importance of the latter have been widely looked into in recent times. With the high-paced advancements in technology, digital agriculture is expected to provide multiple gains to farmers as well as the multiple stakeholders in the value chain. The technologies in digital agriculture are classified as embodied knowledge technologies like yield monitors and information-intensive technologies, which use data collected from the farm as input into a decision support system that generates a prescription for the variable inputs (Ingram and Maye, 2020). But new capacities and decision-making models are required to utilize these information-intensive technologies to their full potential. Digital platforms and apps have the power to fundamentally alter how information is processed, shared, accessed, and used. Digital applications will enable hitherto impractical decision-making for farmers, perhaps resulting in fundamental changes to farm management. Farming operations will become more data-driven and data-enabled as smart devices and sensor networks are deployed on more farms, enhancing farm data volume and its scope (Wolfert et al., 2017). Critical considerations are raised regarding how digital agriculture may impact existing forms of knowledge processing, necessitate the development of new capacities, facilitate decision- making, and exploit the existing knowledge management channels.

Big data in agriculture

Massive data generation is a by-product of the ever-evolving digital agriculture era. As noted by John Baer, "We are surrounded by data but starving of insights". According to Coble et al. (2016), big data is a sizeable, multifaceted, complicated, and dispersed data set collected from various sources. When it comes to agriculture, big data can combine all forms of contemporary technology with data analytics to make decisions that are only informed by the data (Jakku et al., 2018). In several industries, big data applications are already being used to boost profitability and productivity (Davenport and Dyché, 2013; Kitchin, 2014; van Rijmenam, 2017). Big data applications may also alter the power and role dynamics among many players in the agriculture industry (Bronson and Knezevic, 2016).

Earlier deployment of Big Data in agriculture indicate that their success depends on a variety of social and technical aspects, including stakeholder openness to sharing and integrating data, acceptance of the technology solutions by farmers, and the presence of protocols for safeguarding users' rights to privacy, data ownership, and control (Eastwood and Yule, 2015). The big data are of little value unless they can be turned into actionable knowledge that can be used as customized decision support tools for farmers (Janssen et al., 2017; Weersink et al., 2018). Big Data analytics has been viewed as a tool for both predicting farm output, optimizing production and improving marketing decisions, i.e. by forecasting agricultural commodity prices, consumer preferences and food demands (Wu et al. 2017; Satheesh et al. 2015; Lusk 2017).

However, according to experts, we are better at gathering vast volumes of data than at turning it into useful or actionable knowledge. (Ingram and Maye, 2020). For tapping the full potential of digital agriculture, data analytics is essential, however up to this point, the interpretation and application of data from digital technologies and devices have fallen short of expectations, and the capacity to efficiently analyze this data has been constrained (Leonard et al., 2017). So, although we cannot completely attribute the limited exploitation of data generated from digital agriculture to a lack of data analytics and data usage capacities, it is evident that the capacities of the AKIS need to be enhanced (Lowenberg-DeBoer and Erickson, 2019). Also, studies (Kamilaris et al., 2017; Fountas et al., 2015; Ortiz-crespo et al., 2021) suggest that co-creating digital technologies with farmers or end users also needs to be emphasized as top-down approach in designing and delivering advisories often fail to diagnose the actual filed level difficulties, problems by farmers and delivering apt advisories (Cole and Fernando, 2021) for instance like the co-designing approach adopted in Australia for nitrogen management in sugarcane production where engagement between researchers, farmers and advisors incentivized on-farm practice change by aligning technology design and information presentation with different values held by targeted end users (Porciello et al., 2021; Stitzlein et al., 2020). Multiple user-oriented design methodologies for the development sector exist, often referred to as 'human-centered design' (Bazzano et al., 2017). Hence while looking into the extent of use of digital extension tools, the word appropriation needs to be considered rather than adoption (Glover et al., 2019) and consider farmers as fellow creators (Coggins et al., 2022).

