Smart Farming Innovations for Small-Scale Producers

A Grand Challenge Request for Proposal

Summary

Smart Farming Innovations for Small-Scale Producers Request for Proposals (RFP) seeks Smart Farming solutions that leverage digital technology innovations that have the potential to drive positive impact for small-scale producer (SSP) entrepreneurs delivered through bundled farmer services and enabled by scalable digital and data platforms (Figure 1). Solutions should address one or more challenges faced by small-scale crop and livestock producers in one or more areas of agricultural advisory, farm management decision support, input supply, finance, insurance, market access and linkages. Solutions should use human-centered design to elucidate the barriers that prevent SSPs from improving productivity, profitability and income – then propose Smart Farming solutions that can help elevate small-scale production entrepreneurs. Some of the fundamental challenges to address include: 1) low productivity driven by lack of access to information and services; climate change, weather variability and pest and disease outbreaks; 2) lack of access to tailored financial and insurance products, and 3) lack of access to and choice of market and offtake options. Additionally, solutions will need to consider barriers to adoption of digital farmer services, such as low language and digital literacy, the high relative cost of services and devices and, in particular, gender gaps and other potential downsides of digital solutions (e.g. the growing digital divide).

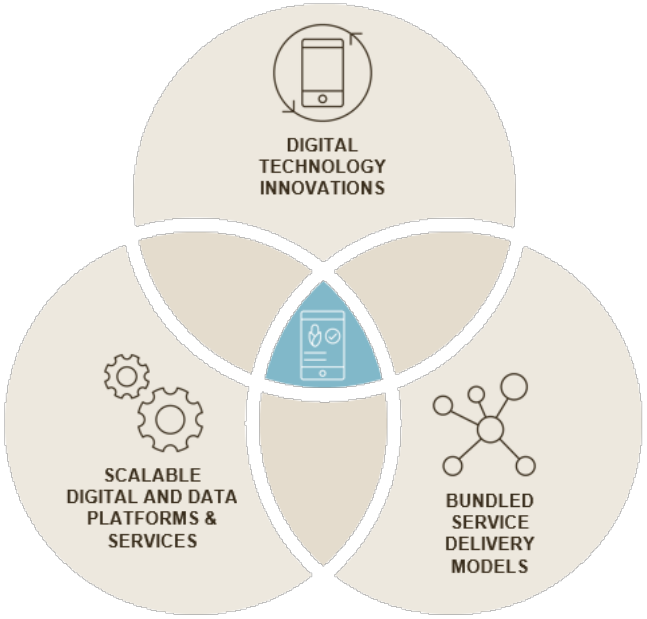

Figure 1. Smart Farming Innovations for SSPs

Awards: There are two grant types – Seed Grants and Scale-Up Grants – each with its own requirements. Applicants can only apply for one of these grant types must select which level for which they are applying (proposal should *not* be submitted for both grant types).

Seed Grants – Up to **USD 250,000** to be implemented up to **12 months**. Seed Grants are proposals for Smart Farming solutions that can demonstrate potential in meeting the following criteria:

- **Leveraging digital technology innovations** with the potential to scale, for example, utilizing a proven technology that has been applied in agriculture in another geography, ; transferring a technology from another sector such as health, infrastructure or finance; sourcing an entirely new technology;
- Show potential to improve SSP **incomes**, **productivity and ability to adapt to climate change**;
- Address **barriers to scaled adoption of digital services**, such as access, affordability and language and digital literacy. This includes addressing **women's access** to digital services and closing the digital divide between those who have access and marginalized populations who do not;
- Have the potential to be **bundled** with multiple farmer-facing services into an integrated solution;
- Are enabled by robust **digital and data technology platforms and services**;
- **Provide fit-for-purpose solutions** (e.g. developed using human-centered design) for SSP enterprises who seek to sell a portion of production to markets;
- Show **potential to be scaled using a sustainable business model and are affordable and able to provide positive return on investment** at a smallholder farm level through successful pilots, scaling partners, or higher volume production driving down prices.

Scale-Up Grants – Up to **USD 1,500,000** to be implemented up to **24 months**. Scale-Up Grants are proposals with demonstrated ability and sufficient evidence to have positive impact. In addition to the criteria listed above for Seed Grants, Scale-Up Grants must also:

- Leverage digital technology innovations with demonstrated **readiness to scale** and proven ability to bundle with other services;
- Meet all criteria regarding technology innovations, scalable platforms, and sustainable bundled service delivery models;
- Demonstrate that additional funding will enable value capture by SSPs or other value chain actors and sustainable and viable service delivery models over the long term.
- Please upload a separate document – **1 additional page maximum** – that describes your partner consortium in more detail, including the various partners' capabilities, and additional evidence of value add, income, productivity, women's empowerment and long-term sustainability of the solution.

