ACCELERATING CGIAR'S DIGITAL TRANSFORMATION

A high-level assessment of digital strategy across CGIAR

CGIAR Platform for Big Data in Agriculture

accenture

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CONTENTS

LIST OF ABBREVIATIONS

BDP	Big Data Platform
CGIAR	Consultative Group for International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CIO	Chief Information Officer
CoE	Center of Excellence
DTI	Digital Transformation Initiative
FAO	Food and Agriculture Organization of the United Nations
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IP	Intellectual Property
IRRI	International Rice Research Institute
IT	Information Technology
IWMI	International Water Management Institute
KPI	Key Performance Indicator
MIT	Massachusetts Institute of Technology
OA/OD	Open Access / Open Data
WEF	World Economic Forum

EXECUTIVE SUMMARY

The international development sector is no stranger to disruption; however, the speed and scope of change in the sector today is unprecedented. Moving forward, every economy will become a digital economy of some kind. The total value of digital transformation to industry and society will reach $100 trillion USD throughout the next decade, according to calculations by the World Economic Forum and Accenture (World Economic Forum, 2016). At the intersection of rapidly digitizing economies and dramatic changes in their environmental context, the agriculture development sector has arrived at a turning point: apply and unlock the value of digital tools and technologies or become increasingly ineffectual or irrelevant. We see the change happening already in ways that touch on the core mission of CGIAR. Commercial parties have already significantly reduced the breeding cycle time for crop improvement to three to four years, for example, by applying the computational power of digital technologies (Gary N. Atlin et al., 2017). Moreover, 95 percent of the global population already lives in areas with mobile network coverage (UN Food & Agriculture Organization, 2011) and more than 90 percent of the projected new phone subscriptions in 2020 are based in developing economies, opening new avenues for reaching underserved farmers and transforming agriculture in their favor (GSMA, 2016). Soon, a majority of people on the planet will have interacted with some form of digital technology since childhood.

A portion of those companies that have faced digital disruption have failed. Others have transformed themselves and their industries. We have seen dramatic "big bang" changes in diverse sectors including music (Napster, Apple iTunes), retail (Amazon), and transportation (Uber) (Accenture, n.d.). Changes in development organizations may be more subtle, characterized by a slow degradation of efficiency, funding, and the effectiveness of their interventions if they do not embrace digital tools and approaches to transform their mindsets, operations, and services to keep pace with changes in their socioeconomic context. Funders increasingly demand the program efficiencies, increased reach and innovation, and improved transparency that digital resources can bring.

The challenge of digital transformation also represents an opportunity: CGIAR can leverage digital disruption in the sector and create meaningful new and lasting responses to climate variability, food insecurity and malnutrition, and environmental degradation. To begin to identify the first steps forward, the Platform for Big Data in Agriculture engaged Accenture Development Partnerships to conduct a high-level assessment of the state of digital strategy and how this is reflected in the people, process, and technology investments across the organization. The findings and recommendations of this assessment are structured around five critical enablers for building an analytics-driven organization (Accenture and the World Economic Forum, 2018):

FINDINGS AND RECOMMENDATIONS

The assessment team conducted in-depth interviews with an array of personnel from eight Centers[1], conducted an online survey with the help of Big Data focal points at all Centers, and conducted several interviews and interactive sessions at the Big Data in Agriculture Convention co-hosted by ILRI and ICRAF in October 2018. The most pressing, over-arching recommendations resulting from this process include:

1. **Develop Center-level digital strategies.** A digital strategy for CGIAR must reflect Center-level strategies, yet most Centers reported that they had no explicit digital strategy, and those that did have them noted they could be developed further. Without a well-articulated digital strategy the organization will lack a clear framework for aligning digital investments with the organization's goals and mission.

2. **Improve data findability and accessibility**. CGIAR appears to be struggling with treating data as an organizational asset for itself and the sector as a whole. Greater findability and accessibility of data can reinforce data quality, enable reproducibility of research, and enhance collaboration across the organization and the sector. CGIAR should continue to invest in the key systems for data discovery and use including GARDIAN, CGSpace, and the open data repository Dataverse.

3. **Invest in data interoperability.** The ability to formulate and answer research questions spanning multiple disciplines is critical for responding to multi-faceted food security challenges and data interoperability is a critical enabler of this. CGIAR has made significant progress in defining organization-wide standards for describing data and linking these to reference data ontologies (indeed, CGIAR shows some technical leadership in this regard) but more work must be done to ensure the standards are adopted across the organization.

4. **Invest in digital systems and services for connecting**. Our research found varying maturity in technology adoption and use of new digital technologies. Thoughtful infrastructure investments are required to connect systems within and across Centers to support delivery of research outputs. Cloud technology and open source products merit special consideration when making these investments.

5. **Invest in culture change**. Overall awareness and adoption of digital tools and technologies was found to be low across the organization, and many employees did not feel any urgency to change this. To become a more analytics-driven organization, CGIAR needs to invest in a creating a more digital culture, making it an integral part of processes and performance evaluation throughout an employee's journey with the organization.

More findings and recommendations are presented according to each of the critical enablers (Table 1).

[1] ICRISAT, Bioversity, IRRI, CIP, CIAT, CIMMYT, IWMI, WorldFish

Provide Agile and Digital-Savvy Leadership

Leaders that are knowledgeable about the value digital technology are more equipped to address gaps and adjust priorities as needs in the organization shift. They define a clear digital vision, communicate about it effectively, and reinforce it at every level of the organization.

Findings

1. **The importance of digital transformation is recognized across the board.** Center Directors General, Directors of Research, Data Managers, and many researchers recognize the importance of the digital transformation to the continued relevance of the organization.