Digital agro-advisory services

Globally, digital extension initiatives are upending newly emerging, data-rich approaches in agriculture (Nettle et al., 2018), replacing conventional farmer extension agent engagements with intricate, back-end data collection and analysis procedures (Eastwood et al., 2019). Advisories are essential to enhancing rural livelihoods, attaining food security, boosting productivity, and promoting agriculture as a source of economic growth for the poorest people (IFPRI, 2020). Both in developed and developing countries, digital extension initiatives are gaining traction among farmers (Steinke et al., 2021). Thus, digital agricultural extension can enable a break from the cycle of low production, vulnerability, and poverty, particularly for smallholders (Davis and Franzel, 2018). Few of the prominent digital initiatives delivering data informed services in developing countries are "Farmstack" in Ethiopia, which integrates farm-level data, local weather, input availability, and market information (Digital Green, 2019), and in India, advisories about weather and disease forecasts, markets, and other information are sent by SMS or voice message alerts by agencies such as the farm science centers, IFFCO Kisan Sanchar Limited (IKSL) (Saravanan, 2010; Das et al., 2016; Cole and Fernando, 2021) and other private companies like, DeHaat providing end to end solutions and services with AI enabled technologies to enhance supply chain and production efficiency.

Although past studies report low adoption of digital agro-advisory services by farmers, especially in developing countries, the COVID-19 pandemic has compelled farmers to trust and adopt these services as there was no option for in-person extension advisory (GSMA, 2022). Thus, farmers are now acclamatory to digital advisories than before (Singh et al., 2022), but need based and context-specific information requirement of farmers is highly unfulfilled as most of the digital initiatives deliver generic information rather than data-driven advisories customized to the specific farm plot or crop (Cole and Sharma, 2017; Steinke et al., 2019; Arouna et al., 2021; Bhattacharyya, Wani and Tiwary, 2021). A review of agricultural extension approaches in India reveals that the farmers generally struggle to receive reliable information relevant to them at the right time (Glendenning et al., 2010) and this is mostly due to lack of adequate interactions between the stakeholders on the agricultural value chain (Feder et al., 2010).

Due to this information inefficiency (Cole and Fernando, 2021), farmers in developing countries rely on their own experiential knowledge based instincts, observations, experimentations, input agents and peer opinions as their primary information source for decision making (Birner and Anderson, 2007; Fafchamps and Minten, 2012). This current scenario provides huge scope of utilizing data from digital tools in smart farming that has enormous legacy data (Wolfert et al., 2017), like from sensors measuring animal, plant, soil, and water parameters (Rutten et al., 2013; Hostiou et al., 2017; Neethirajan, 2017), and online data platforms, to generate more customized advisories by enabling effective stakeholder interactions (Eastwood et al., 2015).

Extension capacities

The farmers in isolated rural areas lack access to credible scientific information to adopt effective management activities on the farm and, digital agricultural extension is a cost-effective and efficient tool to close this gap (Cole and Fernando, 2021). A big and dispersed farming community with a variety of farming conditions, needs, and challenges, and thus, information requirements must frequently be reached by agricultural extension services. Digital technologies could enhance the effectiveness of extension by reducing outreach costs and helping to better tailor the information to farmers' individual needs and conditions. Results from a study in India (Rajkhowa and Qaim, 2021) reported that use of customized digital extension services is positively and significantly associated with input intensity, production diversity, crop productivity, and crop income. Though digital agriculture tools can supplement Extension and Advisory System's (EAS) effort in delivering information services to farmers (Ayre et al., 2019), this calls for a need to assess the capacities of extension and advisory systems to respond to the new demand (Eastwood et al., 2016; Rijswijk et al., 2018). The capacities to nurture new collaborations and networking between technology providers, research organizations, knowledge providers, service delivery partners, and other stakeholders (Lundström and Lindblom, 2018); capacities to collect feedback (Jones and Kondylis, 2018) would be vital.

Although there is an impending role for technology providers to take on extension support for farmers and act as knowledge "interpreters," their understanding on farming systems may not match up that of the EAS agents (Eastwood et al., 2015). Hence the advent of digital technologies can seldom replace the role of extension agents (Fuchs et al., 2016). Enhancing capabilities at every level, from the farm and adviser level to new technology providers and established researchers will be important if digital technologies are to make a real impact (Ingram and Maye, 2020). As policymakers hire extension agents to produce public goods and services for farmers and farm communities, the agents must be responsive to the needs of both the policymakers and the communities simultaneously (Speilman et al., 2021). No one curriculum area would suffice to enhance competencies in data management (Tang and Sae-Lim 2016). Effective algorithms or models used in predictive analytics require both data science expertise and specific domain knowledge (cf. Antle et al. 2017).