Consortiums: To increase the probability that projects funded through this RFP will continue after the initial project completion and evolve into a continuing global public good or sustained solution, applicants are encouraged to consider of a range of partners to form a consortium. This investment will prioritize those who partner with organizations interested in Smart Farming in low- and middle-income countries (LMICs) as long-term opportunities. There are several types of organizations we envisage being part of consortia submitting proposals: Enterprise Technology Platforms (Big-Tech), Enterprise Agriculture (Big-Ag), Ag-Tech Startups (Ag-Tech + Farm-Tech), Research Organizations (R&D), national and international NGOs and farmer-based organizations (Implementors), Government and International Organizations.

Geographies: While we primarily seek solutions applicable to the LMICs listed below and favor those forming local partnerships. Other geographies will be considered if a strong case is made for doing so.

- Africa: Kenya, Uganda, Ethiopia, Tanzania, Rwanda, Ghana, Senegal, Mali, Burkina Faso, Malawi, Zambia, Mozambique, Nigeria
- Asia: India (Bihar, Odisha, Uttar Pradesh, Andhra Pradesh), Bangladesh

Background

Inclusive Agricultural Transformation (IAT) posits that the agricultural sector will play a pivotal role in advancing economic growth in many Low and Middle-Income Countries (LMICs). The modernization of farming systems is a key element of IAT (Mellor 2017) and to achieve this, agriculture must grow approximately 6% per annum in geographies where agriculture dominates labor productivity (up to 70%).

Growing populations and a changing climate exacerbate the challenge for countries undergoing IAT. Modernizing agriculture will require more efficient and diversified agricultural production and a transition from predominantly subsistence farming to small-scale producer (SSP) entrepreneurship to enable improvements in quality, quantity and diversity of food production. Additionally, SSPs will need improved connectivity to inputs, finance and markets. Small-scale crop and livestock producers in low and middle-income countries face many challenges and barriers to becoming sustainable farm entrepreneurs. These include lack of timely and relevant advisory information, limited access to tailored finance and insurance products or social safety nets, few entrepreneurial decision support tools, and lack of access to commercial markets and options for selling. Equally challenged are the value chain stakeholders who rely on inefficient and analog systems to service farmers. Progress in agricultural modernization is threatened as climate change is increasing weather variability and farmers' ability to predict, adapt and absorb risk. As recent events have shown with COVID-19 and the East African locust outbreak, the poor are extremely vulnerable to compounding shocks. While IAT requires investment in infrastructure, government subsidy programs, policy and commercial engagement, there is also growing evidence that digital solutions can help SSPs overcome and mitigate many of these challenges. Digital technology has the potential to address inefficiencies and do so at scale. This will be required to reach the hundreds of millions of SSPs worldwide. To date, however, digital solutions and services have failed to reach the multitude of SSPs – just 13% of SSPs in Sub Saharan Africa have registered for any digital farmer service and only 3% are active users (CTA-Dalberg 2019).

Digitalization of food systems has the potential to enable greater efficiency, transparency, profitability and equity and is well under way in High Income Countries (HICs). Rapid growth and investment in digital agriculture has spurred numerous new innovations in Smart Farming (AgFunder 2020). Examples include solutions based on technologies such as sensors, Internet of Things (IoT), imagery, automation, blockchain, artificial intelligence and computer vision, as well as many others. However, most of these solutions are tailored to large commercial farming systems prevalent in HICs, such as precision planting, precision weeding, automated irrigation and ubiquitous internet connectivity. Digital technologies applied to SSP challenges have successfully reached millions of farmers. Examples include Interactive Voice Response systems (e.g. Ethiopia's Agricultural Transformation Agency 8028 service); peer to peer advisory services (e.g. WeFarm); video-based extension (e.g. Digital Green); private sector contract farming applications (e.g. CropIn), and bundled services (e.g. Safaricom DigiFarm and Pula) that combine finance, insurance, advisory and input supply. However, impact in terms of incomes, productivity and women's

empowerment is less clear and most applications have been in the area of agricultural advisory. More comprehensive application of digital technology for farm management, decision support, market linkages, supply chain and risk management are possible if solutions are designed specifically with SSP challenges in mind; appropriate technologies are leveraged and applied in a fit-for-purpose manner, and systems are built for scale and services are bundled as viable business models.

