



**FEED THE FUTURE**

The U.S. Government's Global Hunger & Food Security Initiative

# ICT4AG HANDBOOK

A quick guide to ICT solutions for smallholder farmers



**USAID**  
FROM THE AMERICAN PEOPLE

Digital Green



INTERNATIONAL  
FOOD POLICY  
RESEARCH  
INSTITUTE



## Acknowledgements

This report is made possible by the generous support of the American people through the United States Agency for International Development (USAID). The contents are the responsibility of Digital Green and do not necessarily reflect the views of USAID or the United States Government.

Extensive interviews and field visits were conducted in Bangladesh to understand the ICT4Ag landscape. Particular acknowledgement goes to our facilitators and interviewees at a2i, AIS, DAM, BAMIS, SRDI, mPower, Grameen Intel, ACI-Bangladesh, Bank Asia-Bangladesh, Syngenta Foundation, Agriculture Information and Communication Center- Rangpur, Bangladesh. Their inputs provided in-depth information and nuanced understanding of the various ICT solutions, their uptake and the challenges faced in the context of South Asia and Least Developed Countries.

Desk research was conducted to find examples of ICT solutions being used in other developing and least developed countries.

## About DLEC

The Feed the Future Developing Local Extension Capacity (DLEC) project galvanizes diverse extension and advisory services stakeholders to measurably improve extension programs, policies and services. DLEC accomplishes this objective through three inter-related sets of activities: conducting targeted diagnostics on aspects of country EAS systems to identify gaps and opportunities and potential areas for investment; implementing action research activities that generate evidence and build local capacity to improve EAS; and mobilizing lasting communities of practice (CoPs) to advocate for scaling proven approaches. The five-year (2016-2021) project is led by Digital Green in partnership with the International Food Policy Research Institute (IFPRI), the Global Forum for Rural Advisory Services (GFRAS) and Care International.

Learn more here: <https://agrilinks.org/activities/feed-future-developing-local-extension-capacity-project>

Written by Dr. Namita Singh, Head of Training, Digital Green.

## Table of Contents

<b>ACKNOWLEDGEMENTS</b> .....	I
<b>ABOUT DLEC</b> .....	I
<b>INTRODUCTION TO THE HANDBOOK</b> .....	III
WHAT IS ICT4AG? .....	III
WHY IS ICT4AG IMPORTANT? .....	III
WHO IS THIS HANDBOOK FOR? .....	III
WHAT WILL I FIND IN THIS HANDBOOK? .....	IV
<b>TECHNOLOGIES THAT HAVE BEEN AROUND FOR A WHILE</b> .....	1
<b>1. COMMUNITY RADIO</b> .....	2
CASE STUDY: KRISHI RADIO, NEPAL .....	3
<b>2. COMMUNITY VIDEO</b> .....	4
CASE STUDY: DIGITAL GREEN, SOUTH ASIA AND SUB-SAHARAN AFRICA.....	5
<b>3. IVR</b> .....	6
CASE STUDY: KRISHAK BONDHU PHONE SEBA, BANGLADESH .....	7
<b>4. SMS</b> .....	8
CASE STUDY: MPOWER, BANGLADESH .....	9
<b>5. USSD</b> .....	10
CASE STUDY: MAgRI, BOTSWANA .....	11
<b>TECHNOLOGIES THAT ARE CATCHING UP FAST</b> .....	12
<b>6. WEB PLATFORMS</b> .....	13
CASE STUDY: KRISHI BATAYAN, BANGLADESH.....	14
<b>7. SOCIAL NETWORKING</b> .....	15
CASE STUDY: KRISHI BIOSCOPE, BANGLADESH .....	16
<b>8. INCLUSIVE DIGITAL FINANCE</b> .....	17
CASE STUDY: BANK ASIA – AGENT BANKING, BANGLADESH.....	18
<b>9. MOBILE APP-BASED AGRO-ADVISORY SERVICES</b> .....	19
CASE STUDY: FOSHOLI, BANGLADESH .....	21
<b>10. MOBILE APP-BASED MARKET SERVICES</b> .....	22
CASE STUDY: E-FARMER’S HUB, BANGLADESH.....	23
<b>TECHNOLOGIES THAT CAN SHAPE THE FUTURE</b> .....	24
<b>11. SATELLITE-BASED GIS</b> .....	25
CASE STUDY: GEOPOTATO, BANGLADESH .....	26
<b>12. DRONES</b> .....	27
CASE STUDY: STARS PROJECT, WEST AFRICA, EAST AFRICA AND BANGLADESH .....	28
<b>13. INTERNET OF THINGS AND SENSORS</b> .....	29
CASE STUDY: ACI E-FISHERIES, BANGLADESH.....	30
<b>USING ICT4AG IN PRACTICE: AIS, BANGLADESH</b> .....	31

# Introduction to the Handbook

## What is ICT4Ag?

Information Communication Technologies (ICTs) have been used in the development sector for a substantial amount of time. ICTs have got mainstreamed as a tool to achieve development goals, including in the Sustainable Development goals. In the agriculture sector, extension services have been the primary way for farmers to receive information about agriculture technologies and innovation. ICTs have the potential to amplify the efforts of the extension agents who work directly on the ground with farmers. Use of ICTs in agricultural programmes is called ICT4Ag. It includes the whole suite of ICTs that are available, which can be applied to agriculture across the entire value chain from sourcing inputs for crop cultivation to selling it in the market.

## Why is ICT4Ag important?

Smallholder farmers are often the ones with limited resources and connectivity, living in remote areas. This means that they have limited services available to them, lesser opportunity to access information themselves and limited capability to adapt new and better agricultural technologies. Extension services that are meant to reach these farmers are usually inadequate given the limited human resources. Typically, in developing and under-developed countries, extension agent to farmer ratio exceeds 1:1000, making it nearly impossible for extension services to reach all farmers. With climate change impacting more and more farmers, particularly the most vulnerable ones, the need for reaching farmers with information that supports them to adapt their traditional practices is more pressing than ever. This is where ICT4Ag can play a crucial role. Additionally, it can provide newer ways for farmers to access inputs, credit and markets, unavailable to them before. ICT4Ag solutions can enable personalized and customized services for farmers, which are more relevant to them, respond to their specific needs and context, and can be accessed in limited resource settings. The potential to achieve high impact at the farm-level requires not just the appropriate technology, but also committed human efforts and engagement. The Case Studies given in this handbook highlight the technologies themselves and the requirements to make them work on ground.

## Who is this handbook for?

This handbook gives an overview of a broad range of technologies and can be useful for professionals engaged in agriculture extension, organizations working with smallholder farmers, implementors, donors and other public sector partners. Those interested in the use ICTs for development may also find the content relevant. Though this handbook is particularly aimed at agricultural professionals in Bangladesh, for sharing the various initiatives in Bangladesh and across the

developing world, it can be used as a reference document by anyone having interest in the field.

The ICT4Ag field is evolving very fast and embracing new technologies as they are coming up, along with using older technologies that are relevant for smallholder farmers. This handbook intends to showcase major technologies and is not necessarily exhaustive. It aims to provide a fundamental understanding of ICTs being used in agriculture, in a clear and simple manner. Using ICTs has substantial technical requirements, need for appropriate infrastructure and trained human resource. It becomes even more challenging in low-resource settings, where smallholder farmers' access to technology and available infrastructure, such as electricity and internet, are limited. This handbook highlights the requirements and constraints to provide some insight into the complexities involved. While it does not go into detailed technical requirements, it does aim to provide a first level of understanding on how to integrate ICTs in agriculture extension and programming.