Big Data is bound to transform the role of extension and the nature of advice provided to farmers by extension professionals and other educators. Agricultural educators and extension specialists would require more data and use cases assessment, possibly in a sizable and easily accessible database, to demonstrate how advanced data analytics may impact agricultural development (Varshney et al., 2015). Current technological progress outpaces the education and capacity of the agricultural extension system. Successful implementation of Big Data would require enhanced education and communication among all stakeholders engaged in the agrifood chains (Kosior, 2017). Fundamental challenges highlighted in the literature relate thus to developing skills needed for interdisciplinary collaboration and good communication within the data value chain. Most of the extension work hence will have to focus on communicating and explaining innovative opportunities arising from the use of Big Data technologies (Coble et al. 2016). These developments undoubtedly will demand EAS to enhance the capacities in knowledge management, communication and enabling innovation (Leeuwis 2013; Kosior, 2017).

It is equally important to look into the existing inherent challenges, in both public and private extension organizations like lack of funding, lack of field level staff and the related transportation costs for farm visits and one-on-one contacts (Taylor & Bhasme, 2018) for enhancing capacities of EAS. The amount and quality of advising interactions are frequently impaired as a result of these limitations. The performance of the advisory personnel is not routinely reviewed and consequently, they are seldom motivated to increase their service delivery efficacy (Davis, 2008; Jones & Kondylis, 2018).

Metadata

The future of agricultural research, according to Harper et al. (2018), "depends on data," and the vast amount of agricultural data produced today "makes efficient data management crucial." The value of data, according to these writers, "increases tremendously when it is correctly kept, documented, integrated, and disseminated, allowing for easy use in future studies." Making data findable is the first step in using big data in agriculture for advanced services. Data are made more findable by having rich metadata. The term 'metadata' generally refers to 'information about information' or 'data about data' (Brand et al., 2003), and there are increasing calls for metadata to be treated as equally important as the objects they describe (Kircz and de Waard, 2003). However, metadata records vary greatly in their richness; that is, how much or little of the data is described and captured in the metadata record, where generally the 'richer the metadata record, the greater the possibilities' (Brand et al., 2003). The creation and use of meaningful metadata are now recognized as crucial elements in providing value-added services (Simek et al., 2013).

Metadata is increasingly being used to detect trends and obtain insights into social, economic, and political interactions (Conte et al., 2012; Oh & Park, 2018), like the On-farm trials metadata of the Australian grains industry made available through Online Farm Trials Website (Walters, Light and Robinson, 2020). There can be well-curated, deeply-integrated, special-purpose repositories as well as traditional, low-throughput, less curated, general-purpose data repositories. Both of these datasets are of equal importance with respect to integrative research, reproducibility, and reuse in general. The resulting data ecosystem, therefore, appears to be moving away from centralization and is becoming more diverse and less integrated thereby exacerbating the discovery and re-usability problem for both human and computational stakeholders.

Challenges in using (big) data

Data-driven research initiatives in agriculture have a number of challenges, according to da Cruz and do Nascimento (2019), including an inadequate infrastructure that is suitable for storing and preserving data and challenges with sharing datasets. If the desired datasets existed, where might they have been published, and how would one begin to search for them, using what search tools? The desired search would need to filter based on specific types of data. Is that information ('metadata') captured by the repositories, and if so, what formats is it in, is it searchable, and how? Once the data is discovered, can it be downloaded? In what formats? Can that format be easily integrated with private in-house data as well as other data publications from third parties? Can this integration be done automatically to save time and avoid copy/paste errors? Does the researcher have permission to use the data from these third-party researchers, under what license conditions, and who should be cited if a data point is reused? Questions such as these highlight some of the barriers to data discovery and reuse, not only for humans but even more so for machines (Wilkinson et al., 2016).

Making sense of the massive data is difficult

Data is just numbers until the useful information is derived from it. The primary barrier to achieving the competitive advantage that big data can offer is a lack of understanding of how to use analytics to derive the information to improve the service (Lycett, 2013). Identifying use cases is thus important for making sense of the big data as it will give a primary direction in which the massive data need to be analyzed. Data collection, processing, cleaning, and analyzing are the processes in data analytics, and the pace at which data grows makes it challenging to undertake these processes.

Poor data quality

Big data does not always mean better data. Duplicity, inadequacy, and inaccuracy are major issues in big data that causes poor data quality. This poses a great challenge in the analysis of big data. Poor data gives poor insights. Hence due to the sheer volume of data, there is a need to understand and repair erroneous data in a scalable and timely manner (Saha and Srivastava, 2014).

