Digital Technology

U.S. Government's Global Food Security Strategy Activity Design Guidance

This is one of several Activity Design Guidance documents for implementing the U.S. Government's Global Food Security Strategy. The full set of documents is at www.feedthefuture.gov and www.agrilinks.org.

Introduction

Global agricultural development is increasingly shaped by the unprecedented growth of the digital economy. As noted in the U.S. Government's Global Food Security Strategy (GFSS), digital technologies—which includes digitally enabled infrastructure (e.g., satellites), hardware (e.g., mobile phones and sensors), and software (e.g., mobile apps and websites)—have demonstrated the potential to redefine economic growth models, empower poor people with new communications tools, facilitate more productive interactions and financial transactions across agricultural market systems, and promote dietary diversity and nutrition-sensitive agricultural practices. As the GFSS emphasizes, "Digital technology must play an integral role in the [U.S. Government]'s work in food systems, rather than being treated as an add-on or an afterthought."

Terminology and Context

Agricultural development has been undergoing a period of intense digital transition, and the myriad models for realizing the full benefit of this transformation are emerging and evolving.[1] Advancements in earth science, computational power, geospatial analysis, and data communications systems over the last few decades have made it possible, for example, to monitor crops and assess yields from space,[2] better predict and manage economic or climatic shocks,[3] help producers identify more profitable markets, improve traceability systems, deliver finance and advisory services to rural communities more efficiently, and improve the precision and profitability of agricultural production. There is also growing consensus that the precise management of production factors made possible by digital technologies will be critical for achieving the sustainable, adaptive global intensification of agricultural production the world requires.[4] Investment in digital agriculture technologies globally surpassed $12.75 billion in 2020[5] and, by one estimate, the wide-scale implementation of advanced Internet connectivity infrastructure in the agriculture sector could increase global gross domestic product (GDP) by more than $500 billion by 2030.[6]

As the data related to global food and agriculture systems grow, so do opportunities to gain new insights and turn them into action, linking market actors across agriculture and food systems. For example, crop breeding programs can increasingly leverage large, real-world datasets, in addition to controlled field trials, to accelerate development of locally adapted crop varieties and build ongoing feedback with producers. Localized data detailing on- and off-farm productivity and natural resource management are increasingly used to improve the timeliness and site-specificity of agronomic advice[7] and revolutionize new financial services to help producers and agricultural small- and medium-sized enterprises (agri-SMEs) save,[8] access credit and other financial services (e.g., insurance),[9] or manage risk.[10]

Global coordination has led to efforts like the Agricultural Market Information Systems (AMIS), a G20 initiative aimed at improving global data and market transparency, as well as coordination of policy action in response to market uncertainty by disclosing regular, reliable, accurate, timely, and comparable data.

Developing economies are part of this global transformation in large part as a result of the mobile revolution; explosive growth in mobile phone sectors worldwide has made telephony increasingly ubiquitous, driving dramatic expansion in Internet access and decreased transaction costs. In 2021, more than two-thirds of the global population owned a mobile phone, three-quarters of which were smartphones, and over half (53 percent) had access to mobile Internet. By 2025, an additional 400 million people are expected to gain access to mobile phones, with most of them living in sub-Saharan Africa and Asia Pacific.[11] In addition, from 2012 to 2021, the number of mobile money accounts globally grew tenfold to 1.35 billion. This presents great opportunities in the agriculture sector, with one estimate stating that by 2025, nearly half a trillion dollars in cash-based, business-to-producer payments will be available for digitization.[12]

Despite these substantial advances, constraints do persist. This is particularly true in remote environments with low bandwidth and/or unreliable network connectivity and where communities face challenges due to digital illiteracy, lack of locally relevant content, unaffordable mobile and broadband services, and, in some cases, social constraints. Furthermore, despite recent gains, persistent gaps around mobile phone ownership and use continue for certain groups, with women, for example, still less likely than men to own a mobile phone (by 7 percent), own a smartphone (by 18 percent), and to use mobile Internet (16 percent). Challenges may also arise in agricultural markets as emerging technologies are adopted at greater scale. For example, while artificial intelligence technologies have significant potential to improve efficiency and decision-making, they can also end up entrenching existing societal inequities or amplifying biases already present in agricultural systems. Other emerging technologies being deployed in agricultural systems, such as blockchain, may present a different set of challenges, including excessive trust in the technology or reliance on solutions with scant evidence.