### What will I find in this handbook?

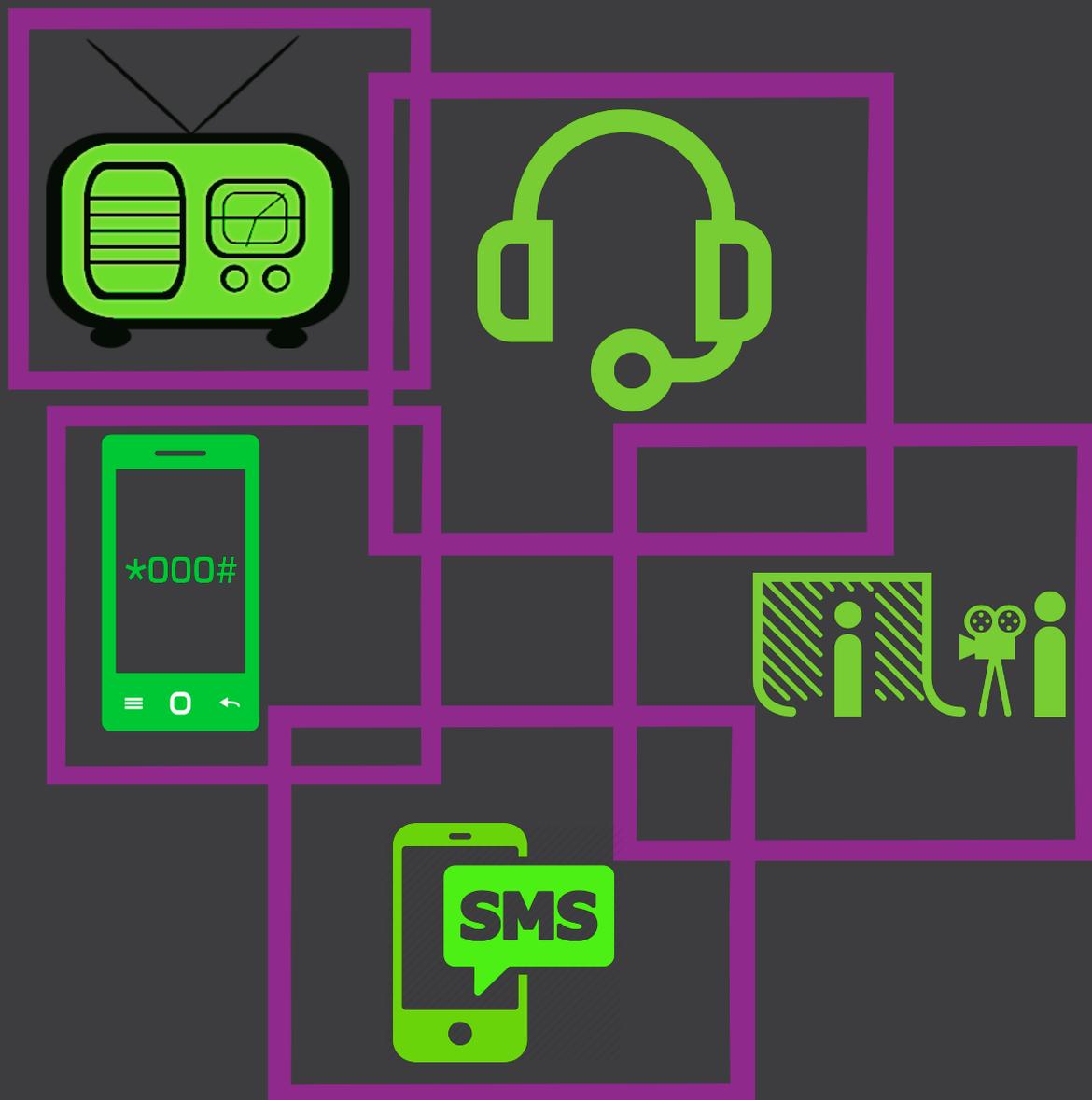
This handbook is divided in 3 main parts: 1) Technologies that have been around for a while; 2) Technologies that are catching up fast; 3) Technologies that can shape the future. Each ICT solution is described in some detail, providing practical information through examples of organizations and initiatives who have used those ICTs. Each ICT solution's technical requirements for setting up and implementing it are listed. Also highlighted are those aspects that make the particular technology useful for farmers, and particularly smallholder farmers. Some important considerations for practitioners are emphasized.

Each ICT solution is accompanied by a case study of where they have been used in low-resource settings, focusing mainly on Bangladesh, and least developed/developing countries. The case studies demonstrate how the ICT solution employed tried to address a particular need being faced by smallholder farmers.

The last section briefly describes the large suite of ICT solutions that have been promoted by the Agriculture Information Services (AIS), Bangladesh, as the biggest information provider for smallholder farmers in Bangladesh.

# ICT4AG Solutions

Technologies that have been around for a while



Community Radio

Short Messaging Service

Interactive Voice Response

Community Video

Unstructured Supplementary Service Data

## 1. Community Radio

Radio has been a powerful communication tool for several decades now. In the earlier part of the 20<sup>th</sup> century, radio's potential as a public service system was widely recognized and used. In many countries, experiments with the use of ICT in agricultural development started with radio. In Bangladesh, Bangladesh Betar<sup>1</sup> has been broadcasting farm programmes for several decades. Same is true for other countries in South Asia, including India, where All India Radio has been bringing new technological information on agriculture and other allied subjects to the farmers, or Nepal where Radio Nepal has been broadcasting agriculture programmes nearly since its beginning in 1951. Even in other parts of the world, radio continues to play an important role in disseminating information on agricultural development. As with most of the broadcast media, radio faced the challenge of being largely top-down and not responding to very specific local needs of farmers. In the last couple of decades, Community Radio started taking over with more localized and contextual agricultural information.

In South Asia, the liberalization of the broadcasting licensing policy meant that community radio received new impetus. In Bangladesh itself, 18 community radio stations have been established, which are coordinated by AIS. Community radio typically serves a very local community, where the content is driven by the needs of that community and often produced by the community members themselves. Community radio adopts a participatory approach and focuses on active participation of its listeners, who are community members, on community development issues, including agriculture.

Community radio usually covers a limited geographical area of few villages in the radius of 20-30 kms. This limited reach means that it works with geographical communities which face common issues, particularly when it comes to farming and agriculture. Community radio can provide highly localized and timely information on weather, pests and disease prevention, market rates and such. It can also be used to provide information on seed varieties, new technologies, low cost production methods etc. Since community radio content is developed by community members themselves, the content can be in a form and language easily understood by the local farmers - either through talk shows with experts, drama or songs. Krishi Radio in Bangladesh' Barguna district (the only government community radio established by AIS) reaches farmers in this distress area in a similar manner. Others like Farm Radio International ([www.farmradio.org](http://www.farmradio.org)) work across with broadcasters to produce high-quality radio programmes for small-scale farmers that are informative, interactive and entertaining.

---

<sup>1</sup> Translates from Bengali to Wireless Bangladesh

## Requirements

- Community radio policy to allow for set up of community radio. Most countries will require operators to obtain a license before starting a community radio station.
- Space and equipment for a Community radio studio, including transmitters, recording studio and equipment, and editing studio.
- Trained staff to run the radio station, such as technicians, programmers and reporters.

## Highlights

- Radio needs little electricity, and once established, the equipment in the radio station is robust and easy to maintain.
- Radio does not need the targeted population to be literate, and enables farmers with low literacy levels to interact with one another, and with extension workers and experts through radio shows.
- Radio is widely available in rural communities and can reach the hard to reach communities, still enjoys a good listenership and can reach far greater number of people with lesser costs, when compared with other broadcast mediums.

## Considerations

- Community participation is vital for community radio to succeed.
- It requires a robust training to build the communication and technical skills of the community.
- Radio programmes should be made in local language/dialect.
- Radio programmes can be complimented with face-to-face advise and extension, with administrative and material support available to have the maximum impact.

### Case Study: Krishi Radio, Nepal

Krishi Radio is the only community radio in Nepal which focuses completely on agriculture, and reaches around 25,000 people in this mountainous country, where literacy levels are still very low. It runs programmes on improved practices, technology adoption and market information in one district of Nepal. Krishi Radio has a robust system for involving the community. In each of the village that it broadcasts to, Local Radio Support Committee has been formed. The committee is formed of people from the community itself, which also takes a decision on who the reporters will be and who will compile the agriculture information. This has led to a high level of ownership. Apart from the community radio programme and involving local community through the committee, Krishi radio also conducts other on-ground activities such as soil testing and organizing visits by agro-technicians. Farmers have found the radio programmes and activities quite helpful in improving their productivity. Most importantly, they have found the information on market prices, which supports them in negotiating a fair price. Krishi Radio continues in a sustainable manner with support and participation from the local community.

## 2. Community Video

Videos are another popular medium to make the information reach farmers. With the cost of video-making reducing substantially over the past couple of decades, it has become quite popular in agriculture extension. Videos can be shot either professionally or by local extension staff and community members, depending on the need of the project. Professional videos can be very high quality, shot by professional filmmakers on high-end cameras. Low-cost community videos can be shot on handycams by trained local community members. Videos, which are high in quality, can be made for broadcasting on television. Broadcast videos can be on generic topics of interest for farmers spread across a large geography. Highly localized videos, which are relevant to specific geographies, are made to provide farmers with the exact information they need based on their agro-climatic zones. Often, highly localized videos are also low-cost, made by the local community members catering to the needs of farmers. Such videos are shared locally by extension workers through mostly offline platforms, such as tabs, projectors and mobile devices. Videos, which are more generic and apply over a large geography, can be shared online on video sharing platforms.