Smart Farming

Smart Farming is the application of digital information and data technologies for optimizing complex farming systems. **This RFP defines Smart Farming as scalable solutions that leverage technological innovations delivered through farmer bundled services to address challenges SSP entrepreneurs face through specific use cases (e.g. agricultural advisory, inclusive finance, market access, decision support, etc.).** The integration of smart agricultural technologies and modern data analytics enables more efficient production. The application of information and data technologies supports farmers in making informed business decisions and choices based on data. Smart Farming, like Precision Agriculture, is considered here as a sub-topic of Digital Agriculture, which refers to digital tools, data and technologies applied across food systems and value chains to enable greater efficiency, transparency and value.

Smart Farming already has significant impact on farming worldwide. Farmers around the globe are leveraging sensors, data, analytics and predictive models to make better business decisions. However, most digital innovation in agriculture is tailored for large-scale commercial agriculture in HICs with well-organized supply chains where higher margins support in-field precision agriculture technology innovations. While there is significant potential for Smart Farming to positively impact SSPs and marginalized populations in LMICs where supply chains are less structured and farmers are more remote, such solutions have yet to reach farmers at scale.

There are numerous barriers for Smart Farming solutions to have scalable and sustainable impact for SSPs and it will require transformative solutions for digital innovations to reach them. Such solutions need to be lean, fit-for-purpose, easy to use, affordable, robust and deliver clear value to reach poor, undercapitalized farmers. The trends of rapidly declining technology costs, increasing government appetite to utilize “digital” and be more food secure, stronger private sector support for SSP farming businesses, increasing adoption of digital tools and mobile network coverage, and innovations from global investment in ag-tech all increase the probability that Smart Farming will positively impact the 410 million SSPs across the globe.

Small-scale Producers

According to AGRA’s 2017 Africa Agriculture Status Report, SSPs provide livelihoods for more than 2 billion people and produce about 80% of the food in sub-Saharan Africa and Asia. While a generalized definition of a smallholder farmer is based on area (less than 1 hectare or 2.5 acres) a more nuanced typology is based on the share of crop production value that is sold and the share of non-farm income to total household income, as shown in Figure 2.

Based on this definition the general categories are:

a) Subsistence-oriented small farms: Defined as selling less than 5% of their agricultural output and obtaining less than 33% of their total income from non-farm sources;
b) Transition farms: Obtain 33% or more of their income from non-farm sources and sell up to 50% of their crop output;

c) Pre-commercial small farms: Selling 5–50% of their production, and earning less than 33% of their income from non-farm sources; and
d) Commercial small farms: Selling 50% or more of their production.

They are further sub-divided into specialized commercial farms if their non-farm income share is less than 33% and diversified commercial farms otherwise. Across the groups that have farming as their main source of income (i.e. subsistence, pre-commercial and specialized commercial) the average annual farm income is around $780 per year. Understanding this context in terms of the scale required and the resources available to SSPs to access and use technology is critical to designing solutions for them.

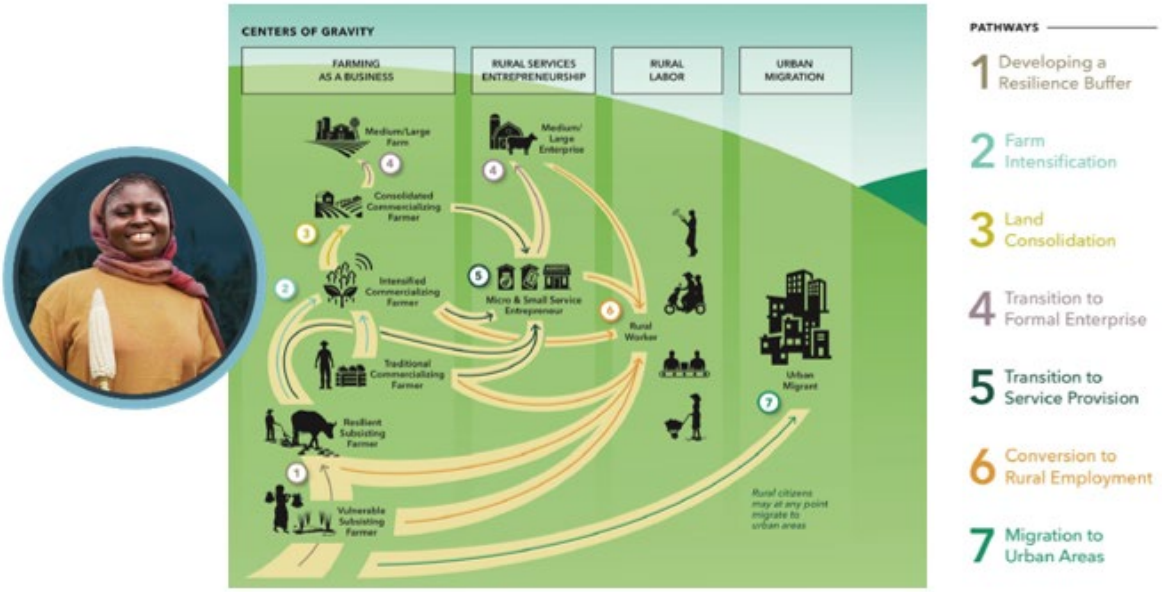

Figure 2. Small-scale producer centers of gravity (ISF Advisors)

We can better identify SSP needs by defining these sub-categories. Small commercial farmers, for example, need support around farming as a business, access to better technologies and services, encouragement to become better entrepreneurs and securing land rights, finance and access to markets (Figure 3).