2. **Digital tools and competencies are spread across different units and are poorly aligned with each organization's goals**. Digital capabilities are dispersed across the Centers between finite projects, research informatics units, and enterprise IT functions. In the absence of a unifying digital vision and supporting processes, these disparate digital capabilities cannot be driven throughout all levels of the organization nor can they be leveraged as effectively as they have the potential to be.

3. **Digital focal points have limited time and authority.** Leadership has nominated key people in focal roles for digital initiatives, but these focal individuals tend to not have the dedicated time nor a strong mandate from leadership to help drive transformation efforts throughout all levels across their Centers.

Recommendations

1. **Align digital investments to the organizational goals**. Guide digital investments by looking at concrete use cases and specific capabilities to be strengthened and re-evaluate these frequently. Finding the right technology solutions for organizational or research needs will be an iterative process.

2. **Engage an executive to lead the digital transformation.** Those Centers that have not yet defined a digital strategy are advised to designate an Executive from the management team to lead the digital transformation effort and mandate task forces to execute those plans. Many organizations designate a CIO to specify the role of digital technologies in supporting the organization's goals.

3. **Communicate and engage frequently about the transformation effort.** The leadership needs to ensure that the digital transformation is understood and owned at all levels of the organization.

CIO

A Chief information officer (CIO) is an executive role at an enterprise for overseeing development of information technology (IT) strategy and the computer systems required to support the organization's unique objectives and goals.

Mobilize Data and Access Management

Data mobilization and access management is about driving efficiencies and competitiveness through strong data infrastructure and warehouse capability, combined with the right analytics and communication tools. This will create an environment in which data can be easily found, accessed, combined, and re-used.

Findings

1. **Centers do not recognize their data as an asset**. Centers are struggling to recognize and capture the value of their data and, then, subsequently turn this data into an asset either for reproducing or accelerating research or for developing new data-driven products or services.

2. **Adoption of data standards and data sharing lags across Centers.** CGIAR has defined standards for describing data but this is applied inconsistently across the system; data sharing does not form part of a researcher's common practice at most Centers.

3. **Data policies are rarely enforced**. Almost all Centers have data policies in place; however, these are often not enforced by leadership nor are they fully embedded in the processes of the organization. As a result, there is little incentive for sharing data.

Recommendations

1. **Invest in data-standards, -management, and analytics capabilities.** Centers and the CGIAR as a whole should continue to invest in analytics and data management to enable data to be translated into meaningful and reusable outputs.

2. **Invest in change management**. CGIAR and its Centers must continue to invest in the adoption and use of digital and data technologies and standards across the entire organization.

Foster Digital Ecosystem Thinking

The vast range of actors and stakeholders in food security research includes public, private, and non-profit organizations,

TABLE 1: Key enablers for digital transformation (World Economic Forum, Accenture (2018)).

Agile and Digital-savvy Leadership	Forward looking skills agenda	Ecosystem thinking	Data and Access Management	Technology infrastructure readiness
Maintain a strategic vision, purpose, skills and allignment accross management levels to ensure efficient decision-making process on innovation.	Maintain digital mindset in the workforce by making innovation focus of training and hiring programmes.	Collaborate within the value chain (e.g. Innovation Accelorators, Technology suppiers).	Drive competitiveness through data infrastructure and warehouse capabilities conducted with right analytics and communication tools.	Build the required technology infrastructure to ensure strong capablities on cloud, cybersecurity and interoperatbity.

which might be termed the overall "ecosystem" of the industry or field.

Findings

1. **CGIAR has a unique position in the agriculture ecosystem**. The organization is uniquely positioned to be a trusted global intermediary and has the potential to play an important role in building a collaborative community around digital agriculture.

2. **Limited digital ecosystem thinking exists at the Centers**. Since data is not considered an asset, a data sharing culture with the wider ecosystem is often not fostered. Technology partnerships are rarely established at the CGIAR-level and are, instead, formed at the Center level.

3. **There are promising internal models that could be scaled across CGIAR**. The digital agriculture startup accelerator at ICRISAT has fostered active collaboration between global IT firms, startups, policymakers and researchers. The Platform for Big Data has created an International Advisory Board with key industry players such as Mars Inc., Google, GODAN, FAO, GIZ, and Ag Gateway -- an agriculture data standards organization. These are promising approaches for building more engagement and partnerships with the array of actors in the digital agriculture ecosystem.

Recommendations

1. **Further develop CGIAR's partnership strategy**. Alliances and other forms of coordinated action among multiple stakeholders are key to fulfilling CGIAR's mission. A partnership strategy leveraging promising internal models and exploring their replication across CGIAR will strengthen its value proposition to an array of potential partners within the digital agriculture ecosystem.

2. **Explore new business efficiencies and expand capabilities**. Aggregating demand and current spending on "big data" services such as storage, computation, or accessing key datasets for research can enable CGIAR to save costs and access capabilities of new partners.

Build a Forward-Looking Skills Agenda

Infuse a digital mindset in the workforce by making innovation the focus of training and hiring programs. A forward-looking skills agenda helps the organization develop employees who have the skills needed to get the most out of digital technologies.

Findings

1. **There is interest in learning new skills**. Researchers are interested to learn about new technologies and skills (e.g. data analytics), but are time-constrained.

2. **Centers do not have a talent strategy**. Despite the increasing interest among the workforce to develop their digital skills, most Centers lack a well-defined strategy to upskill their talent at the level required for them to perform effectively in the digital age.

Recommendations

1. **Invest in a talent strategy**. Write a plan to upskill staff and explore opportunities to work with partners to train them. The listed skills can also be used for attracting and hiring new employees. This strategy should encompass foundational skills for research delivery (e.g. statistics) as well as newer skills for which demand is increasing (e.g. analytics and machine learning leveraging either the R or Python languages, introduction to machine learning).