Videos are made for several uses, such as raising awareness, documenting traditional practices, disseminating agriculture best practices, generating demand for services and products, and monitoring and evaluation of projects. Insightshare ([www.insightshare.org](http://www.insightshare.org)) is one organization which has supported farming communities in documenting traditional farming practices that farmers want to share with other farmers. Several traditional practices are slowly dying and video becomes an effective medium to document and preserve them.

Videos are also used for training purposes. They offer the ability to show and explain exact processes, which can be challenging to explain through any other medium. The combination of audio and visuals makes it easy for the farmers to see and understand how they need to apply a particular agriculture practice. Access agriculture ([www.accessagriculture.org](http://www.accessagriculture.org)) is one such organization which produces high-quality professional videos that are instructional and cover various crops and their entire production cycle. Videos are translated in local languages for where they are found relevant. On the other hand, Digital Green ([www.digitalgreen.org](http://www.digitalgreen.org)) trains extension workers to produce their own localized community-based training videos, often in local dialects featuring the local model farmers. The videos are shared by extension agents with farmers groups, which ensure that consistent information is being disseminated. In all three cases mentioned, the role of the farmer in the videos as the one sharing knowledge with peer farmers is crucial. Informational videos can be made on the various aspects that a farmer needs information on. These can include information on pre-harvest, harvest and post-harvest agriculture best practices, marketing, business management, financial management and so on.

One of the first use of community video in Bangladesh was by Poverty Elimination Through Rice Research Assistance (PETRRA) project in 2003, and has since been used by organizations such as Access Agriculture and Digital Green.

### Requirements

- Training in video production or professional video producers.
- Video production set: camera, tripod, microphones, headphones and editing system.
- Dissemination platform: either offline through projectors, mobile phones and tablets, or online through video-sharing sites such as YouTube.

### Highlights

- Can be used easily with low-literacy level groups.
- Combination of audio and visual makes for a great learning tool.
- Can be either highly localized or generic.
- Can be made in local dialects, which farmers can understand easily.
- Depending on the needs, videos can be made with either high or low resources.

### Considerations

- If the quality of videos is poor, the information may not be understood well by farmers.
- Producing good quality videos require either extensive training or professional video producers.
- As important as producing the video is the platform used for dissemination. An appropriate platform that farmers can access is essential for them to see the videos and use them.

## Case Study: Digital Green, South Asia and Sub-Saharan Africa

Digital Green ([www.digitalgreen.org](http://www.digitalgreen.org)) is an international non-profit organization which uses community video to improve livelihood of smallholder farmers in South Asia and sub-Saharan Africa. It trains farmers themselves to produce and disseminate videos made on innovative agricultural practices, which have the potential to increase the crop yield. The localized videos made by farmers in their own local language features model farmers from the same community who have already adopted the improved practices. Farmers often learn about new practices from their own peers because they trust them, and these community videos leverage this peer to peer network. These videos are shown by a community-level extension agent, who typically belongs to the same community. During the video screening, the farmers can ask questions related to the practice before adopting it in the field. Over 5000 local language videos have been made by farmers across the globe, which have led to an increase of 50% in adoption of practices.

### 3.IVR

Interactive voice response or IVR is voice based, and relies on the most basic feature phones to be able to be used. IVR can be a 'push' or a 'pull' service. A push call is when the service provider sends a call to the user. A pull call is when the user himself/herself calls a given IVR number. There can be different types of IVR services – those that are fully automated and one-way, those that are fully automated, but interactive and requiring users to select from a number menu, and those that are linked to human services/call center for a two-way conversation. These different types of IVR services are dependent on the need of the user, and what the service intends to provide.

If the IVR service intends to just share information, a pre-recorded call can go to the user and when the user picks up the phone on getting the call, s/he can listen to the pre-recorded message. If the IVR service wants to get thoughts or questions from users, it can allow them to save their recording. For instance, Khedut Saathi<sup>2</sup> by Awaaz De ([www.awaaz.de](http://www.awaaz.de)) in India sent pre-recorded agriculture messages by experts over IVR, and at the end of the message farmers could record their feedback and questions, making it a two-way process. IVR services in agriculture can also be linked to human call centers, where a farmer can reach an agriculture expert, get market information, or avail extension services. The 16123 Krishi Call Center<sup>3</sup> by AIS, Bangladesh is one such service where farmers can dial-in and ask for help on any problem related to livestock, aquaculture and agriculture. M-Kilimo<sup>4</sup> in Kenya is another such helpline which allowed farmers to call the Farmer Helpline in several local languages along with Swahili and English. The Farmer Hotline by the Ethiopian Agricultural Transformation Agency ([www.ata.gov.et](http://www.ata.gov.et)) offers both push and pull services. Once a farmer has registered on the toll-free service with their areas of interest, they receive automated information on it whenever they call in. They also receive customized calls pushed by the hotline in cases of drought, pest and disease.

A good customer relationship management (CRM) system can allow service providers to collect data about usability of the service – for instance the number of users, how long are users listening to the message, how many in-bound and out-going calls are happening, what type of questions are people asking, what are the specific needs of men and women farmers and so on. Such data can help the service provider to make better-suited services for farmers.

#### Requirements

- Different countries have different rules and regulations with respect to voice over IP and telephony, and that has to be navigated.

---

<sup>2</sup> Translates from Gujarati to Farmer friend

<sup>3</sup> Translates from Bengali to Agriculture Call Center

<sup>4</sup> Translates from Swahili to M-Agriculture

- Agriculture call-center can require a complex ICT setup when providing high quality diverse information, including hardware and software requirements. However, providers such as Awaaz.De and GramVaani ([www.gramvaani.org](http://www.gramvaani.org)), which work specifically in the development sector, can provide-readymade solutions for IVR services that can be adapted.

### Highlights

- Illiterate audiences can benefit from IVR because they're simply listening to prompts and messages and then choosing a key message to listen to. They can also record their questions, enabling it to become an interactive system.
- Anyone with any type of phone, not necessarily smartphone, can use the IVR service.
- You can broadcast messages to a large population of farmers simultaneously. It is helpful in being able to inform all farmers at the same time about a particular agriculture practice.

### Considerations

- An IVR has to be easy to access, easily memorable short code e.g. 5454 or 6565.
- Information has to be provided in languages most users can understand, and it has to be simplified enough for them to remember.
- In centralized call centers, experts may not fully understand the local languages and dialects spoken by farmers.
- IVR can sometimes be a bit difficult to navigate when it has multiple options, or multiple numbers to be pressed before getting the desired information.
- The success of outbound calls/push voice calls is dependent on the availability of the farmer to pick up the phone. Often, women farmers do not have their own phones and may get access only at a certain time of the day.
- IVR has to provide trustworthy, highly accurate information. For better acceptability and impact, it has to be clubbed with offline support, often provided by NGOs or government.

### Case Study: Krishak Bondhu Phone Seba, Bangladesh

Access to information ([www.a2i.gov.bd](http://www.a2i.gov.bd)), the flagship program under Digital Bangladesh have developed the Krishak Bondhu Phone Seba<sup>1</sup>, 3331, on which farmers can call to receive information that they receive. When a farmer, who is enlisted with the portal, calls 3331 the call is automatically carried to his/her respective block agriculture extension officer. If the extension officer is unable to pick the call up, the call automatically goes to the supervisor. If the call remains unanswered the message from the farmer can be recorded and the farmer will receive the answer via SMS. Most IVR helplines for smallholder farmers are dependent on a central call center, but with this helpline farmers can reach their area's block supervisor, thereby reducing the gap between the farmer and agriculture expert.

## 4.SMS

SMS is another basic function that is available on all mobile phones. There can be a request-reply model, or pull SMS where farmer requests for information each time s/he needs it. It can be a subscription-based model, where once subscribed the farmer keeps receiving messages on what s/he opted for. Users receive a written message on their phones, which can be on a variety of aspects, to get information that they could previously not access so easily. SMS has been used for various purposes in agriculture, such as delivering information on market price, weather data and crop production. SMS are often sent in local languages so that farmers are able to read and understand it.

In India, mKisan<sup>5</sup> is a SMS portal for farmers, reaches out to farmers through SMS in their language, preference of agriculture practice and location. Farmers have to register themselves by calling the Kisan Call Center where their details are taken and farmers receive SMS pushed by local agricultural experts. In Philippines, Farmer's Text Center provides SMS on technical information to rice farmers.