Type of small farm	Types of assistance
Commercial	• Farming as a business • Better technologies and NRM practices • Organizing farmers for marketing purposes • Incentivizing large agribusiness to link with small farms • Accessing seeds, fertilizer, finance and insurance on commercial terms • Securing land rights and development of efficient land markets • Encouraging entrepreneurship • Building resilient farming systems
Pre-commercial	• Stepping up into commercial farming • As for commercial farms, but with special attention to developing needed skills and accessing modern value chains. • Some subsidized support may be worthwhile to help launch their businesses.
Transition	• Stepping out of farming • Training and support for non-farm activity, including development of own small businesses • Encouraging entrepreneurship • Empowering women and other vulnerable groups • Securing land rights and development of efficient land markets • Better technologies and NRM practices • Safety nets
Subsistence	• Social protection • Safety nets and transfers • Better but low cost technologies and NRM practices • Perhaps some subsidized inputs for own food crops • Securing land rights • Building resilient farming systems • Empowering women and other vulnerable groups • Support for non-farm diversification

Figure 3. Types of small-scale producers and their needs (AGRA strategy 2017)

Potential of Smart Farming for SSPs

There is enormous potential for SSPs to benefit from Smart Farming technologies. The more information is known about a farmer's preferences, their fields, the environment, climate, soil type, market and supply chain, the better Smart Farming solutions can help them adapt to changing circumstances and leverage opportunities. Smart Farming technology has the potential to collect data at very low cost and turn it into valuable insights for farmers, field agents, financiers, insurance providers, input suppliers, governments and off-takers. If we understand what a farmer seeks to produce, what the climate and soil health characteristics of their fields are and the demand for their produce then we can help better advise on seed and fertilizer, best agronomic practices, market options and the most profitable scenarios to consider within the risk tolerances of the geographic location and farmer's ability to absorb risk.

Agricultural Advisory Services: Many SSPs use historical or local knowledge to grow crops and raise livestock. Without access to modern, best farming practices appropriate for their growing conditions, especially in the face of climate change and market goals, it is difficult for SSPs to increase productivity. Improved knowledge has been shown to increase yields. If the data from a farm can be captured, either from sensors or remote sensing data, it can, in the case of crop production, be used in combination with research in agronomy to create better digital advisories for:

- Planning: What crop to grow in the season based on expected weather, crop prices and market demand;

- Cropping: When to sow the seed based on the type of crop and predicted weather
- Management: When to irrigate, fertilize and apply pesticide. This can help reduce the amount of inputs used in the farm and help with profitability.
- Harvest: When to harvest the crop based on market prices, predicted weather and storage cost.

Examples: DeHaat, Digital Green, CropIn, DigiFarm, WeFarm. Similar examples exist in livestock, such as StellApps.

Market Linkages: SSPs attempting to transition from subsistence or marginal market sales to augment incomes with greater percentage of production sold to markets are often challenged to connect to markets efficiently. Digital tools can help by connecting farmers to certified seeds and fertilizers through digital ordering services. DigiFarm and iProcure in Kenya, for example, allow farmers to apply for loans using a feature phone. Farmers receive an eVoucher that can be used at the local iProcure-DigiFarm kiosk to pay for and collect seeds, fertilizers and other inputs. iProcure then restocks on-demand based on data from the service.

With access to current market prices at surrounding local markets through SMS messaging services like Esoko, farmers can make informed decisions on where to sell their produce and may increase income. Farmers can also be digitally connected to transport and aggregation centers, such as Loop in India, that match local produce transporters with farmers for pickup and delivery, including digital payments so farmers have visibility to the price paid to the buyer at the aggregation center. Similarly, milk producers in India can receive instant feedback on the quality of the milk the are providing to an aggregator through the StellApps digital scale and testing service and get rewarded for higher quality milk. By improving the flow and efficiency of goods and payments related to SSP markets through digital tools, farmer incomes can also improve.