Design the Right Technology Infrastructure

Investing in the right infrastructure that enables interoperability and collaboration beyond silos will help CGIAR reach its goals more effectively.

Findings

1. **IT solutions are often isolated between different units within Centers**. Fragmented budgets across research programs and other organizational units led to fragmented and Balkanized IT capabilities in the organization and has contributed to poorly integrated information systems.

Recommendations

1. **Align technology investments with organizational strategy**. Technology infrastructure must support the necessary business functions or capabilities needed to cost-efficiently execute the strategy. Aligning these investments with the strategy of the organization will provide a more objective means to evaluate technology investments and will support greater interoperability between systems under the common right security and regulatory compliance practices.

2. **Create a more unified IT strategy (as part of the digital strategy).** A unified IT strategy highlights cost savings and opportunities to share research services across business units. Taking stock of the existing systems within Centers will help inform a more unified information architecture vision for CGIAR that can better inform more harmonized IT investments.

Conclusion

CGIAR holds a unique position and the essential capabilities needed to create positive changes in global food security. As a trusted intermediary, CGIAR can help build a thriving, collaborative data and analytics community working toward global food security and human resilience. A more efficient use of data and research products will accelerate the generation of insights into human, economic, and environmental challenges to which the organization can respond. Efficient data usage will also enable policymakers, funders, researchers, and firms worldwide to take quicker action. Digital strategy -- and the digital transformations in the organization that it can enable -- will be central to CGIAR fully claiming this potential in the digital age.

INTRODUCTION: THE IMPORTANCE OF A DIGITAL STRATEGY

The international development community is no stranger to disruption; however, the velocity and intensity of change in the sector today is unprecedented. New players, business and funding models, societal and donor expectations, demographic shifts, globalization and digital technologies are rapidly changing the face of the sector. Ignoring the changing market will result in the decline of efficiency, funding, and, eventually, the ability of the organization to effective positive changes in the world. Data is permeating every aspect of human activity. People in the developing world, for example, are becoming increasingly easier to reach via mobile phones. It is becoming ever more important for organizations to be progressively digital and data-savvy in order to seize the value from these opportunities and stay relevant to stakeholders. Better use of digital technologies will enable the creation of robust responses to some of the most pressing challenges of our time, including climate variability, food insecurity and malnutrition, and environmental degradation.

Research has shown that digitally savvy organizations are 26 percent more profitable and earn 9 percent more revenue with existing capacity than their peers (Westerman et al., 2014). Organizational research has also shown that change can be difficult in large, complex organizations (McCalla, 2017), and that most large-scale transformation efforts fail (Forbes, 2016). Digital transformation efforts face the same challenges; however, a digital strategy with clearly defined objectives is a key factor in ensuring successful organizational change (MIT Sloan, 2015).

A digital strategy must be well-anchored in the organization: it must align with organizational objectives, speak to the target audience, and provide guiding principles and actionable details (MIT Sloan, 2015). A 2016 study by Forbes found that, despite having a digital strategy, many companies still failed to succeed because they lacked one or more of these key attributes. In isolation, digital technologies are no silver bullet for the international development sector. But when they are linked to the organization's mission, programs, operations, partnerships, and people, they can drive profound economic and social transformations.

The Big Data Platform partnered with Accenture Development Partnerships to assess the state of digital strategy in CGIAR. The findings – and subsequent recommendations – have been structured around the five enablers for digital transformation, as defined by the World Economic Forum.

CONCEPTS

A **digital strategy** is the application of digital technologies to develop new or improve existing business capabilities. It defines how an organization can use digital technologies to create new competitive advantages. To be effective, a digital strategy must align with the organization's strategic objectives and outline the concrete interventions needed to implement the strategy (Liferay, 2018).

The term **digital transformation** is often used interchangeably with digital strategy; however, the former focuses on processes and cultural change within the organization. Typically, a digital transformation occurs during the initial period in which the organization is undergoing any changes required to execute the digital strategy.

Although these terms are related, each has a different scope. A digital strategy is a fundamental component of a digital transformation as it ensures that technology implementations align with organizational objectives (Accenture, 2015). A digital strategy provides the organization with a critical reference point or anchor for digital investment decisions, ensuring that these investments help build a foundation from which the organization can achieve its goals. Beyond the initial stages of transformation, a digital strategy guides the organization in executing its long-term plan. This might, for example, guide executives in making decisions related to either technology purchases or identifying new hires.

REVIEW OF DIGITAL ENABLERS AND DIGITAL TRENDS

Every organization is different and needs a custom approach to effectively transform itself into a digitally-capable organization; however, there are some guiding principles that may help minimize inefficiencies and mitigate financial and operational risks while their leadership strategizes about any long-term digital transformation or short term digital opportunities. This section details the five digital enablers and the four digital trends specific to creating successful digital transformation in agriculture in developing countries that may help and inspire CGIAR in forming an effective and sustainable long-term digital strategy.