Certain mobile networks offer bundled services, such as EcoNet Wireless ([www.econet.co.za](http://www.econet.co.za)) in Zimbabwe. When farmers subscribe to the EcoNet farmer platform they get a package of services, including microinsurance, advisory tips and market information for their crops, which are a part of the subscription they pay. SMS has also been used to provide market services, connecting buyers and farmers. MFarm ([www.mfarm.co.ke](http://www.mfarm.co.ke)) in Kenya connects farmers and buyers by allowing farmers to team up, collect their products and send a SMS promoting what they have to sell.

In Bangladesh, mobile penetration is increasing steadily, and by unique subscribers was around 51%<sup>6</sup> at the end of 2017. Several NGOs, government agencies and mobile network providers are leveraging this to offer SMS-based services. Agencies such as Bangladesh Agro-Meteorological Information System (BAMIS) and Bangladesh Meteorological Department (BMD) are integrating SMS for advisories to farmers. E-Krishok<sup>7</sup> ([wp.e-krishok.com](http://wp.e-krishok.com)) in Bangladesh integrates SMS along with other ICTs to connect buyers and farmers. Traders quote a price which is directly sent to relevant group of farmers through SMS which has the contact information of farmers.

### Requirements

- Software requirement to run a SMS-based services. There are companies providing all the support to set up such SMS services, such as Rapid SMS ([www.rapidsms.co.in](http://www.rapidsms.co.in)) and Africa's Talking ([www.africastalking.com](http://www.africastalking.com)).

---

<sup>5</sup> Translates from Hindi to mFarmer

<sup>6</sup> Country Overview: Bangladesh. Mobile industry driving growth and enabling digital inclusion. GSMA.2018

<sup>7</sup> Translates from Bengali to E-Farmer

- Experts who provide the right technical information to queries and requirements of farmers.
- Promoting the SMS service offline to register as many farmers as possible

### Highlights

- SMS needs a basic mobile phone which works even without internet connectivity.
- It requires minimal digital literacy to receive and send SMS, therefore it requires little training or local capacity building for both the farmer and also the extension staff.

### Considerations

- The farmer has to be literate and the SMS has to be short, precise and clear to get the message across.
- Receiving texts is easy, but sending texts can be quite difficult in local languages, which have long words that can be spelled in different ways.
- Trust is essential when promoting a SMS service. To market the SMS service, partnering with NGO/extension agencies which work with farmers can be critical for success.
- Power issues make it difficult to send farmers real-time information (like price or weather), as their phone might not be charged at that moment.
- There can be 'SMS-fatigue' among users if they receive too many generic messages. Subscription-based offers therefore work better than a free push-model.

### Case Study: mPower, Bangladesh

mPower ([www.mpower-social.com](http://www.mpower-social.com)) is a social enterprise which has been working in Bangladesh to strengthen the advisory services available to farmers. It provides a host of ICT-based services to farmers. While complex technology solutions are used to generate advisory for farmers, the farmers are reached using low-tech options including IVR and SMS. In one of its projects, mPower combines data on weather forecast, gathered from automatic weather stations at union level, with crop stages of select crops. The combination of this information triggers advisory for farmers automatically. The advisory is vetted by experts for correctness of information and language. The advisory is then sent to farmers automatically through SMS. The SMS advisory is in a short and clear format, giving actionable recommendations, for instance, when to spray the crops with fertilizers and how much. This not only saves cost for farmers by optimally utilizing the inputs, but also provides preventive and remedial actions from pest and disease attacks. It is essential for farmers to receive advisory when it is relevant to them. mPower is now beginning to register farmers with their specific date of planting to provide more customized advisory based on individual farmer's crop growth stage.

## 5. USSD

USSD is short for Unstructured Supplementary Service Data, and sometimes referred to as 'Quick Codes' or 'Feature Codes'. It is most often used by mobile network providers to establish a real-time communication between the user and their USSD computer, for example to check balance money. When a user sends a 'code' to the mobile network, the computer responds back to it immediately in a basic format that can be seen on the phone screen itself. For instance, a user types \*123# on their phone and sends it to the mobile network operator and the operator's computer sends a response corresponding to that particular code, which can be seen on the user's phone. This response cannot be stored or saved. However, on sending a request through USSD, response can be sent back via SMS too. Often, USSD and SMS services are integrated. USSD can be used for multiple purposes, such as for requesting a call back, for mobile money payments, location-based content services or information services. They can even be used for small group social networking, where farmers can exchange messages using USSD.

The biggest benefit of USSD is that it requires far less signal strength to work and therefore, can be accessed in areas with very limited network connectivity. It uses very limited power and devices using USSD can last longer. It is also extremely affordable for the user.

The mobile network Orange started USSD services for farmers in several countries in Africa. Farmers can use that service to get a range of information, from market information and cultivation techniques in Ivory Coast, to information on fertilizers and government subsidies in Egypt, to publication of agricultural products offers in Madagascar. mAgri ([www.magri.co.bw](http://www.magri.co.bw)) in Botswana provides agriculture tips, weather information, access to Wikipedia, a market place and functionality to chat with fellow farmers and even email, through USSD. mKisan in India provides information to farmers through USSD services too, along with other mobile-base services. mLouma in Senegal allows farmers to connect to a virtual agriculture platform for commodity exchange via USSD, as well as SMS. A farmer pays a subscription fee and can then find a product to buy or advertise to sell a product.

### Requirements

- Until recently, it was difficult to use USSD because you had to work directly with mobile network operators, but now third-party companies can make USSD services available across networks, such as Africa's Talking.
- Content needs to be created in the USSD format, with expert inputs.
- A CRM should be integrated to better understand customer needs and usage.

### Highlights

- USSD can work on a basic mobile phone, without internet connectivity.

- It can work in places with limited mobile connectivity too, where even connecting phone calls might be challenging.
- Users get a real-time response to their queries.
- It requires very limited digital literacy to use USSD services.

### Considerations

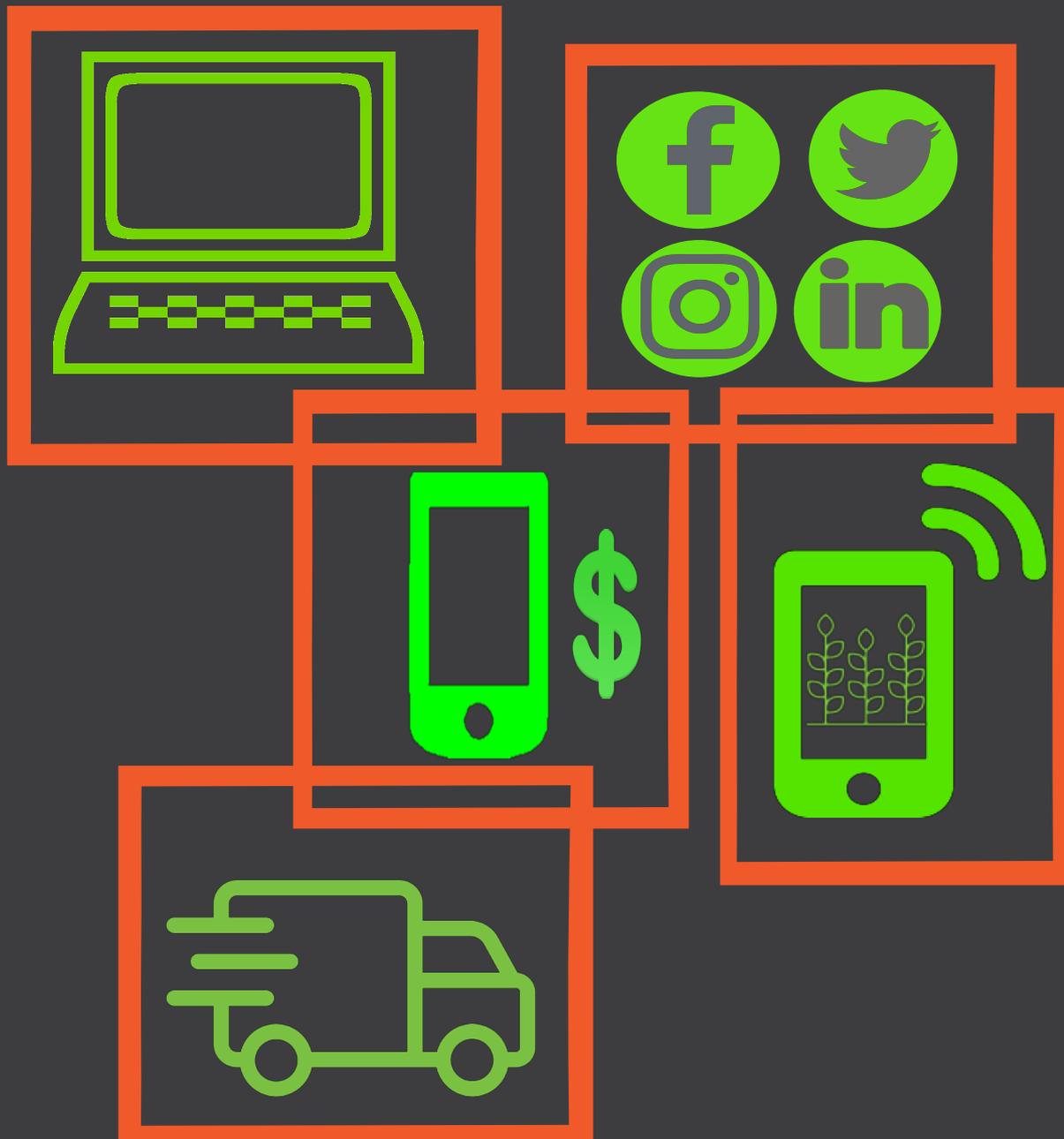
- Navigating USSD menu can be quite tedious, thus reducing usage.
- It might be difficult for the farmer to understand the information clearly, since short messages are sent as a response.
- Many other challenges associated with SMS, particularly around language and content, are equally applicable to USSD notifications too.