Because these constraints might have implications on program design, market research should be performed at the outset. The U.S. Agency for International Development's (USAID) Mobile Access Diagnostic Tool provides an online platform for measuring the strength of a mobile ecosystem at national and regional levels. In addition, a number of USAID Missions have undertaken digital agriculture ecosystem assessments to better understand the opportunities and barriers to effectively and equitably using digital technology in their food security programs.[13]
The power of digital technologies comes from how they can be integrated to address challenges across agriculture and food systems, at multiple scales, to:

Improve feedback between market actors. There is a growing body of rich evidence[14] demonstrating that digital channels—such as interactive voice response, low-cost video, digital payments, and text messaging campaigns—enable true interactivity between producers and other market system actors, and this can support adoption of improved practices from production to marketing, and creation of new commercial connections. Quicker feedback also enables more rapid decision-making and response.

Strengthen producers, agri-SMEs, and system resilience. The expansion of mobile money has dramatically lowered transaction costs in many countries and, by providing the ability to store funds and access remittances quickly, has, in some contexts, directly improved smallholders' resilience to economic shocks and enabled new pathways out of poverty.[15] Once they are established, mobile money networks can enable innovations in digital delivery of the full array of financial services—including savings, insurance, and credit for smallholders[16]—and the array of other market actors, such as input suppliers. In turn, this can contribute to greater household resilience, with digital technologies and approaches helping

to connect producers and agri-SMEs with additional income-generating activities and business opportunities at the production level and beyond, as well as helping female producers, in particular, to gain access to and control over their incomes.

When mobile money networks are established to make humanitarian response payments, this critical infrastructure can serve as a bridge to resilience and long-term food security. Digital financial services also generate data that can be used for rapid feedback, particularly when compared with data from the farm or other links in the market system—improving transparency, trust, and coordination between actors at all levels of the food system.

Increase farming precision. Integrated data on production factors—including hyper-localized weather, soils, inputs, and management—are being used to improve the timeliness or site-specificity of agronomic advice, and there is growing evidence that this is effective for increasing productivity in developing agriculture sectors.[17,18] For example, text message or interactive voice campaigns can remind producers to conduct time-sensitive tasks and achieve increased productivity with no change in the producer's costs. While augmented reality tools can help producers identify pests and diseases in real time.[19] These types of data and digital solutions are also useful to pastoralists; for example, SERVIR—a partnership between USAID, the National Aeronautics and Space Administration (NASA), and organizations around the world—has developed a Rangeland Assessment and Monitoring Service in Kenya that uses cloud computing and machine learning algorithms to conduct cropland assessments and monitoring, enabling improved livestock management.[20]

Extend reach of advisory services. Existing extension and advisory services can include more producers and agri-SMEs—including women, who may not have the same level of access to agricultural resources, business development, or market information—and leverage greater interaction with them over digital channels, such as through locally produced, low-cost video on improved agronomic practices.[21] These same channels can also be used to promote improved household nutrition by encouraging the consumption of nutrient-rich, bio-fortified foods. Advisory services can also utilize satellite imagery data to provide targeted advice to smallholder producers; for example, using weather forecasts to advise on planting times and provide early warnings for extreme weather events. These services can also provide static agronomic advice, typically crop- or livestock-relevant best practice tips, and guidance on how to manage and expand an agribusiness.[22]

Tighten connections across a food and agriculture system. Digital tools enable business models that are founded on improved coordination by unlocking value across a food system, such as facilitating on-demand mechanization,[23] transport,[24] and traceability,[25] or enabling bundling of digital financial products with critical agricultural and business services at multiple points in the market system to help producers and agri-SMEs access the right inputs and services when they need them. Digitally enabled business models can have lower transaction costs and higher potential for scale, as well as create new channels to reach vulnerable populations, including women and youth, who may not have the same networks or priority to access these services. Similarly, digital payments and tools can enable firms to purchase commodities directly from smallholders who were previously too expensive to reach.