DIGITAL ENABLERS

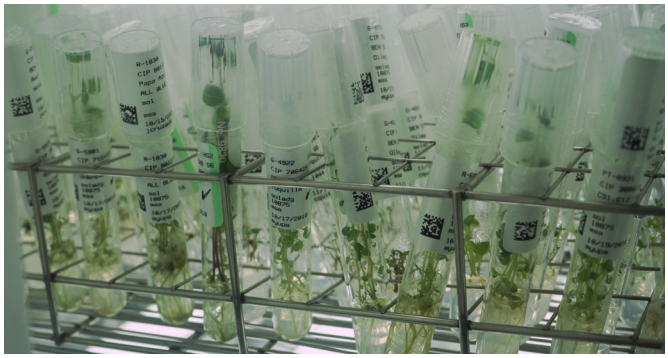
The World Economic Forum (WEF) launched its Digital Transformation Initiative (DTI) in 2015 in collaboration with Accenture to research and evaluate digital transformation developments across 14 industries (World Economic Forum; Accenture, 2018). In a study published in 2018, the WEF and Accenture shared their research into some 16,000 organizations, resulting in an estimate of the positive productivity impacts on investments in emerging technologies by public companies. Using both qualitative and quantitative methods, they identified the five key enablers required for a successful digital transformation. These enablers were found to be essential for accelerating the adoption of new tools, processes, and technological innovations by both end-users and upper-level management. These five key enablers are:

1. **Agile and digital-savvy leadership**: Maintaining a strategic vision, purpose, skills, and alignment across management levels is essential to ensuring efficient decision-making processes on innovation. One example of a company that has demonstrated this kind of leadership is Royal Dutch Shell. It implemented a digital strategy to foster an innovation-led culture in which each line of business is tasked with driving value from data at a working level, supported by a central team of technology experts in solving digital challenges (World Economic Forum, 2018).

2. **Forward-looking skills agenda**: Innovation needs to be the focus of training and hiring programs. An exemplary private sector company is the telco giant AT&T, which embraced the use of more software-defined systems. The digitization of industry between 2007 and 2015 increased the data traffic on AT&T's network by 150,000 percent. To address the company's need for employees with the new, required skills, it started a program called Workforce 2020 and have, since 2013, invested more than $250 million USD in employee education (Harvard Business Review, 2016).

3. **Digital Ecosystem thinking**: Working with a wider ecosystem of public, private, and non-profit partners enables collaboration within and outside the agricultural value chain. Such partners could include, for example, Innovation Accelerators or new technology suppliers. In the development sector, digital ecosystem thinking around data can be seen in the Global Partnership for Sustainable Development Data. This multi-party alliance with a growing network of 300+ members seeks to advance data sharing and harness advances in data and analytics to solve the most pressing needs within the development sector.

4. **Data and Access Management**: Driving competitiveness through data infrastructure and warehouse capabilities conducted with the right analytics and communication tools supports data access and management. Evonik is an example of a digital transformation enabler in the life-sciences private sector. It created a digital lab to improve data management and give the company all the needed prerequisites for building and scaling machine learning and artificial intelligence-driven solutions. The foundation for Evonik's outward-facing digital activities are its internal best practices in data management, supported through strategic partnerships with universities and IBM. Evonik dedicated USD$100 million towards its digitization (Evonik, 2017).



5. **Technology infrastructure readiness**: Building the required technology infrastructure ensures organizations have strong capabilities in the cloud as well as effective cybersecurity and interoperability. A case study by A. Whyte (2013) highlights the collaboration between researchers and the RADAR institutional repository at Oxford Brookes University. They aim to make data more visible and improve the chances of it being accessible to researchers in the long-term through RADAR. Having a complete technology infrastructure created a space in which collaboration could occur and improved researchers' ability to find needed data and assets.

The Findings and Recommendations section of this report further explains how these five enablers could help CGIAR become a thriving digital organization.

DIGITAL TRENDS ILLUSTRATED BY INDUSTRY EXAMPLES

High input costs, low access to information and credit, and declining productivity are threatening African farmers' abilities to grow a thriving, sustainable farming business (Accenture, 2018). In a report focused on digital value in African agriculture, Accenture identified four digital trends that help address these key challenges (Table 2). The adoption of technologies that address and/or enable each of these could help create a thriving, sustainable, modern agriculture value chain. CGIAR

TABLE 2: Overview of digital agriculture trends.

Agriculture trends	Description
Autonomous operations	Adoption of autonomous technology to automate manual tasks and time-intensive activities for an increase in productivity, yield optimization and minimization of human error.
Precision agriculture	Sensors and technologies are combined with analytics to drive effective and efficient use of resources.
Connected supply chain	Technologies for real-time movement monitoring of agricultural products to eliminate bottlenecks within the supply chain.
Digital marketplace	Information and a transaction platform for farmers to deal directly with vendors and distributors for better prices.

holds a key position that could be leveraged to drive and accelerate the adoption of these technologies in developing counties and has the potential to transform rural livelihoods. Accenture has selected various cases to illustrate how these trends are already being applied in the industry and how they are making scalable, but situation specific, impact.

Autonomous agriculture

The use of autonomous technologies -- such as self-driving tractors equipped with sensors, milking robots, and drones -- allows farmers to increase their crop productivity by minimizing human errors, reducing input quantities, and providing them with access to previously inaccessible fields. Companies such as DeLaval and Hello Tractor have brought these capabilities to farmers in developing countries.

Autonomous vehicles generate important amounts of data. For CGIAR, these data sources represent an opportunity for new types of large-scale analysis and collaboration. The data can be enriched with existing data from research efforts on, for example, soil, water, and the in-field performance of particular crop varieties.

Industry examples

Autonomous agriculture

DeLaval has helped Indian women run their own competitive and sustainable dairy businesses. By moving from hand milking to automated bucket-milking, milk production per animal has doubled (DeLaval, 2018).

Hello Tractor, an Uber-like platform for renting tractors, has partnered with John Deere to provide 10,000 tractors to smallholder farms in Nigeria in the next five years. Hello Tractor estimates that, through new access to mechanization they have facilitated, their customers have produced 37 million tons of additional food. The tractors are equipped with connected sensors, enabling the company's IT platform to record and display when a tractor turns, how far it travels, and when it requires maintenance or repairs (Peters, A., 2018).