### Case Study: mAgri, Botswana

mAgri ([www.magri.co.bw](http://www.magri.co.bw)) in Botswana provides a host of services through USSD. Farmers can dial \*118# from any mobile phone, including the most basic of the phones, and access the information that they need. The first time a farmer dials s/he sets up her profile and registers herself for the services. There is a nominal subscription charge per month, which the farmer can chose to stop any time they want. It provides three main types of services: 1) agricultural and weather information; 2) marketing and sale of products; 3) connection with other farmers. Farmers can access information on agricultural practices, weather and market prices of crops. They can also set up their business profile and list their location, products and services. This information is available on the marketplace which other farmers and buyers can see and either buy from you or sell to you. Moreover, it allows farmers to connect with each other through email, which is generated by nFrnds – the social aspect of the USSD service, or via individual and group chat. It uses a simple to use navigation through an easily accessible technology, which has reduced the digital gap for smallholder remote farmers, who can now access services with very limited cost.

# ICT4AG Solutions

Technologies that are catching up fast



Web Platforms

Inclusive Digital Finance

Mobile-app based agro advisory

Social Networking

Mobile-app based market services

## 6. Web platforms

Web-based platforms are now making a headway as some farmers are gaining access to internet either through their smartphones or computers. A very limited number of smallholder farmers in the developing world have access to internet and computers, but smallholder farmers in developed countries are beginning to use internet to access information related to agriculture practices, market prices and others. These web platforms can be websites, blogs or discussion forums.

A website can support agricultural advisory in innumerable ways – it can be a repository of best agricultural practices in form of print, audio or video; it can provide real time data on weather and market prices; it can enable farmers to interact with each other or experts; it can link farmers to markets, and several such. APOLLO project's [apollo-h2020.eu](http://apollo-h2020.eu) is one such website providing agricultural advisory services focused primarily on smallholder farmers in Europe. It uses open source data available to provide all of its tailored services to farmers through its web platform. The platform supports farmers through all stages of farming, helping them schedule activities based on weather data, monitor crop growth and estimate the yield. MyAgriGuru ([myagriguru.com](http://myagriguru.com)) is an India-based platform which establishes a network of the agricultural community- connecting farmers and agricultural experts to share knowledge, discuss ideas and seek support.

In Bangladesh, internet penetration was estimated to be 55% at the end of 2017 by Bangladesh government<sup>8</sup>. Some other reports put a lower figure<sup>9</sup>, however, it is expected that the penetration will keep increasing by 10% or more every year<sup>10</sup>. This has encouraged a multitude of web-based platforms to come up, such as the AIS website - [www.ais.gov.bd](http://www.ais.gov.bd) which contains factsheets on over 80 crops. Department of Agricultural Marketing (DAM) collects market information on a daily basis in 64 districts and disseminates it through its web platform [www.dam.gov.bd](http://www.dam.gov.bd). Soil Resource Development Institute (SRDI) has developed an online platform [www.frs-bd.com](http://www.frs-bd.com) which allows farmers to get online fertilizer recommendation based on soil, location, crop and land parameters.

Blogs are another web platform used by organizations to share and exchange knowledge. Often blogs are integrated with the websites, like CGIAR ([ccafs.cgiar.org/blog](http://ccafs.cgiar.org/blog)), Grameen Foundation ([www.grameenfoundation.org/blog](http://www.grameenfoundation.org/blog)) and IFPRI ([www.ifpri.org/blogs](http://www.ifpri.org/blogs)) have done. The blog pages have news and updates related to agriculture, projects that are going on, research that is being done, opinion pieces by experts and so on. Following these blogs can support farmers and agricultural extension agents to remain up to date with advances and research in the field. Similarly, there are online discussion forums, webinars and meetings

---

<sup>8</sup> <http://www.btrc.gov.bd/content/internet-subscribers-bangladesh-december-2018>

<sup>9</sup> ITU puts it at 18% at the end of 2017; Internet Live stats puts it at 13% at the end of 2017. This is potentially to the different definitions of 'internet penetration' used by different agencies.

<sup>10</sup> Country Overview: Bangladesh. Mobile industry driving growth and enabling digital inclusion. GSMA.2018

planned by organizations to engage farmers and experts. For instance, Food and Agriculture Organization runs a Global Forum on Food Security and Nutrition ([www.fao.org/fsnforum/home](http://www.fao.org/fsnforum/home)). The Forum for Agricultural Research in Africa ([www.faraafrica.org](http://www.faraafrica.org)) uses Dgroups, a platform to engage groups, to run its online platform for African farmer organizations. Several webinars are organized periodically, which extension workers can participate in to support their knowledge of agriculture advisory services.

### Requirements

- A website developer or knowledge of developing online platforms.
- Content management on the online platform to keep it updated.
- Good internet connectivity to maintain an online platform.

### Highlights

- A vast amount of data and resources can be available on online platforms.
- Data can be in various formats, including text, audio and video.

### Considerations

- Users of online platforms need to have good internet connectivity to access resources and data.
- Users should have a device which supports internet to access the online platform, such as a desktop, laptop or smartphone.

### Case Study: Krishi Batayan, Bangladesh

Krishi Batayan – [www.krishi.gov.bd](http://www.krishi.gov.bd) is an extremely comprehensive web platform in Bengali, covering extensive agricultural information. The portal provides different types of information in different formats. It has news and feature articles on current agricultural topics on its homepage, which extension agents can find useful. There are articles highlighting some highly effective traditional agricultural practices, both with a purpose of documenting and disseminating them. There is an information repository on about 165 crops grown in Bangladesh, ranging from fruits, vegetables, spices, to pulses and more. The repository contains major pests and diseases of each of these plants, a photograph of how a pest/disease attack actually looks like and ways to manage it. Beyond the text and photo-based information, the website has over 370 videos on agricultural practices of various crops. There is an interactive section on the website, the Q&A forum, where users can log in and post questions they may have on agriculture-related topics. Questions are answered by experts and this exchange can be viewed by every user. For extension agents it is a useful platform to support the work that they do.

## 7. Social Networking

Social media is becoming increasingly popular as a means to be in touch with your networks. Within Bangladesh 17%, i.e. 28 million people, are supposed to be active social media users<sup>11</sup>. The various tools that social media platforms offer are being used by development professionals and organizations to advance their causes. Similarly, agriculture and rural development professionals are using social media to connect communities, disseminate information, advocate, strengthen networks and make their work more visible. There is a deluge of social media platforms available and what they can offer, but the most popular social media platforms are the ones which can be used to leverage the power of social networks.