Leverage new data for system-wide analysis and decision-making. Use of digital technologies generates data that may unlock a more precise understanding of market systems when combined with data from other sectors or sources. For example, researchers have successfully established mobile phone usage patterns as proxies for differences in wealth[26] or food security[27] that could enable in-depth analysis and decision support, as well as more effective monitoring, evaluation, and learning in development programs. This includes data collected from producers, other market actors, communities, and implementers on the ground—using mobile phones and tablets equipped with a variety of off-the-shelf, proven, and affordable

collection tools, as appropriate—and the array of big data sources and processes, such as geospatial imagery combined with artificial intelligence and machine learning.

Designing Activities

With one estimate predicting that the digital economy will comprise roughly a quarter of the global GDP by 2025, it is no longer a question of if an activity should use digital technology, but how it should do so in a way that is responsible, inclusive, appropriate, and impactful. Even if the use of digital technology is not a key component of an activity, it is important to consider how digital technologies can be effectively leveraged to support the achievement of development objectives without leaving anyone behind.

Key Lessons Learned

The Principles for Digital Development, which as of October 2022 have been endorsed by more than 300 organizations and companies across the globe, encapsulate many of the most important lessons learned when it comes to effectively integrating digital technologies into activities. They consist of nine precepts for design, diffusion, and adoption of digital innovations, and are a great place to start.

While there is no single answer to how digital technologies may be helpful within an activity, the digital for resilience and food security planning tool can help guide practitioners as to whether digital technology may be useful in their activity. In addition, before deciding what digital technology to use, it also helps to ask the following seven questions:

- Is the particular digital technology **available** in the activity area?
- Do the intended users have **access** to that technology?
- Can the intended users **afford** to own and use it?
- Do the intended users have the **ability** (or requisite digital literacy) to use it?
- What **attitudes** might the intended users have toward the technology?
- What **aspirations** do the intended users have when it comes to using digital technology?
- What **anticipated** (and unanticipated) **risks** might occur through the use of this technology?

On that last question in particular, it is important to recognize that there are both anticipated and unanticipated risks to the introduction of any new digital technology in a development context, which can hinder or actively detract from development objectives. For instance, a 2021 study by FIAN International found that digitized land registries in Brazil and Indonesia have enabled land grabbers to more easily identify prospective plots of land and push rural and/or Indigenous Peoples' communities off of their land.[28] In addition, as more people and devices (such as Internet of Things (IoT) sensors and machines) connect to the Internet, potential cybersecurity and privacy risks will also grow. Women and girls also often face unique risks as a result of increased use of digital technologies. For example, more than half of young women globally have reported experiencing abuse online.[29,30] It is important, therefore, to consider these potential risks and develop plans to mitigate them from the outset.

Practitioners must also be cognizant of the implications of bias in data collection, modeling, analysis, and algorithm development.[31] Aligning the design and deployment of digital technologies in ways that are consistent with principles of inclusive development and localization are important as well. This includes an emphasis on equitable information access, inclusive data governance, and the rights of data subjects (including informed consent); responsible data sharing and standards development;[32] and developing the capacity of local partners to be aware of these broader issues and how to integrate them into their programming.[30]

Design Guidance

Scalable, successful implementations of digital tools in agriculture and food systems development activities should build on decades of U.S. Government experience in agricultural market systems and value chain programming while leveraging and contributing to the evidence base for digital interventions. High-level precepts for programming include:

Analyze and understand your market system challenges. Identify the key constraints or challenges in target market systems that can be addressed through the use of digital solutions, leveraging U.S. Government expertise and the specific technical guidance on market systems programming. The digital agriculture ecosystem assessments previously mentioned are one way of doing this, either on their own or as a component of a wider digital ecosystem country assessment.[33]

Leverage the digital economy. U.S. Government programs have decades of experience with market systems and value chain development methodologies, but a shorter history of leveraging the digital economy in specific country environments.