Precision agriculture

With help of sensors, technology and real-time information precision agriculture empowers farmers to optimize the application of inputs such as seeds, fertilizer, water, and electricity. This enables them to save on input costs and maximize their yields. The capabilities of precision agriculture have begun to appear in developing economies. For example, Microsoft and ICRISAT teamed up to develop the Sowing App, which leverages agricultural analytics and provides a farmer-facing information service. Another interesting and growing communications channel for interacting with famers is Interactive Voice Response (IVR) over mobile phones, as demonstrated by the Avaaj Otalo precision agriculture solution targeting farmers in developing countries.

Through the use of such digital solutions, knowledge from research can be brought to the intended, target audience to make impact in a scalable manner and also provide advice tailored to specific farmers and farming conditions.

Industry examples

Precision agriculture

The **Sowing App** acts as a guidance system for Indian farmers. Early results have shown a 30 percent yield increase and better financial returns for farmers despite irregular rainfall and an overall improved financial return for participating farmers. It uses artificial intelligence combined with a farming management solution, which is based on observing, measuring, and responding to variability in crops. The app guides farmers by sending them targeted and timely SMS messages on farming and research-proven farm management practices (Microsoft, 2017).

The **Avaaj Otalo** service, a mobile phone-enabled farm management service and research project, pushed weekly content such as weather forecasts and pest planning strategies directly to farmers in about 800 households in 40 Indian villages. The system is sustainable. Roughly 80 percent of users experienced a yield increase of 26 percent and each dollar invested in the system generated a return of $10 USD over two seasons (Cole, A. & Nilesh Fernando, A., 2014).

Connected supply chain

By connecting the information systems of all players in the supply chain and by tracking products with sensors and radio frequency ID (RFID) tags across the supply chain, bottlenecks and redundant processes can be eliminated. This results in fresher products for customers, less food waste, and greater transparency regarding product origins. 3S Sustainable Cashew Supply Chain and MyAgro both provide solutions for connected supply chains in developing countries.

Supply chains require collaborations with various parties within and outside the value chain in order to be successful; however, digital technologies enable greater visibility into coordination across the whole chain, opening new opportunities to create shared value among participants.

Industry examples

Connected supply chain

3S Sustainable Cashew Supply Chain has developed a management information system that captures progress made on its sustainability goals via data collected from indicators across the supply chain. Their goal is to make the cashew supply more stable by improving cashew yield and quality, which would directly improve the livelihood of smallholders and the stability of future supplies. The system

informs users on training from institutions and shares best practices with local farmers. (ChainPoint, 2019)

MyAgro is a mobile phone-enabled financial product for women smallholder farmers designed to help them save money on inputs such as fertilizer and seeds. Smallholder farmers struggle to buy these products every year due to low income and the absence of bank accounts, which makes bulk purchasing difficult. MyAgro helps farmers to put money aside in small amounts, through the same mechanism that they would use to pre-pay talk time on their mobile phones: the purchase of a scratch card. Farmers use this card by dialing a phone number and loading money into a virtual bank account. MyAgro partnered with local stores to create a convenient, trustworthy sales network used to deliver high-quality seeds and fertilizer. As a result, participating farmers accessed genuine, good quality inputs and advice, enabling them to have successfully increased their crop yield by 50 to 100 percent (MyAgro, 2019).

Digital market place

A digital marketplace eliminates information asymmetry by providing farmers with a platform they can use to exchange information with buyers and make transactions. By eliminating intermediaries, a digital marketplace provides farmers with easier access to input products and information, resulting in better prices and increased profit. IVR Market and the Indian government provide digital marketplace solutions for small farm holders they can use to help increase their bargaining power.

A digital marketplace also generates significant data of interest to researchers seeking to better understand food system flows and overall market dynamics.

Industry examples

Digital market place

IVR Market helps aggregate the small holder farmer value chain in Nepal. This subscription-based service provides pre-recorded voice messages (IVR) connecting buyers with sellers and allows them to discuss location, price, and volumes via a toll-free number via mobile phone. By connecting sellers and buyers, the IVR service is becoming increasingly important to rural isolated farmers, a group also targeted by CGIAR (CGIAR, 2017).

The Indian government has dedicated $30 million USD for the creation of a national **online agriculture market trading portal** to tackle the problem of distress selling. To eliminate the asymmetry that often occurs within smallholder farm markets, the government charges a premium of 2 percent of the sum insured for all Kharif crops. This portal favors the wet-season crops on which most Indian smallholders rely (Garcia, M., 2016).

ASSESSMENT METHODOLOGY

The team adopted an array of assessment approaches, combining views from inside and outside the organization. More specifically, at the Centers (Figure 1) the team:

- Reviewed Center and System-level strategy and program documents;
- Conducted multiple stakeholder interviews with leadership, research leaders, researchers, and information technology personnel;
- Reviewed relevant cases from other organizations that attempted or succeeded at digital transformation;
- Implemented participatory design workshops at Centers to further uncover perceptions about the organization;
- Conducted an online survey.

The data gathered was combined with insights from organizational research and examples of digital transformations in other organizations. The result represents both an “inside out” and “outside in” view of CGIAR’s digital strategy.

INTERVIEWS

Anonymous stakeholders from three groups of Center employees were interviewed: end-users, data and information specialists, and executives. These end users shared the pains and gains in their daily work flow. To understand how the organization’s skills and capabilities can best be leveraged to generate valuable products and services, questions were based on a common framework called the Value Proposition Canvas (Osterwalder, Pigneur, Bernarda, & Smith, 2014). For data specialists and executives, the interview questions were focused on subjects such as digital strategy, local data initiatives, and data processes. To create a safe environment in which participants felt they could speak freely, the interviews were conducted anonymously.