Community-building platforms, such as Facebook are popular for being able to form communities of interest and connecting people with similar interest. Farmer groups can be made on Facebook, who can engage with each other on topics of interest. Bangladesh Agriculture ([www.facebook.com/BangladeshAgriculture/](http://www.facebook.com/BangladeshAgriculture/)) is one such Facebook page. Mkulima Young<sup>12</sup> ([www.facebook.com/mkulima.young/](http://www.facebook.com/mkulima.young/)) connects young farmers in Kenya to communicate with each other. Image or photo-sharing websites, such as Pinterest, Flickr and Instagram can similarly help build a community of people with similar interest. Such groups and communities are often used by organizations working on agriculture and rural development to build their support community, raise awareness and share information about the work that they are doing. LinkedIn is a professional network platform, often used to build communities with similar professional interest and share related news and information. Twitter is also a popular platform to share updates, news, research and articles with fellow professionals.

Video-sharing social media platforms, including YouTube and Vimeo, are used to share information primarily in the form of videos. Organizations such as Digital Green ([youtube.com/user/digitalgreenorg](http://youtube.com/user/digitalgreenorg)), International Rice Research Institute ([youtube.com/user/irrivideo](http://youtube.com/user/irrivideo)), TNAU Agritech Portal ([youtube.com/user/tnauagritechportal](http://youtube.com/user/tnauagritechportal)), FAO ([youtube.com/user/FAOoftheUN](http://youtube.com/user/FAOoftheUN)) have YouTube channels with thousands of videos on innovative agricultural practices.

WhatsApp, Viber and IMO are other popular social networking and messaging apps that are becoming popular, even in rural areas of South Asia, including Bangladesh. Groups can be made on these apps and messages can be sent to all members of the group in one go. The benefit over SMS is that these messages need not be only text, but can include audio and video as well. It enables any member in the group to message directly to the rest of the group, making it more participatory and engaging. E-Horticulture in India is an example of using WhatsApp for posting information on the group on cultivation and management of horticulture crops,

---

<sup>11</sup> <https://www.statista.com/statistics/295643/mobile-social-media-mau-asia-pacific-countries/>

<sup>12</sup> Translates from Swahili to Young MFarmer

where farmers and experts interact with each other. Real Farmers in Kenya is another WhatsApp enabled group used by extension agents to reach out to the farmers they work with. While various social networking platforms can be used by an organization, the need is to use them strategically and continuously based on the nature of the users.

### Requirements

- Expertise in using the various social media platforms strategically and effectively.
- Ability to capture information continuously and share it on social media to engage communities on a regular basis.
- Users should be literate and have access to internet and social media platforms.

### Highlights

- Social media can be used effectively to highlight the work being done globally and build support communities and networks.
- It can reach out to a large number of farmers directly, if the farmers have access to internet.

### Considerations

- Social media needs to be used strategically. Running and maintaining your own Facebook page, Twitter handle, Flickr page, YouTube channel etc., takes a considerable amount of effort to be effective.
- Users of social media need to have good internet connectivity and devices which support internet access.

### Case Study: Krishi Bioscope, Bangladesh

One of the most interesting examples of use of social media by an individual for agriculture extension in Bangladesh is that of Krishi Bioscope. An Upazila (sub-district) Agriculture Officer of the Department of Agricultural Extension started Krishi Bioscope which uses two social media platforms – Facebook and YouTube. The Facebook community group is an open group on which the administrators post videos and news items and group members can comment on the posts. The videos are hosted on the YouTube channel and cover a range of crops and topics. Several videos inform farmers about non-traditional crops that can be grown to increase income. Videos feature several success stories of farmers growing such crops. They also share innovative techniques used by farmers to increase productivity. Facebook group of Krishi Bioscope ([www.facebook.com/krishibioscope.krishibioscope.7](http://www.facebook.com/krishibioscope.krishibioscope.7)) has over 500 members and the YouTube channel (<https://www.youtube.com/user/jubairmasror>) has over 100,000 subscribers, and both are increasing in popularity.

## 8. Inclusive Digital Finance

Smallholder farmers have extremely limited access to formal financial institutions such as banks, microfinance institutions and formal credit providers. Therefore, smallholder farmer often finds herself in debt and does not have financial resources to either adopt improved technologies or practices or insure the crop in case of crop failure. Digital finance services (DFS) for smallholder farmers are now beginning to address some of these gaps. DFS got a big push with the emergence of mobile money, though the penetration of DFS and adoption by farmers is still slow. Still, as more smallholder farmers own mobile phones, with connectivity getting better, DFS and mobile banking are becoming a reality for them.

There are several DFS products available which can be provided by banks or other financial institutions, including digital credit, crop insurance, payments and savings. Mobile banking essentially means being able to conduct financial transactions through the mobile phone. Farmers in remote locations do not have to travel to access banking services and transacting is transparent, faster, safer and cheaper. Kenya's M-Pesa and Philippines G-cash are such services where farmers transfer money fast and safely either for business and bill payments or to any individual person. However, several of such services are not necessarily tailored for farmers, but anyone who uses them.

There are certain DFS products that focus on agriculture. Some of those 'bundle' financial services with important information services for farmers. Examples include EcoFarmer ([ecofarmer.co.zw](http://ecofarmer.co.zw)) and Agri-Fin ([www.mercycorps.org/research/agri-fin-mobile](http://www.mercycorps.org/research/agri-fin-mobile)) in Zimbabwe. EcoFarmer provides information tips, weather indexed insurance, and even a funeral cover, for a subscription fee. Agri-fin mobile project helped farmers significantly during the financial crisis in the country. Even in the absence of cash, farmers were able to conduct transactions through mobile banking and earn their livelihood.

DFS is also helping banking and financial institutions to gather digital data for credit scoring which helps them in providing loans to farmers. Initiatives like Farm Drive ([www.farmdrive.co.ke](http://www.farmdrive.co.ke)) and M-Shwari<sup>13</sup> in Kenya use mobile phones, alternative data and machine learning to provide a risk assessment model specific to the agriculture sector. Other DFS products such as smart cards, POS devices, ATMs and biometric identification systems are also making inroads in rural sectors, enabling financial institutions to build new business models, financial products and services specifically for farmers.

### Requirements

- A good understanding of farmers' lives to understand their financial needs.

---

<sup>13</sup> Translates from Swahili to M-Calm

- A good understanding of the value chain in agri-businesses to comprehend the specific needs of farmers for developing customized and relevant DFS products.
- On-ground efforts to build trust amongst farmers, and inform and train them in using DFS products.
- Technology system requirements are high to build specific products and services.,

### Highlights

- Enables transparent, fast and safe financial transactions, for both farmers and individuals/businesses working with farmers.
- Supports farmers' digital data being available to financial institutions to provide credit, insurance and other services.
- Can support farmers to increase their savings.

### Considerations

- Adoption of DFS is still slow due to limited information about the process.
- There is less adoption due to limited trust and lack of training in using DFS.
- DFS products are often not tailored to the needs of smallholder farmers, and thereby do not find market with them.
- Credit rates are often quite high, preventing farmers from getting loans for their agri-businesses despite having access.
- Financial institutions might still find farmers high-risk clients and therefore unwilling to develop services and products specifically for them.

### Case Study: Bank Asia – Agent Banking, Bangladesh

Bank Asia ([www.bankasia-bd.com](http://www.bankasia-bd.com)) started its Agent Banking model as an attempt to reach to the large number of rural-unbanked, most of whom are farmers. In partnership with multi-national organizations and donors, Bank Asia has done various projects aimed at the financial needs of farmers. To improve farmers' accessibility to formal banking it introduced an agricultural digital finance model, which focuses on providing farmers loans customized to their needs. Data is collected on farmers digitally, though it has its own challenges, which includes live photographs and information on their land. Based on farmer data, loans are processed and approved and farmers receive a Near-field communication (NFC) enabled payment card. This card can be used to buy inputs, hire machines and to take out cash from agent points. Farmers simply need to tap the NFC card at the retailer's device for buying any input, they get an OTP on their mobile phone and upon confirmation, the money is deducted from their loan account. In some projects, farmers are connected with aggregators who buy their products and pay them directly into their account. Though Bank Asia has been facing some challenges in recovering loans, particularly with farmers suffering losses due to climate change-related factors, efforts are being accelerated to design products even better suited to farmers' reality.

## 9. Mobile App-based agro-advisory services

Getting the right information at the right time during crop production has usually been a big need of the farmers. Due to the remote rural locations, which most smallholder farmers usually are in, trusted advisory services often do not reach them in time. These could be input, weather or disease-prevention related. They tend to rely on information they gather from their peers or biased information from input suppliers. This lack of right information often means that they are not able to use the best inputs that they can, apply best practices or protect their crops from impending risks and disasters. Mobile applications can be used to overcome many such barriers faced by farmers.