To design scalable digital interventions, program designers must consider how their program can benefit from and contribute to the digital economy in their country contexts, as comprised by:

- Policy and enabling environment for mobile telephony, Internet diffusion, value-added service providers, online dispute resolution, and digital financial services.
- Policies and/or stakeholders promoting inclusive data governance structures and open data sharing, where relevant.
- Presence of digital enterprises and startups, such as those engaged in end-to-end business process outsourcing or web and mobile application development.
- Number and position of market participants in each of these categories of service and number of products or services targeting the agriculture sector.

Leverage public, private, and nonprofit alliances. Agricultural intensification is enabled by active collaboration among public, private, and nonprofit actors, including the research and academic communities. Similarly, multiple stakeholders will have incentive to help a new digital service succeed if it addresses a key challenge or constraint. Stakeholders include traditional market system actors—such as distributors, processors, input and service providers, producers, and associations—as well as digital actors—such as mobile network operators, investors or funders, and information technology firms. Innovation processes, such as challenges, prizes, alliances, or co-creation events, can create opportunities to leverage the unique capabilities of an array of actors. The U.S. Government is often well-placed to convene this array of actors to improve the enabling environment and overall functioning of the market system. An example of this is the USAID/Nigeria COVID-19 Food Security Challenge, which supported local companies to help farmers and other stakeholders in the food system increase agricultural productivity and food security to mitigate the effect of COVID-19 on Nigeria's food system. Several of the challenge winners were digital solutions or made significant use of digital technologies.[34] It is important to note that challenges and prizes are often used by winners as a seal of approval to grow their business, so practitioners should make sure to use robust selection criteria and due diligence processes to avoid potential market distortion.

Make inclusivity a design principle. Women comprise up to 50 percent of agricultural workers, yet they play different roles in agricultural production and the household (generally more informal roles), have different price sensitivities and purchasing priorities than men (reinvesting an estimated 90 percent of their income in their families), and access information through different, often informal, channels.[35] They are less likely to have access to technology due to cultural barriers, lower literacy levels, and less

disposable income, so addressing the needs of women in agriculture often requires a more tailored approach.[36] Closing these access gaps can play a important role in accelerating food security. Therefore, gender inclusion and equity should be prioritized at the outset of developing a digital intervention to ensure that the particular needs of women are adequately met. These access gaps are not unique to only women. They can also impact persons with disabilities;[37] rural communities; Indigenous Peoples; ethnic, linguistic, and religious minorities; low-income populations; persons with limited literacy or education; and others.[30] What demographic groups to prioritize will depend on the local context.

It is also important to think about how youth are engaged, given the fact that significant portions of the population in many developing economies are under 30 years of age. Digital technologies have the potential to provide youth with a pathway to successful livelihoods in agriculture.[38] In addition, young people who grow up with an early exposure to digital technology may be well-suited to assist less digitally literate community members.

For more information on how to effectively engage women and youth, refer to the GFSS Activity Design Guidance for Gender Equality and Women's Empowerment and Youth Empowerment and Livelihoods in Food Systems, respectively.

Some other key practices that will help unlock the full potential of digital solutions across the program cycle include:

Default to "electronic first" data. The increased efficiency, quality, and cost savings of digital data collection makes its adoption good business practice. Electronic data enables easier comparison of indicator data with nontraditional datasets (such as mobile network data), potentially providing new, cost-effective proxy measurements for changes in food security. As a result, USAID has developed publicly available guidance[39] on geo-referenced, electronic data collection and reporting that will help accelerate collection of good quality data.

Default to digital payments, wherever possible. Electronic payments are good development practice. To support this, USAID has adopted procurement guidance[40] stating that all grantees or contract awardees must make electronic payments the default means of transaction, wherever possible; this guidance is in accordance with the Digital Accountability and Transparency Act of 2014. Agreement and Contracting Officers have critical roles to play here.