Data sharing issues

Ownership of the data, data sharing cost, interoperability of the data, and data privacy are the key issues that limit data sharing (Kaewkungwal et al., 2020). The ownership of the data is a big question that needs to be answered to know who can decide upon data sharing. The data will be stored in different formats that might not be compatible with the system requirements of other stakeholders questioning the interoperability of the data shared. Also, data privacy and confidentiality is other major issue that hinders data sharing.

Lack of data standard

A data standard is a guideline or series of guidelines that define the way in which data should be collected or structured. By following the standard, similar data can be easily compared over time, across locations, and within and between organizations, as well as being easily manipulated to produce visualizations and identify trends. In other words, they help to make reuse simple.

Lack of data infrastructure for agriculture

Many of the current limitations of agricultural advisory (agro-advisory) services are due to imperfect information flows between the stakeholders of a complex knowledge system, including farmers, traders, processors, extension agents, and researchers (Faure et al., 2012). The sheer volume of data being produced means that excellent data management is essential (Harper et al., 2018) and for this data infrastructure should also be well-developed.

Digital Agriculture Tools in Odisha

We reviewed some of the digital tools being used in Odisha to provide information and advice to farmers. These are presented in Table 1.

Table 1 Types of digital tools currently being used in Odisha

Digital Tool	Services/ advisories provided	Information available in the database
Rice Crop Manager (RCM)	Provides site-specific nutrient management advisories for both rainfed and irrigated rice crops.	Demographic details of farmers (District, block, panchayat, village), land size, season for which recommendation is needed, irrigation details, crop establishment details (sowing/transplanting-date/month), rice variety, past season yield, previous season crop, fertilizer applied during the previous season, preferred P containing fertilizer, details about the person accessing RCM (name, gender, affiliation)
AmaKrushi	Ama Krushi is a free agricultural service run in collaboration with the Department of Agriculture, Government of Odisha, which provides customized agricultural advice to farmers at no cost. It provides customized advisory services according to farmer needs. Information regarding the full crop	Personal and demographic details of farmers, cropping details (crops grown, land area), preferred advisory topic, feedback

	cycle of major crops in Odisha, right from soil preparation to storage of harvest, minimum support prices (MSP), and various government schemes related to agriculture. Service delivery modes are IVR, call center hotline, radio, and SMS	
Meghdoot	Meghdoot is a simple and easy-to-use mobile application that provides crop advisories to farmers based on weather information. It is a joint initiative of the India Meteorological Department (IMD), the Indian Institute of Tropical Meteorology (IITM), and the Indian Council of Agricultural Research (ICAR). The app provides district-wise advisories on crop and livestock management issued by Agro Met Field Units (AMFU) every Tuesday and Friday based on past and forecasted weather information. It will help the farmers to make weather-sensitive decisions like the sowing of crops, pesticide and fertilizer application, irrigation scheduling, and vaccination of animals.	Past weather data, real-time weather data, farmer details, and agro advisories on major crops. The same advisories are delivered to all the farmers in a particular district.
Krushak Odisha – DAFE, Government of Odisha	It is an online single window platform for the application of government schemes and services of the agriculture and allied sector, with 7.5M farmers registered in it. Relevant information, such as guidelines and eligibility criteria for all schemes, is available on the platform. Farmers will also be able to track the real-time status of their applications.	Demographic details: Aadhar details, Address, gender, caste Occupation details: Crop cultivator (landholder/ sharecropper/ tenant) /agricultural laborer (min/marginal), activities done (crop production, animal production, fisheries, forestry), cropping land details, land type (low medium/high land), crop cultivated (kharif/Rabi/Zaid), land size, farming practice (organic farming, natural farming, mixed cropping), Farm machinery and equipment used, animal details (types and numbers). Bank details.
ADAPT (DSS) Portal – Government of	The aim is to help farmers to increase their agricultural productivity by streamlining the supply chain of raw materials, providing customized pest	Data from multiple departments are collected. Information on schemes, crops, pests/diseases, input supply chain, GIS data, etc.