Various mobile app-based rural advisory services provide information throughout the production cycle – from information on inputs such as seeds, land and water management, pest and disease management, amount of fertilizers and pesticides to be used, to information on weather and harvesting. Mobile apps can provide information in multiple ways, including text, audio, video and photograph. The functionality of the mobile app can also make it easy to search for the right information. IFFCO (Indian Farmers Fertilizer Cooperative) Kisan is one such app for Indian farmers with information on crop, weather and market prices. Information is already fed in the app, and the farmers can search for the specific information they need.

There are mobile apps in which farmers can ask specific questions to experts and receive the information they need – either as app notifications or through SMS and IVR. One such mobile app is the Farmer Query System by mPower ([www.mpower-social.com](http://www.mpower-social.com)). Farmers or extension agents (on behalf of farmers) submit their query through the app, which experts receive on a web dashboard and reply to within 12 hours through recorded audio, SMS or phone calls. The extension agents can also take photographs of the problem, which helps experts diagnose the problem properly. This is being used not just for crops, but also livestock, through the Shurakha<sup>14</sup> app.

Apart from mobile apps which provide information services, there are apps which enable decision-making based on the data entered by farmers. Grameen Intel ([www.grameen-intel.com](http://www.grameen-intel.com)) in Bangladesh has developed a suite of mobile apps – i) Mrittika<sup>15</sup>, which is a fertilizer recommendation app based on farmer's land condition, ii) Ankur<sup>16</sup>, which lets farmers select seeds based on their soil and iii) Protikar<sup>17</sup> which works as an encyclopedia of pest and disease images for their appropriate management.

---

<sup>14</sup> Translates from Bengali to Safety

<sup>15</sup> Translates from Bengali to Soil

<sup>16</sup> Translates from Bengali to Sapling

<sup>17</sup> Translates from Bengali to Remedies

In Bangladesh, while currently the smartphone penetration is 31% of the total population, both are supposed to double in 6-7 years' time<sup>18</sup> reaching further into rural areas, opening up a huge potential. Often, mobile apps provide a host of services to farmers and newer innovations are happening in this space to ensure that farmers are able to easily use the app. Mobile apps can be available offline overcoming issues of connectivity, introducing intermediaries like extension agents where farmers themselves do not have smartphones, and using more image and icon-based interface to overcome literacy barriers.

### Requirements

- Developing and maintaining your own mobile app requires a strong ICT solutions team, resources and infrastructure.
- Offline activities including marketing and training are needed to onboard extension agents and/or farmers to use your app
- Regular IT maintenance is needed to update the app itself and the information available on it.

### Highlights

- A large amount of data in various formats can be readily available, suiting different needs of different types of users.
- A broad range of services and functionalities can be made available through a mobile app.
- If designed well, with minimal use of text, the users need not be highly literate to use apps.

### Considerations

- To use an existing mobile app requires a smartphone and often good internet connectivity.
- Some amount of literacy and digital literacy is required by users to effectively use mobile apps.

---

<sup>18</sup> Country Overview: Bangladesh. Mobile industry driving growth and enabling digital inclusion. GSMA. 2018.

## Case Study: Fosholi, Bangladesh

Fosholi<sup>1</sup> is a mobile app that has been developed by ACI Bangladesh ([aci-bd.com](http://aci-bd.com)) and is available in English and Bengali. The app aims to provide services to farmers on every stage of growing a crop – from pre-cultivation to post-cultivation. It sources information from a lot of available services, instead of creating its own. At the pre-cultivation stage it sources information from SRDI (Soil Resource Development Institute; [srdi.gov.bd](http://srdi.gov.bd)) and uses 13 parameters to suggest crops that are suitable for the particular crop type. During cultivation, it gathers information on crop growth through satellite images and provides tips to farmers of particular crops based on the growth stage. It also provides a pest and disease forecast, for which the weather and crop growth stage data are combined. When situations for a pest/disease attack are created, registered farmers receive an alert through a notification on the app. If the farmer themselves are not registered, an intermediary can register farmers on the app and farmers instead receive a SMS. Some other services available are information on inputs and their retailers close to the farmer's location, a leaf color chart for identifying nitrogen need of the crop, and photo library for identifying nutrition deficiency in crops. Weather alerts are available based on data from Bangladesh Meteorological Department ([www.bmd.gov.bd](http://www.bmd.gov.bd)). Post-cultivation services include functionality for farmers to calculate their profit and loss. Farmers can keep logging their expenses and get to know at the end of the season their exact expenditure. The market information integrates the market price information from the Department of Agriculture Marketing ([www.dam.gov.bd](http://www.dam.gov.bd)), and also maps markets close to the farmer. While it is a fairly comprehensive app, its reach will increase as internet quality gets better, when farmers can use the app more effectively than they can right now.

## 10. Mobile app-based market services

A specific focus of some mobile applications is market services for farmers. Smallholder farmers are usually farther off from markets, have limited access to transportation, have limited information about market prices and have less tools to make business plans. This often means that farmers are not able to realize the price or profit that they could if they had the required tools and resources. Different mobile apps are trying to fill in these various gaps so that farmers get a better price and gain more profits for their products. Some mobile apps integrate market services along with other services and others aim to provide exclusive market-related solutions. Most of these apps work on the geographic location of the farmer and provide market-related information to the farmer.

Mobile app-based market services usually provide market prices of different crops. These apps also connect buyers and sellers directly, avoiding middlemen who often take a big share from smallholder farmers' profit. Vistar<sup>19</sup> by Grameen Intel is a bidding system, where buyers provide their requirements on crop, amount and price. Farmers get this information and can contact buyers through SMS or email to sell their produce at an optimum, transparent price. LOOP app by Digital Green, functioning in both India and Bangladesh, provides the market prices of crops in nearby markets through a helpline. Farmers can decide which market to sell the crop in, based on this information. LOOP app also allows farmers to aggregate their vegetable products and use a shared transportation services, thus bringing their transportation cost down and saving time.

Another part of market service is providing farmers with solutions to keep track of their expenses and income. Since farmers keep making various types of expenses throughout their crop cycle, they often do not know how much expenditure they incurred and while selling their crop are unable to estimate whether the price is profitable or not. Farmerbook, which is a part of the e-Krishok services, also supports farmers with exactly this and helps them to plan their farm business.

While the services mentioned here are available on a mobile phone, several organizations providing these services have to develop significant on-ground infrastructure and resources. From gathering correct market prices, to building users for the platform, and organizing farmers in groups for better prices.

### Requirements

- Developing your own mobile app requires a strong ICT solutions team, resources and infrastructure.
- Strong offline infrastructure is needed to collect and provide market information, promote the usage of apps and systematize other resources to organize farmers.

---

<sup>19</sup> Translates from Bengali to Propagation

## Highlights

- It can enable better decision-making for smallholder farmers as they can compare prices and chose what suits them.
- It can reduce the role of middlemen to a certain extent, thus fetching farmers a better price.