Embrace open data, wherever possible. The spirit of U.S. Government open data effort is to default toward sharing and openness—provided no sensitive information or personally identifiable information is shared—in recognition that U.S. Government-funded data can be leveraged for the public good. Leveraging data from implementing partners, U.S. Government-funded researchers, open data repositories, and nontraditional sources, such as mobile network data, can inform strategy, support implementation, and enhance learning and adaptation. For example, robust nutrition data systems can play a critical role in helping policymakers target malnutrition. To realize the potential of open data, Agreement and Contracting Officers' Representatives have critical roles to play in requiring implementing partners to provide well-organized, machine-readable data as a deliverable.

Include digital capabilities in procurement requirements. Contractors and grantees need digital expertise to fulfill minimum U.S. Government reporting requirements, and there may be specific competencies or approaches that need to be identified in procurement documents (e.g., geospatial analysis for monitoring natural resource management) to ensure that contractors and awardees are leveraging proven digital tools and business models that embody and contribute to good digital development practice.

Strengthen capacity of local policymakers to better regulate in the digital agriculture space. The integration of digital solutions into economic activity disrupts traditional markets and can often make regulatory frameworks obsolete. Agricultural trade, competition policy, privacy and data ownership, payment systems, and even the introduction of central bank digital currencies are fundamentally reshaping the policy systems that create the rules of agricultural business. Governments often have limited capacity to regulate effectively in sectors with such rapid disruptive change. Strengthening traditional policy systems to enhance stakeholder consultations and increase accountability, supplemented by innovative approaches like innovation offices, regulatory sandboxes, or early industry consultations, can help governments to protect the public from adverse consequences of technological change while enabling innovation.

Consider key lessons learned in scaling and diffusion of technologies. Since the early days of the Feed the Future initiative, USAID has built a body of work drawing on key learning for technology diffusion and uptake. Most crucial, and aligned with the Principles for Digital Development and other Activity Design Guidance referenced in this document, is to assess scalability as early as possible and plan for scale up front. Notable for digital technologies in particular, scaling pro-poor agricultural products and services should be accompanied by finance at a matching scale, which is contingent on significantly reducing the risk or transaction costs associated with investment in pro-poor food systems. When designing or supporting an activity with digital elements, it is important to also reference the GFSS Activity Design Guidance for Scaling for Widespread Adoption of Improved Technologies and Practices.

Programming in Practice

SERVIR partners in East Africa are working on an agriculture insurance system with Kenya's State Department of Agriculture and other stakeholders including crop insurance providers. This system pays out to participating farmers when weather extremes trigger crop failures. In the last five years, the Kenya Crop Insurance program has scaled from 900 to over 1.4 million participating farmers that are insured. USAID is investing to increase female farmers' participation in risk transfer via agriculture insurance. Since 2016, the system has resulted in the payout of some 275 million Kenya shillings (over $3 million) to over 37,000 farmers in Kenya. These payouts help build resilience to climate shocks that would otherwise send these farmers into crisis. Through the SERVIR partnership, the local institution we partner with, the Regional Centre for Mapping of Resources for Development (RCMRD), was able to develop wall-to-wall crop maps for Kenya, identifying which crops were planted where and when. By taking this information and partnering with the Kenya State Department of Agriculture, they were able to realize an enormous cost reduction—there was about a 70 percent cost decrease over previous ground-based data collection methods. This allowed the program to scale to the national level.[41]

In Nepal, livestock diseases cause significant losses due to lack of outbreak information, limited capacity to control diseases, and poor road conditions that make it difficult for animal health workers to reach remote areas. To address this, the **Livestock Systems Innovation Lab** developed a smartphone app for livestock disease reporting that allows rural producers to report livestock diseases to a lead female "sentry" who uses the app to upload disease symptoms, an image of the sick animal, and GPS coordinates to a server. The focus on female sentries was a deliberate decision aimed at empowering women in local communities. A veterinarian reviews them, diagnoses the disease, and notifies local authorities if further action is needed. This app-based system has helped prevent an outbreak of hemorrhagic septicemia, an acute and fatal bacterial disease of cows and buffalo, from becoming an epidemic. During testing, the app almost doubled disease reporting and improved grassroots-level disease surveillance.[42]