SURVEY

A survey was sent to all Centers to get a global overview of how each uses data analytics tools in the operation of

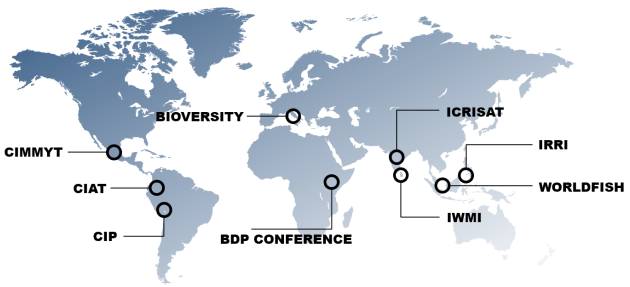


Figure 1: Centers visited to conduct the interviews and workshops.

their organization and how these enable execution of the organizational strategy, also known as an analytical operating model. The total response to the survey across all Centers was poor (N = 21). Nevertheless, the team was able to gather enough of a representative view of the organization through interviews, Center visits, and dedicated sessions at the CGIAR Big Data in Agriculture Convention. The analytical operating model was assessed and the average score for each Center was compared to both the other Centers that responded to the survey and to a benchmark created by MIT and the Accenture Analytics Alliance (MIT & Accenture, 2014), used for describing effective analytics-driven organizations across eight dimensions. The survey draws on this benchmark and maps responses to eight components of an effective analytical operating model. This operating model is described in more detail in the Appendix.

WORKSHOPS

Successful digital transformation requires the buy-in of end-users and the fostering a feeling of belonging, ownership and accountability among them. Design thinking workshops are intended to help create such an environment, while facilitating the development of new ideas. The workshops were organized around the following questions:

1. How might we create the best research experience?
2. How might we create the most impact with combined research data?
3. How might we reduce poverty and increase food security by re-using research data?

Some common methods used in spurring design thinking – such as creative matrix, value/difficulty matrix, Round Robin, and voting – were applied to help expose some of the challenges and opportunities within the organization. These then informed a process of identifying concrete initiatives that could be implemented within Centers (e.g. new approaches to recruit digitally-savvy personnel, or ways to better integrate enterprise and research IT systems and services), which further enhanced the conversation about data sharing and data collaboration.

FINDINGS AND RECOMMENDATIONS

The findings and recommendations from the assessment draw on established best practices from industry and observations made through interviews, visits to the various Centers, and industry comparisons. There is one important recommendation that applies to all: **CGIAR Centers need to further develop their digital strategies.** The development of Center-level strategies will help CGIAR identify differences and common needs across its Centers. As such, it is important to identify the organization-wide needs and blockers for digital transformation. The following findings and recommendations have been organized by digital transformation enabler.

PROVIDE AGILE AND DIGITAL-SAVVY LEADERSHIP

The active engagement of leadership is essential for any successful digital transformation. Agile and digital-savvy leaders understand the value of digital technology for their Center, making them critical players in any digital transformation. Moreover, agile and digital-savvy leaders lead their Centers with a strong digital vision and strategy that they communicate across the business. Additionally, they have clear responsibilities for people at every level of the organization that are intended to drive digital transformation. An agile and digital-savvy leadership is required to ensure that the whole organization remains focused on executing its digital strategy effectively. Shell incorporated the analytics Center of Excellence (CoE), for instance, as an internal unit tasked with implementing digital strategy in the company (World Economic Forum, 2018).

Findings

Center Directors General, Directors of Research, Data Managers, and many researchers recognize the importance of digital transformation and ensuring the continued relevance of the organization; yet, in most Centers, digital tools and competencies are spread across different units and are not aligned with the organization's goals. Digital capabilities are dispersed across the Centers and digital transformation is not driven throughout all levels in the organization. As a result, these digital resources can hardly be used in any meaningful way, including in any means needed to ensure the organization's continued relevance.

Second, even though leadership has defined focal points for digital activities, due to limited resources and time, these efforts are often not enough to drive transformation throughout all levels across the Center.

Recommendations

Centers must align digital investments with organizational goals to provide CGIAR with an agile and digital-savvy leadership. Leadership must also ensure that the digital transformation is driven by all levels of the Center. Centers without a defined a digital strategy are advised to designate a specific executive to lead the digital transformation effort.

To ensure that digital investments are aligned with each Center's objectives, Directors of Research need to have the mandate to bring together multi-disciplinary input on the digital direction and investments of Centers. Directors of Research have the experience and knowledge required to ensure that any digital investments are aligned with one or more of a Center's goals. Industry best practices have shown that digital technology investment decisions must flow from concrete use cases and capabilities that the organization has or needs to build, rather than making investments in digital tools based on their perceived usefulness.

To drive digital transformation across each Center, Center leaders must commit, and communicate such commitment, to

further development of Center digital strategies and actively embed these strategies throughout the organization. The digital strategy needs to be reflected in the roles and responsibilities of management, research leaders, information technology units, human resources professionals, legal professionals—and, of course, the researchers themselves. Ownership of digital strategy and digital transformation must be fostered at all levels of the organization.

Centers that have not yet defined an explicit digital strategy should consider designating an executive with extensive technological, industry, and data knowledge and give them a mandate to develop and execute the strategy. In the private sector, such a role is often referred to as a Chief Information Officer or Chief Data Officer.

MOBILIZE DATA AND ACCESS MANAGEMENT

Data is a critical element needed for building competitive advantage and relevant organizational capabilities in the Digital Age. More than 79 percent of executives responding to the Accenture Technology Vision 2018 survey agreed that, although organizations base their most critical systems and strategies on data, many have not invested in the capabilities needed to validate the data they have or are gathering (Accenture, 2018).