Financial Services and Insurance: Farming businesses generate income once they sell their produce, which may often be 90 days after they require capital to purchase inputs and hire labor. Credit can be obtained from banks and other creditors if farmers have collateral (such as land or other assets). However, many farmers do not have title to the land they are farming and nor possess other forms of collateral. This makes it difficult for creditors to provide credit at reasonable rates. Insights and information about the SSPs' production can provide financial services and insurance providers valuable information to assess risk and provide more tailored loans and insurance policies. There are many companies in Africa and South Asia (e.g. Pula, Oko, Acre, Farmdrive and Skymet) working to assess risk using satellite imagery and weather data to create credit scoring algorithms and insurance risk assessments. If Smart Farming solutions could generate trusted and verifiable credit scores and risk profiles, this could unlock finance and risk mitigation tools SSPs need to invest in their farms and try new technologies.

Climate-Smart Agriculture. Smart Farming solutions provide decision support and advisory services as weather volatility increases and climate changes disrupt agroecological zones. Solutions can include real-time information on weather patterns, trends and outlooks so farmers can make informed in-season risk management decisions. Information at the seasonal time scale or longer can inform decisions like changing the crops they have traditionally grown.

Farming as a Business. Commercial agriculture requires a commercial mindset. Farming as a business requires skills and tools to run such a financial enterprise. Many SSPs lack the tools and skills to evaluate decisions from a financial investment and risk perspective. There are some prototype examples, such as

Digital Green's KisanDiary application, which provides basic accounting of incoming and outgoing payments. There is potential to improve knowledge, skills and tools available using digital as a mechanism and human-centered design approaches.

Enabling Technology Trends

There are a myriad of digital solutions emerging across the globe (CTA 2019, GSMA Agritracker, AgFunder 2020) to address the challenges SSPs face. Yet very few of these solutions have scaled. In Sub-Saharan Africa, only 13 percent of farmers have registered for any form of digital service and only 3 percent are active users. There is a long way to go to fully digitalize agriculture and enable the 500 million farmers globally to be more efficient, productive and connected.

We have seen the impact of technology innovations in other sectors, such as health and finance. Some examples are Short Message Services (SMS), peer-to-peer video services, Interactive Voice Response (IVR) and USSD. These technologies empower farmers with better information and access to services. The underlying trends and enabling factors driving digital agriculture and the adoption of Smart Farming are:

Mobile Internet Coverage: Gaps persist but access is rapidly improving across LMICs.

Mobile Access: Mobile handsets are cheaper, easier to use and more readily available.

Mobile Internet Usage: Rural populations are 40% less likely to use mobile internet than urban populations.

Technology Costs: Sensors, satellites, drones, switches, handsets will continue to become more affordable and available.

Digital Agriculture Platforms: There has been a proliferation of platforms needing consolidation to drive adoption, scale and service bundling.

Changing SSP demographics: Movement of farmers from subsistence to pre-commercial to small commercial.

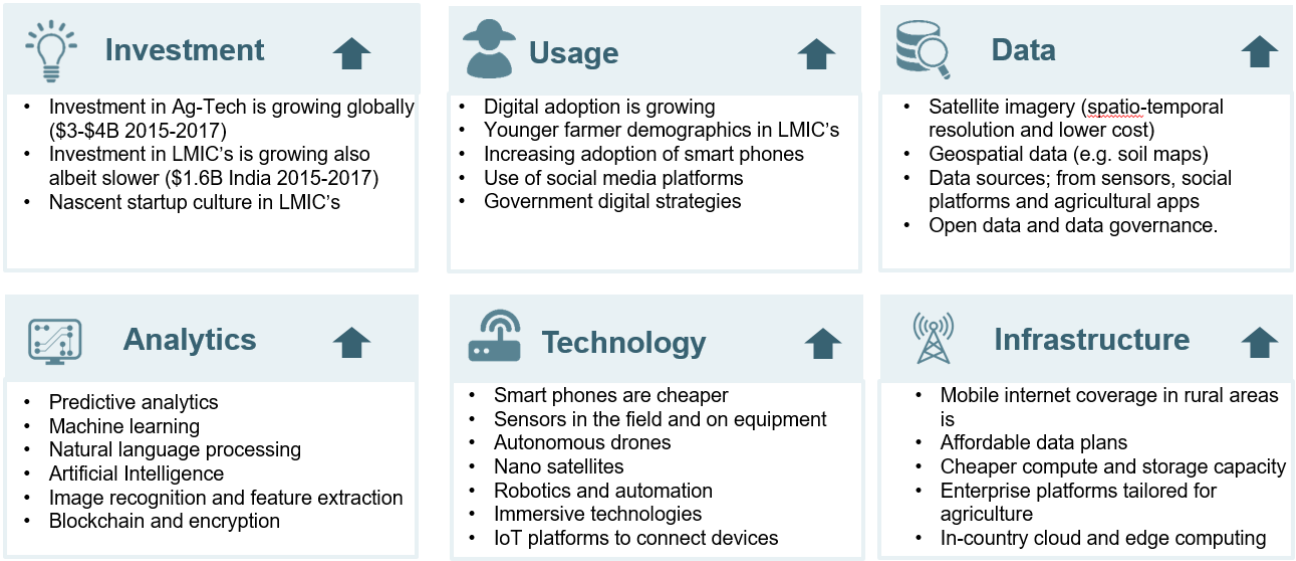

Figure 4. Enabling Trends for Digital Farmer Services

Examples of potential technologies that could be leveraged for Smart Farming include:

Sensors: Existing sensors measure weather or basic soil properties. There are new sensor types being developed, such as for nutrients or more accurate sensing for plants and livestock. There is also new research on in-plant sensing.

Internet of Things (IoT): Small, cheap and disposable sensors enable more monitoring, however, connecting these sensors through IoT platforms enables real-time monitoring and cloud computing to provide greater visibility and traceability of food throughout the supply chain. For example, if fresh produce exceeds temperature thresholds at any point during transit, this can be recorded and flagged in real-time. There is an increased demand to learn where food came from. Several startups are building technologies to trace the produce through storage units and retail stores using IoT.

Automation: There are already robotic milling stations for dairy or autonomous tractors. Startups are developing new applications around sowing, chemical application, irrigation and weeding. Autonomous vehicles equipped with high resolution cameras to continually monitor crops as they grow, known as rapid phenotyping, promises to increase the pace of new crop variety development. Though these technologies may be further out for SSPs, they will potentially have dramatic effects on labor markets globally.

Imagery: Remote sensing, which in agriculture typically refers to imagery analysis from satellite data, has been around for a couple of decades. The new trends are on more frequent satellite imagery using low-earth orbit (LEO) satellites or higher resolution imagery using drones which can fly beneath clouds and are available on demand to monitor crop health or pest and disease outbreaks.

Blockchain: Smart contracts and traceability can be ensured with secure blockchain technology so that buyers and consumers can be certain that no information and data about the source and transit of a food product or shipment has been compromised and can be trusted.

Artificial Intelligence (AI): As new data sources become available in larger quantity, resolution, timeliness and quality, new techniques using distributed computing and machine learning techniques are required to process that data and convert it into actionable information.

Distributed and Cloud Compute: These technologies have enabled far greater processing of very large datasets at lower costs. This becomes increasingly important as more datasets become available from sources like satellite remote sensing, drones, sensors and handset. Computing resources are required to turn raw data into information and insights for SSPs.

Computer Vision: Algorithms are rapidly improving to take advantage of the larger amounts of imagery available. An AI model analyzing a photograph of a leaf, for example, can quickly identify specific plant pests and diseases and make real-time treatment recommendations. Farm field boundaries can be automatically extracted from satellite images.

Smart Phones are rapidly coming down in cost. The Jio smart-feature phones in India now cost less than 10 USD.

Social Media is rapidly growing in usage. WhatsApp and Facebook are growing rapidly and video is the fastest growing communication medium and service that MNOs offer.

Mobile Money enables other digital services. M-PESA in Kenya is one example; however, this is rapidly evolving in other countries and there are now open source platforms like Mojaloop available to implement these services.

Mobile Internet enables smart phone use, access to information, usage of apps and two-way data flows. Jio is an example of very affordable data plans for poor rural farmers.

Digitalization of Services, such as access to inputs, finance, insurance, advisory and connection to markets.

Voice and Conversational AI in the form of voice assistants or chatbots also show potential for providing farmers with automated advice and more streamlined access to information and services.

Impact

Evidence is still being developed on the impact of digital on SSP livelihoods, incomes and productivity; however, initial generalized studies such as CTA 2019 show that bundled services (advisory, finance, market linkages) result in an increase in adoption and impact of +57% income and +168% in productivity (Figure 5). With this as an indicator of how to achieve greater adoption of digital services more broadly, Smart Farming solutions should combine multiple services from the users' perspective, e.g. advisory should be combined with finance, insurance combined with pest and disease alerts or soil health and agronomy combined with climate adaptation information.