The Alliance for a Green Revolution in Africa (AGRA) has been working for a decade to build the capacity of local extension systems in partnership with African governments. To reduce the

extension-to-farmer ratio, AGRA, through the **Partnership for Inclusive Agricultural Transformation in Africa (PIATA) program**, developed a self-employed, village-based advisor (VBA) model, where VBAs are trained to offer extension services, but also have direct connections with the local private sector and can provide access to inputs and output markets. In March 2021, PIATA developed a partnership with tech provider, CropIn, to digitalize the VBA model with the goal of increasing VBA capacity to act as agro-dealers, output aggregators, and booking agents. Using CropIn's Smart Farm application, the partnership aims to onboard over 10,000 VBAs across six countries onto the platform by mid-2022, of which 40 percent will be women. As of late 2021, they were already over halfway toward that goal. AGRA is also aware of and working to mitigate important risk factors in implementing an activity like this. For example, there is a persistent gender digital divide, which could exacerbate an already existing divide in female VBAs. AGRA has also noted the importance of understanding and working within country-specific data protection acts and legislation, such as protecting farmer consent to data collection and sharing.[43]

Access to information and extension services is vital to producers uptaking new technology and food security. The majority of farmers in Bangladesh face crop losses due to pests and disease, lack of access to information, overfertilization or soil nutrient deficiencies, and climate change. Smallholders depend on other farmers or experts, like extension officers, to resolve the problems. The **Feed the Future Bangladesh Digital Agriculture Activity (BDAA)** has assisted with introducing Plantix, an artificial intelligence (AI)-driven smartphone application for farmers and extension workers, in Bangladesh. By using the Plantix image recognition and intelligent automation technology, farmers, homestead gardeners, and other market actors can receive immediate access to highly accurate diagnoses and recommendations for treatments and corrective measures.[44]

The **Feed the Future Uganda Youth Leadership for Agriculture Activity** in Uganda worked closely with agribusinesses, cooperatives, and community savings groups to integrate relevant digital technologies to streamline their operations. This included helping a seed company digitize its supply chain management system, digitization of over 10,000 farmer profiles to support targeted extension resource allocation, integrating of digital payment solutions into the operations of agribusinesses and community savings groups, as well as others. The activity demonstrates how USAID-funded projects can facilitate partnerships between technology providers and market actors to reduce barriers to testing and deploying digital technologies for specific use cases.[45]

Additional Resources and Tools

General: There are many resources related to digital tools in agricultural development. Check www.agrilinks.org and www.e-agriculture.org for examples. The National E-Agriculture Strategy Guide, published by the Food and Agriculture Organization of the United Nations (FAO) and the International Telecommunication Union, is useful for countries that are developing national e-agriculture strategies.

Skills building: The World Bank's Open Learning Campus has developed a five-week self-paced course on digital agriculture. USAID staff may also benefit from the Principles for Digital Development: Going Slow to Go Fast—The Importance of User-Centered Design (Agriculture) online course.

Development programming: USAID's Bureau for Resilience and Food Security has also developed a number of specific resources related to digital agriculture. If you only have time to read one, refer to the digital for resilience and food security planning tool. Another useful tool is this digital activity design how-to note, which provides actionable guidance for each Digital Principle and shares additional resources for ensuring that programs are well-designed and effective. In addition, USAID's Technology

Division has produced numerous resources on incorporating digital development into programs, including digital inclusion, digital finance, geographic and data analytics, and development informatics.

Strategies: The USAID Digital Strategy, Artificial Intelligence Action Plan, and the Bureau for Resilience and Food Security (RFS) Digital Strategy Action Plan outline the priorities that USAID has when it comes to digital technology.

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For further assistance related to these Activity Design Guidance documents, please contact ftfguidance@usaid.gov.