Findings

Centers are struggling with capturing the full value of the data they generate and turning this data into an asset either for reproducing or accelerating research or else for developing new data-driven products or services. This is mostly due to a lack of data standards, enforced data policies, adoption of standard data management practices, and no data-sharing culture.

While Center data managers and other data-sharing champions have a good understanding of organizational data standards, adoption and use of these standards still lags among most researchers. This is not uncommon in a large, complex organization. Across all industries, it has been observed that significant, continued investments in change management programs and frequent training sessions are often required for new data standards and technologies to take root.

It has been five years since CGIAR adopted its Open Access/Open Data Policy and, while Center Data Managers actively promote the policy and resulting guidelines and norms for data management, the policy does not appear to be well-known or adopted by many researchers. The lack of a data sharing culture is reflected in the fact that individual researchers tend to view the data they generate as their property rather than part of a fundamental asset or capability of the organization. Immediate cultural change may be required to adequately address this issue.

Recommendations

Centers and the system should invest in analytics, change management and data management to effectively translate data to meaningful and reusable insights. CGIAR and its Centers must continue to invest in the adoption and use of common data technologies and guidelines.

The Platform for Big Data in Agriculture should continue to play an active role in facilitating the development of data standards, guidelines, and policies. Center and System leadership must play a key role in embedding data standards in operating procedures throughout the organization.

To ensure the adoption of common data technologies and guidelines, The Platform for Big Data should provide technical assistance in adopting these and monitoring progress across the Center and/or the System. The Platform for Big Data should also collaborate with Centers to deliver training on best practices in data management throughout the research data lifecycle.

Center and System leadership must drive a cultural shift towards the recognition that data collected by individual researchers is a key organizational asset that needs to be managed accordingly. Center leaders, Data Managers, Research Leaders, and the Platform for Big Data all play a crucial role in creating incentives for researchers to share data. This may be through organizing data sprints or by increasing the recognition of those researchers who actively share data and collaborate across the Center or the System.

FOSTER DIGITAL ECOSYSTEM THINKING

The vast range of actors and stakeholders in food security research includes a variety of public, private, and non-profit organizations, which might be termed the overall "ecosystem" of the industry or field. Similarly, an array of data and service providers, public and private researchers, standards bodies, and other organizations constitute a digital "ecosystem." Digital ecosystem thinking is about collaborating either with these new actors in the value chain or outside that chain to create value for all parties involved. The CGIAR System is uniquely positioned to act as a trusted intermediary within the greater agricultural community. It can play an important role in building a thriving, collaborative data and analytics community, creating greater connections between the data and research products generated and the positive changes the organization seeks to effect.

There are, however, promising internal models that could be scaled across CGIAR. The digital agriculture startup accelerator at ICRISAT, for example, has fostered active collaboration between global IT firms, startups, policymakers, and researchers. The



Platform for Big Data has created an international advisory board consisting of members from industry players such as Mars Inc., Google, GODAN, FAO, GIZ, and Ag Gateway - an agriculture data standards organization. These are promising approaches for build more engagement and partnership with the array of actors in the digital agriculture ecosystem.

Findings

A limited digital ecosystem thinking mindset was observed at those Centers visited; data was not considered as an asset, a culture of sharing data was often not fostered. Technology partnerships were most often constructed at the Center, rather than the System, level. The Platform for Big Data can play a key role in coalescing the Centers' digital capabilities across the System and in providing a ready mechanism for partnering with firms and third-party groups, as well as for participating in initiatives outside the organization. Some researchers regard the data as their property or are afraid to share based on their perception that an "outside" reader is frequently not fully familiar with the nuances of the data that give it context and meaning. Several Centers engage in data sprints and hackathons to stimulate sharing and re-use of research data.

Recommendations

Alliances and other forms of coordinated action among multiple stakeholders are key to effecting large-scale positive changes in reducing poverty, eliminating hunger, and averting or reversing environmental degradation. CGIAR should further develop its partnership strategy to better position itself as a trusted global intermediary in the digital agriculture ecosystem. This could take multiple forms such as: aggregating demand and current spending on "big data" services from providers, such as storage, computation, or key datasets for research; developing collaborative, pre-competitive research with private agri-business or information technology firms[2]; providing analytic or data services in support of its traditional partners, such as national research agencies; and fostering new types of partnerships, such as working with digital agriculture start-ups. This can result in new business initiatives. Promising internal models such as the ICRISAT digital technology accelerator, or the new multi-stakeholder International Advisory Board of the Big Data Platform should be further explored for potential scaling or replication across the System.

Sharing of data and analytics services across CGIAR should enable researchers to accelerate common research themes; to generate more, good quality data and evidence; and to enable easier reproducibility of results. Although each Center has its own capabilities, they often encounter similar data management and infrastructure needs. They also have similar funding needs — all of which might signal demand for some shared analytic services across Centers via contracts with third-party service providers that could be consolidated to create economies of scale. The pan-CGIAR Communities of Practice under the Platform for Big Data should help identify these cross-cutting needs and engage Centers and service providers in discussions of how best to address them.

BUILD A FORWARD-LOOKING SKILL AGENDA

Building a workforce with the right skillset enables the organization to execute initiatives that require digital skills; however, research has shown that 64 percent of employees across multiple industries lack the right skillset to execute digital work (World Economic Forum; Accenture, 2018). This impedes their ability to execute and deliver on the potential value of digital initiatives. If CGIAR desires to execute initiatives that require digital skills, Centers should invest in building the right skillsets among their workforce. This might include investing in foundational research skills (e.g. statistics) or newer high-demand skills (e.g. analytics using R or Python, introduction to machine learning). If we do not upskill our researchers, CGIAR will fall behind compared to the private sector.