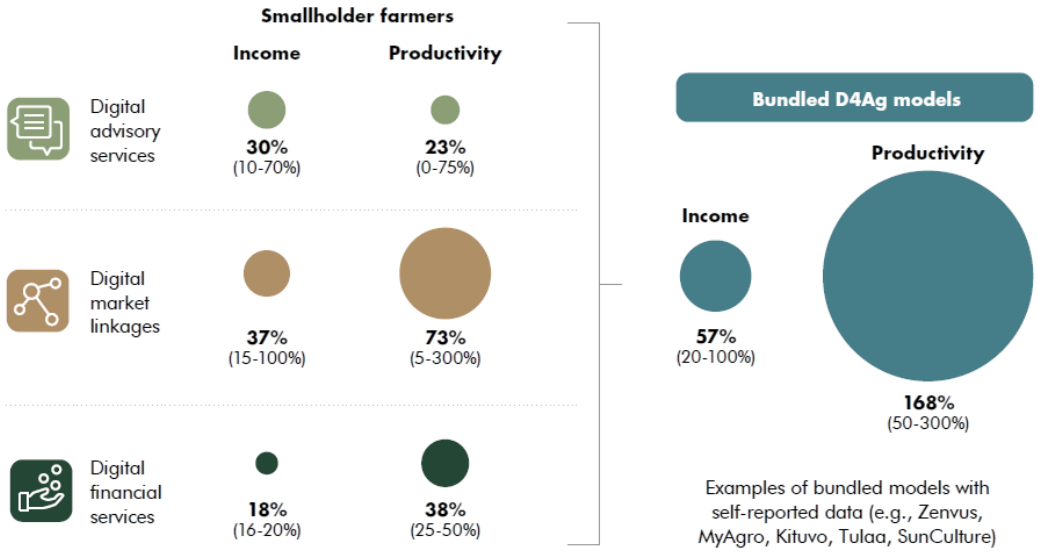

Figure 5. Multiplier effect of bundled services

Barriers

Even with initial evidence of the potential of digital farmer services and Smart Farming technologies, there are still significant barriers to adoption. Few organizations have managed to scale and sustain solutions and services as part of a viable business model for serving SSPs. Some reasons at the farm level include (see Figure 6):

- Mobile network and broadband coverage
- Cost of digital tools, smartphones and mobile data plans
- Digital literacy and language literacy barriers
- Safety, security and trust
- Relevance and value of tailored services, i.e. do they provide what farmers need?

There are also barriers and challenges at the ecosystem and macro levels, such as:

- Digital and data capacity of organizations across the value chain
- Designing sustainable business and delivery models for ag-tech and farm-tech service providers
- Lack of design methodologies, such as human-centered design
- Few middleware services, such as weather and climate services accessible via APIs
- Lack of data policy, consumer protection and data stewardship strategies
- A fragmented marketplace of numerous startups offering a myriad of solutions that are difficult to distinguish between and assess quality

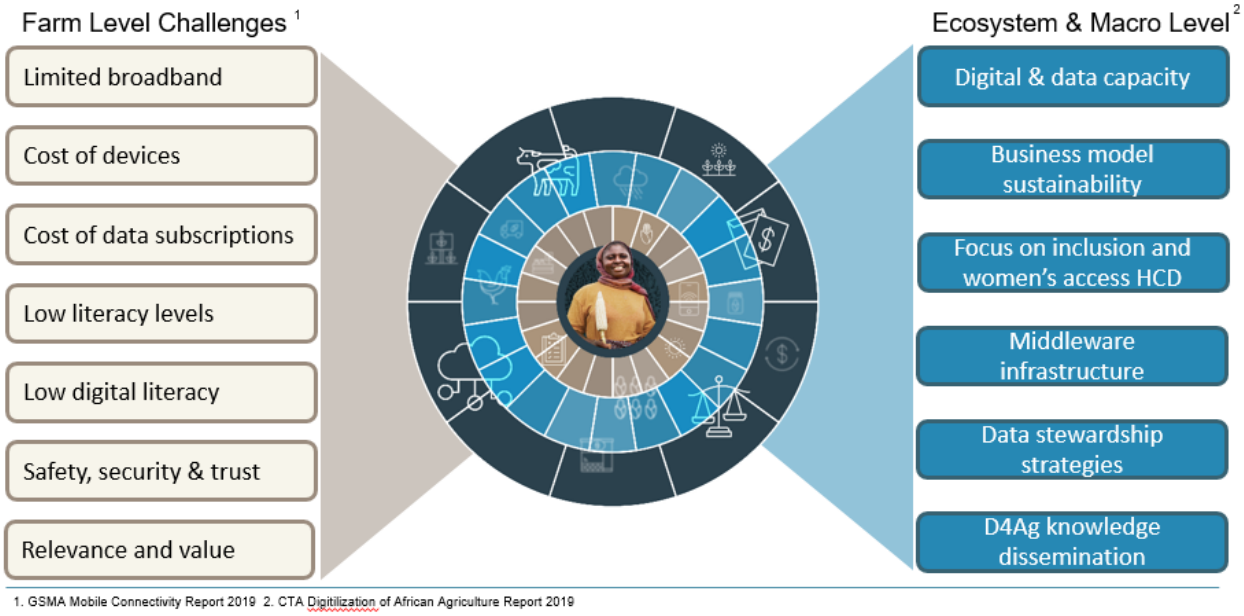

Figure 6: Barriers to small-scale producer adoption of digital farmer services

Smart Farming solutions have the potential to overcome some of these barriers if the digital technologies utilized are tailored for SSP needs, are delivered through integrated bundled service business models that are aligned with the economics of SSPs and have effective market delivery channels and sufficient market demand.