Odisha, BMGF & Samagra	advisory services, and delivering information about markets and modern technology. 6.5M farmers are registered. ADAPT dashboard integrates agricultural data from multiple databases into a single online portal for use by government officials. Through public campaigns and extension workers, pest and weather advisories, along with information on seed treatment, soil health, irrigation, and insurance, are disseminated to farmers. Implements KALIA Scheme. Approach: leveraging data and technology to arm the state Govt. and farmers with timely information that can translate to informed choices.	
GoSugam Portal – Government of Odisha	Single window unified gateway for agrarian management. All farmer-centric schemes and services of the fisheries and animal resource department (F&ARD) and DAFE are digitized on the portal. The aim is to transform the lives of farmers by leveraging technology and fostering teamwork among government officials to enable the timely and transparent delivery of benefits to farmers. Schemes can be availed for setting up the backyard, semi-commercial/ commercial units involving seasonal crop farming, perennial crop farming, livestock rearing, and aquaculture.	Farmer details, land details, bank details, the experience of the farmer in the sector,
e-pest app – DAFE, Government of Odisha	By the use of pest surveillance technology, insects and diseases are identified, and the presence of predators and parasites is counted. Pests and diseases are effectively managed through the application of an eco-friendly integrated pest management system. It is used by farmers, VAW, AAO, and other department officials. The users, mainly VAWs, can upload a picture of	Crop details, land area, pest identified with photos, Farmer details (Aadhar ID, farmer ID, mobile number.

	the pest and get advisories instantly, who then share them with farmers.	

What type of data is available?

We reviewed the common types of data and information provided by those digital tools and categorized them as shown in Table 2.

Table 2 Different types of data available in the varied digital tools

Data Groups	Data Categories
Administration and legislation data	Government law and regulations
	Official records
	Governmental finance data
	Project data
Socioeconomic data	Land use data/ productivity data
	Value chain data
	Infrastructure data
	Market data
Natural resources, earth and environment data	Metereological data
	Hydrological data
	Elevation data
	Soil data
Agronomic data, agricultural technologies	Production advice
	Pest and disease management data

Is EAS aware of this data?

The extension functionaries operating at the field level, like the AAOs, VAWs, and CSCs, are not fully aware of the existence of these databases, especially on how to make use of these, as they are more focused on service delivery and achieving targets set by the service providers. They lack capacities related to data management and analysis. However, scientists and program staff of IRRI are well-aware of the existence of these databases but have not yet used these to design specific extension interventions.

How are the users applying it and benefitting from it?

The potential of using the data for advanced and tailor-made advisories is high. But as of now, it is not being exploited. Data is not analyzed and applied, as the EAS doesn't feel obliged to do so. Moreover, there are no impact studies or case analyses to draw lessons. Feedback from users is rarely collected. There are no incentives to scale up these digital applications, and as most of the services are designed as projects with a specific duration, there is no real ownership after the project ends.

Who can use this data, and how can others access this data?

Ideally, this data could be used in a number of ways. Both public and private sector EAS stakeholders could use these to formulate improved policies and schemes based on user feedback, identify gaps in service delivery, and fine-tune their services to the needs of the users. Similarly, research organizations could use this data to identify priority needs and organize research accordingly.

What purpose could it be put to use?

To provide value-added and customized services

With digital agro-advisory applications, useful insights into farmers' changing knowledge needs could be generated as by-products of farmers' use of the service itself. Take as an example Google, which as a company knows much about its users' interests and knowledge needs – not by asking them directly, but by analyzing users' queries to its service, an online search engine.

Developing user-centered designs

In user-centered design, future users (farmers, extension agents, or researchers) participate in specifying the problem, selecting partial solutions, and refining a new digital tool or service through iterative trials. The multitude of apps existing is collecting as well as generating a massive amount of data on different aspects from the users, which can be used to identify trends and demands of users.

Farmer data profiling

The concept is for an organization to aggregate all the farmers' profile information under its umbrella and then leverage this information to support service development. Profile data gives deep understanding and knowledge of their members and, in particular, who they are, what they do, where they live, and what they produce, etc. This data can be used for planning and strategy, enhanced communication with farmers, a better understanding of farmers' needs, demands, constraints and identify opportunities for new services.

Monitoring and evaluation

Most of the digital apps analyze the quality of services delivered using usage data like the number of farmers reached, how often per season each farmer accessed the service, or how many messages per user were delivered, but results from this can be biased, however, because users who choose not to use the service do not provide feedback. Conversion rates could serve as simple and empirical proxy metrics for the quality and farmer-perceived usefulness of advice. Also, feedback mechanisms, where farmers rate the quality of advice, can be built into digital two-way communication around agricultural advice.