Findings

Although there is interest among the CGIAR workforce to build new digital skills, the Centers lack a well-defined talent strategy and execution of initiatives to keep the whole workforce's skills up to date for the digital age. In the workshops and interviews conducted, researchers at all Centers reported that they were eager to participate in some form of continuous learning for mid-career researchers. Researchers and data specialists at all Centers are eager to continue building their own skills in bioinformatics, machine learning, and data analytics to stay abreast, if not ahead of, changes in the field. Digital skills varied greatly between researchers, often the younger generation appeared more digitally savvy. No Centers were found to have well-defined talent strategies.

Recommendations

To optimize the process of conducting research and to translate this research such that it is making the correct, optimal impact,

[2] Among the visited Centers, for example, several have standing technology partnerships with organizations such as Google, Microsoft, SAS, IBM, Amazon, and other firms.

Centers and the system should invest in building the skill of theirs workforce. Investments should focus on building and maintaining both foundational skills for research (e.g. statistics) and in helping researchers stay abreast of new analytics tools and methods (e.g. R and Python, machine learning). Center-based talent strategies should include upskilling, recruiting, and retention strategies to keep building digital capabilities in the organization.

Centers should include building digital skills as part of an overall digital strategy. Centers and the Platform for Big Data should develop and implement training content related to maintaining those core skills that have been identified as being useful across the organization, such as statistical analysis, bioinformatics, good data management, and regulatory compliance, as well as in building capabilities in more emergent disciplines such as leading-edge analytic methods and machine learning. The Platform for Big Data should leverage its unique cross-cutting mandate to facilitate organization-wide adoption of and training in those new technologies.

Another key aspect of instituting an effective talent strategy would include attracting new, necessary skills for the Centers through recruiting new personnel and developing new partnerships that would enable CGIAR to leverage the training and capabilities of its partner organizations.

DESIGN THE RIGHT TECHNOLOGY INFRASTRUCTURE

Investing only in analytics and digital capabilities will not lead to the desired result(s) without having a suitable data-management system spanning the whole research data lifecycle including collection, analysis, storage, publication, and re-use. The separation or balkanization of information technology capabilities in the organization may be inhibiting arriving at such a holistic design at Centers, and this may result in greater costs over the long term. Many global organizations have found that hosting or leveraging services in the cloud (e.g. for data storage, computation, analytics services) can yield cost savings and increase operational efficiencies (World Economic Forum, 2018). Designing and investing in the optimal infrastructure that best enables interoperability and collaboration beyond silos will help CGIAR reach its organizational goals more effectively.

Findings

Poor alignment was reported across the CGIAR Centers between technology investment and each organization's goals. Also reported was the limited interoperability between information systems, which is inhibiting the Centers from effectively reaching their research goals.

Information technology functions and investment were found, in several cases, to be isolated, which is the result of piecemeal information technology investments being made in research informatics units, enterprise systems, and finite research projects. This has led to a proliferation of tools and systems as well as a lack of a holistic and interoperable information system. This is likely, in part, due to volatility in overall funding for the organization throughout several years. Centers are sometimes unable to migrate to cloud services due to vagaries in funding. Capital information technology equipment, while potentially more expensive than cloud-based options, can be relatively isolated from the vagaries of project funding once purchased. It can be challenging for Centers to escape this "capital costs trap."

The poor interoperability between information systems limits the Centers from effectively sharing data and knowledge in a secure way, although there are already some initiatives taken to overcome these issues. The problem is compounded by culture: most researchers continue to see the data as their own property, rather than an institutional asset to be managed via approved processes and infrastructure. As a result, most Centers are losing opportunities for new data-driven capabilities to accrue to the organization.

Recommendations

Centers and the System should examine how to better align technology investments with the organization's overall strategy. This will ensure that the technology infrastructure supports the research processes or capabilities needed to execute the strategy cost effectively and ensure interoperability between systems with the correct security and regulatory compliance.

A more unified information technology vision can help highlight cost savings and opportunities to share research services across business units or across Centers and it can also help build consensus among funders and other stakeholders that these investments are justified; however, technology investments should still have a proven contribution to concrete capabilities and use cases. Investing in technologies that have an existing use case means that the investment is interwoven with the organization's performance.

Taking stock of the systems within a given Center and evaluating the information architecture within it would provide valuable input to determine whether it is aligned with the organization's vision and can also inform future use-cases and further investment decisions. The Platform for Big Data can assist in connecting Centers with common research needs and in finding the best providers to meet them.

CONCLUSION

CGIAR holds a unique position and the essential capabilities needed to create positive changes in global food security. As a trusted intermediary, CGIAR can help build a thriving, collaborative data and analytics community working toward global food security and human resilience. A more efficient use of data and research products will accelerate the generation of insights into human, economic, and environmental challenges and enable new potential solutions. Efficient data use will also enable quicker action by policymakers, funders, researchers, and firms worldwide. Digital strategy -- and the digital transformations in the organization that it can enable – will be central to CGIAR fully claiming this potential in the digital age.

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APPENDIX: ACCENTURE ANALYTICS OPERATING MODEL

The analytics operating model is a framework designed to assess the eight criteria identified by Accenture that are needed to ensure organizations make the most of their data and analytics. This framework serves as the basis of the online survey and helps guide collection of information on the relative maturity of an organization's analytical operating model. Once the results have been collected from the online survey, the system combines these and generates summary visuals. The visuals highlight how the organization compares to its peers and provides and some specific areas that may need improvement. This diagnostic is constructed based on a database of more than 900 companies across industries and geographies.

ACCELERATING CGIAR'S DIGITAL TRANSFORMATION

A high-level assessment of digital strategy across CGIAR