Emerging Smart Farming Technologies

There are numerous areas for digital innovations to be applied to Smart Farming and food systems (Table 1). These technologies are at various stages of the Gartner Hype Cycle (Figure 7). This RFP seeks both seed and scale opportunities to further develop and prepare potential and partially proven solutions for scale and sustainability. While there are numerous areas where more research in the fields of computer science

and data science is required to address the fundamental barriers to broader adoption of digital farmer services and reduce the costs and increase the applicability of these technologies for SSPs, this RFP is not seeking technologies that are not ready for testing and piloting in the field as part of a bundled service and will give preference to solutions ready for scale.

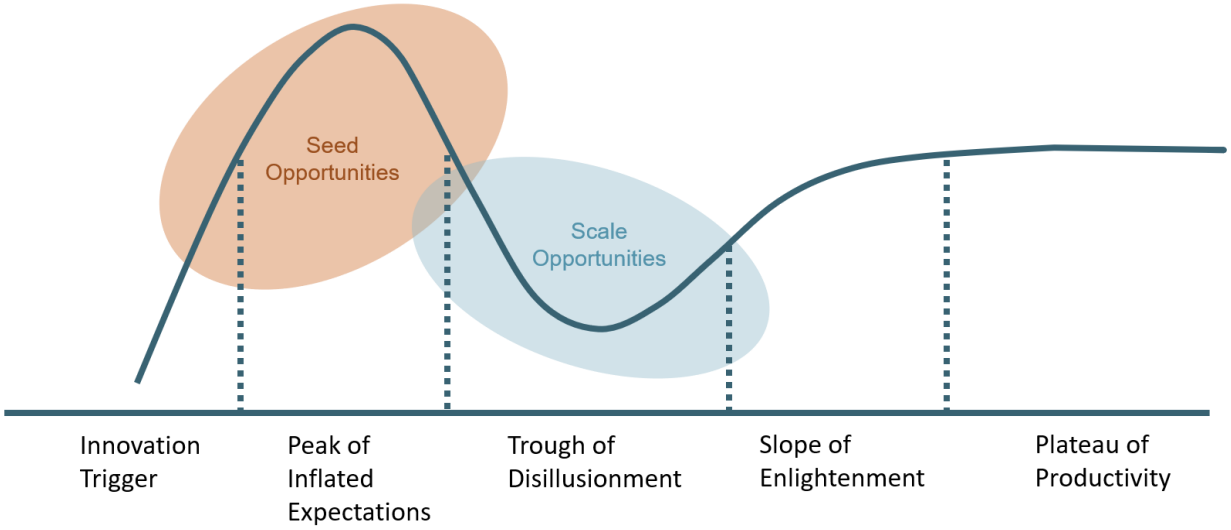

Figure 7. A digital agriculture hype curve, with potential areas for seed and scale opportunities

	Sensors, IoT, GPS-Services	Satellite Imagery	Drones & Robots	Cameras	ICT & Notifications	Data & Compute Platforms
Advisories: Planning, Farm Mgmt, Harvest	Moisture, temp, nutrient, weather, equipment monitoring	Crop health, farm field boundary estimation	Auto spraying, scouting, seeding	Pest detection, Monitoring livestock	SMS/IVR, p2p video education	Secure data sharing, ground truth data, encrypted AI, scalable AI
Mkt linkages: logistics, buyers, inputs	Storage sensors (temp, humidity) truck monitoring	Logistics planning	AVs, drone delivery	Detect crop quality, bid livestock	Connect input suppliers, buyers, markets	Smart contracts, Crop area prediction, Price prediction
Fin Services: insurance, loans	Farm monitoring, credit scoring, index insurance	Credit score, index insurance	Damage & loss assessment	Livestock risk estimation, audits	Digital access to credit, insurance, mobile payments	Biometric ID, mobile money, commodity trading
Sustainability: GHG estimate Climate adaptation	Carbon, nitrogen, weather sensors, climate advisory	Verification of farm management	Robotic weed removal vs tilling	NIR Carbon sensors	Incentive for regenerative ag, climate alerts	Carbon verification, carbon exchange for small producers

Table 1: Digital Farmer Services use cases (rows) versus technology innovations

Application Instructions

For instructions on how to apply and specific formats and structure of proposals, please see the Application Instructions and Rules and Guidelines documents for this RFP.

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