Research and agenda setting

Legacy data on agro-advisory services can provide inputs to research agenda-setting through (1) identifying the topics farmers are asking questions about, (2) verifying if adequate answers are available in a formal body of knowledge, and (3) determining which information gaps still exist and could be relevant to be addressed by new research.

What capacities are needed by others to use this data?

Analytical capacity

To make sense of the data, analytical capacities are key. Capacities to analyze data health, capacities to develop models to ensure interoperability of the data, and capacities to identify use cases for the applicability of the data, are some of the essential capacities. The EAS is unable to operate at the scope, scale, and speed necessitated by the scale of contemporary scientific data and the complexity of massive databases.

Technical capacity

The complex algorithms, models, and software that has to be deployed to analyze the massive data for deriving insights require improved technical capacity.

Legal capacity

Storage and management of data are regulated by specific legislation. It is therefore essential to review this legislation and to capture key requirements, such as official declarations, data sharing rights, obtaining farmer consent.

Collaborative capacity

For enhanced digital service delivery, integrating data from various sources like global data (e.g., satellite images, research studies, databases of information about crops, seeds, pests, and diseases, etc.) with farmer-level (credit records, field ownership documentation, etc.) and field-based information (e.g., soil information, geographic location, state of the fields, crops, etc.) is essential. This necessitates that all stakeholders—including public–private sector actors, researchers, and other service delivery stakeholders collaborate and evolve to tap the emergent potential of big data.

Policy Implications

While a large amount of data is collected by several agencies through several modes (both online and face-to-face), the full potential of this big data is yet to be fully realized for agrifood systems transformation. To remain relevant, Extension and Advisory Services (EAS) must support farmers with data-driven advisories customized to the specific farm or crop and to the capacities of the farmers who have to use the advisory. The use of data can also help EAS prepare pre-emptive action and enhance their program relevance by anticipating potential problems in advance. However, the lack of a comprehensive system for mining, managing, and sharing data is a hindrance. Most of these actions are carried on in isolation at random intervals by different stakeholders. As a result, there is a lack of awareness of the potential of the data, a lack of capacities to manage data, and a lack of collaboration among the wide range of stakeholders needed to mobilize different types of knowledge to provide data-driven advisories. All these factors constrain EAS from playing an effective role in agrifood systems transformation. To address these issues, we argue coordinated actions must be taken on three fronts.

1. Enhance capacities to collect, manage and share data to make actionable advice at all levels

Both educational and training institutions have to organize varied capacity development programs focusing on data-driven EAS. To fully realize the potential of data-driven EAS, capacities are needed not only at the technical side (e.g., digital skills and subject matter area of agriculture) but also at the operational side (e.g., facilitation that includes partnerships and collaboration among multiple stakeholders) that support the exchange of data and co-creation of new relevant knowledge). Staff working at varied levels in the organization (e.g., field level, middle, and senior management level) need different types of knowledge appropriate to their level of managing data. Farmers also need to understand why sharing their socioeconomic and farm-level data is critical for generating customized advisories for them. This would need the development of learning materials (e.g., Good Practice Notes), training manuals, and the Training of Trainers (ToTs) on this topic. In the case of Odisha, the Odisha University of Agriculture and Technology (OUAT) and the Institute on Management of Agricultural Extension (IMAGE) have to take the lead in this area with the support of the private and NGO sector that are more actively involved in this space.

2. Develop and promote protocols related to the collection, storage, and sharing of data

Lack of a shared understanding of the collection of data (including issues related to inclusion and gender responsiveness) as well as its storage, sharing, ownership, searchability, and its eventual use has been found to constrain the use of data in agriculture. It is high time that the state initiates consultations among the varied stakeholders to come up with a uniform system of data collection and an agreed protocol that every organization should use to manage data. It would be useful to constitute a group to start working on this issue and organize a few consultations to share and approve the final policies and protocols in this area.

3. Shared learning from practices

EAS should learn from experience from other sectors on how data is collected and used and also within the agricultural sector, especially how the private sector manages and uses data for customized farm advisory. Inviting experts in this area to make presentations on data-driven EAS at the state and district levels would be useful. The state should also have a core group or a Community of Practice after identifying key champions/all those who are interested/have expertise in this thematic area. This platform can be leveraged to scale up some of the successful innovations in applying data-driven farm advisory.

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