## Considerations

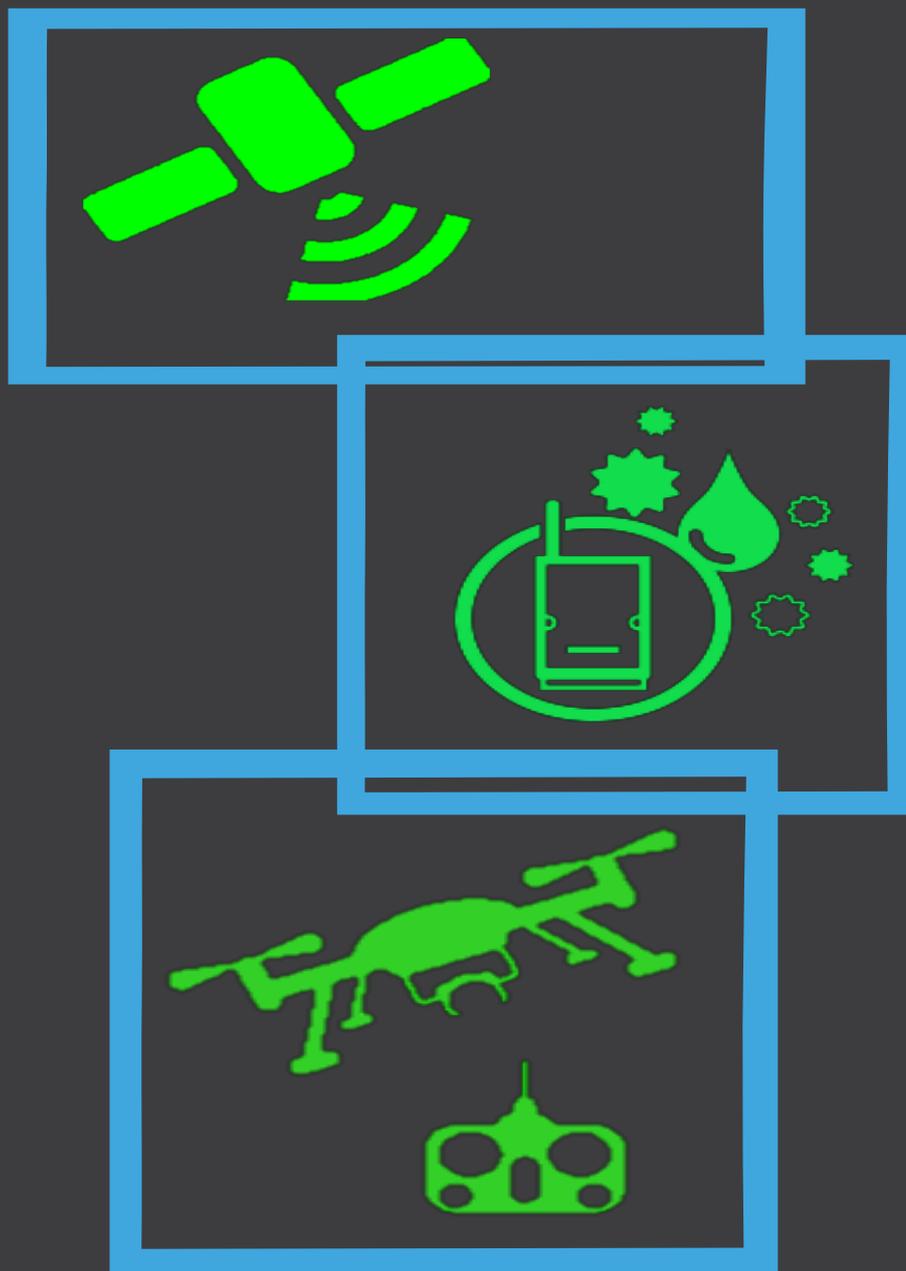
- Farmers may not trust a new market service, particularly a technology-based one, very easily.
- Farmers, and usually older farmers, may not find navigating through the mobile app comfortable. They might need training on understanding the design and navigation of the app.
- Technology infrastructure has to be strong to provide the information at the right time in the fluctuating market, considering low connectivity issues.

## Case Study: e-Farmer's Hub, Bangladesh

e-Farmer's hub by Syngenta Foundation ([www.syngentafoundation.org](http://www.syngentafoundation.org)) aims to strengthen the agricultural value chain. It has both offline and online features. Entrepreneurial individual farmers are selected in a village who are supported to establish their own e-Hubs. These e-Hub owners have established relationships with peer farmers and offer five services to them. These services include providing improved seedlings, inputs, machinery on rent, collection, transportation and selling of crops, and advisory. The entrepreneur has the e-Farmer Hub management app on his/her smartphone. Farmers receive the market price through their phone, which is also listed on a board in their hub. Other farmers in the village can chose to sell the produce at that rate to the entrepreneur. The entrepreneur collects all the produce, transports the produce and sell it in the market. The management app helps farmers to keep a track of their daily transactions. The app enables daily monitoring of transactions, farmer's receive automated profit and loss statements and get an analysis which helps them take sound business decisions. To establish these e-Hubs, the hub owners were selected through a rigorous process and were trained in both providing the required services to other farmers and using the management app. A combination of strong on-ground training and quality assurance, and user-friendly app has made e-Hubs profitable for their owners and supported other farmers get fair prices for their products.

# ICT4AG Solutions

Technologies that can shape the future



Drones

Satellite-based GIS

Internet of Things and Sensors

## 11. Satellite-based GIS

Satellite-based geographical information system (GIS) is a tool which creates visual representation of data and analyses it to support informed decision-making. When used in agriculture, data collected by satellites are often images of agricultural lands. Governments often use it to collect large-scale data on agriculture, including monitoring agricultural land, mapping soil zones, estimating crop area and assessing droughts etc. However, its application for smallholder farmers is now picking up in several regions of the world. The combination of these technologies, satellite images and GIS, is also called precision agriculture or satellite agriculture. Crops are location-based and information collected using satellite data along with the geographic information can prove to be very useful for farmers to take informed decisions regarding their crops. These could help them in cultivation of crops, estimating yield, get banking and insurance services, as well as market services.

Satellite images taken can be processed and analyzed to find out various information about crop growth in a particular region, and trigger actions and warnings for farmers. A project in Sudan, funded by the Technical Center for Agriculture and Rural Cooperation (CTA; [www.cta.int](http://www.cta.int)), used satellite imagery to provide information on crop growth, humidity and plant nutrient needs. The experts analyzed the information and sent SMS to farmers on actions to take regarding irrigation and fertilizer application. This supported farmers to make informed decisions about their wheat crop, thereby increasing their yield by up to 4 times. Farm Drive in Kenya used satellite images to make locating small farms easier for insurers - which tells them about a farm's soil conditions, accessibility to market etc., thereby increasing farmers' access to credit and banking facilities.

It can also be used after natural disasters to assess the damage to farms. In India, satellite images and remote sensing was used with GIS to assess the damage done by floods to farms in Bihar. The insured farmers received compensation based on the damage, under a pilot Index-based flood insurance scheme launched by International Water Management Institute (IWMI; [iwmi.cgiar.org](http://iwmi.cgiar.org)). The satellite-based information can be combined with other geodata using remote sensors, such as weather, soil moisture and others for improved farm management. GeoBis project by mPower is one such solution available to farmers in Bangladesh, providing them advisory on seed selection, land and irrigation management, use of fertilizers, and remedial measure for pests and disease.

With satellite images becoming more high resolution and giving good quality data, it can be increasingly used for smaller land areas, supporting smallholder farmers.

### Requirements

- Usable satellite-data collected over a period of time for suitable analysis.
- Software and hardware capacity to analyze the satellite data.
- Ability to translate satellite data into meaningful information for farmers.

## Highlights

- Very precise information on crop growth can be provided to each farmer based on their crop and soil type.
- If used well, the analyzed information can give indications about possible deficiencies, pests and diseases in crops in a timely manner, supporting farmers to take remedial action.
- It collects data on a regular basis, which can make farm management much easier if data is analyzed regularly.

## Considerations

- Resolution of images captured through satellite is usually not as high as is possible through other methods.
- Information collected may still not be as precise for small land-holdings.
- There is usually a time-delay between when the image is captured and when it can be used. This can be particularly disadvantageous for short-maturity crops.
- The cost of applying satellite-based GIS is quite expensive and prohibitive.

## Case Study: GeoPotato, Bangladesh

Late blight in potato is something that affects a large number of potato farmers in Bangladesh. Often farmers do not know the specific weather conditions when blight strikes and suffer huge crop losses due to that. The GeoPotato project, by mPower in collaboration with Wageningen University and Research ([www.wur.nl](http://www.wur.nl)), Agriculture Information Services and ICCO Cooperation ([iccocooperation.org](http://iccocooperation.org)) addressed this issue. Satellite images are taken to estimate the crop growth and stage of the crop. Weather data is taken from Automatic Weather Stations installed in the particular location. The weather forecast and growth stage are combined to create advisories for potato farmers. Farmers receive a SMS to use preventive spraying of crops when an infected period is predicted to occur. Farmers otherwise tend to spray without any suitable information, and end up spraying much more fungicide than is required. This increases their costs, as well is not necessarily good protection against the blight which strikes under particular weather conditions. On receiving the advisory, farmers were able to both spray at the right time and only the amount that was required. This saved them from crop loss and extra fungicide costs. The success of GeoPotato is now being replicated in other crops as well.

## 12. Drones

Drones are essentially unmanned aerial vehicles (UAV), which fly to gather data or reach farms from a 'bird's point of view'. Recently, drone technology has begun to gain traction to solve several agricultural challenges. Most of these usages are still under research, but have shown some potential to be used at scale. In some cases, applicability to smallholder farmers and farms is also being tested. Due to the size of farms it is difficult to monitor and maintain crops and farms regularly and efficiently through other methods, such as field scouting. This is where drone technology comes in - it can cover farms quickly and gather data which sometimes humans cannot. Drones can be used for multiple purposes, such as taking images of crops, assessing field conditions with sensors, spraying on crops and assessing crop health with scanning. Drones are attached with required equipment such as cameras or scanners, through which they collect raw data. Raw data can be analysed through specialized software. The analyzed data can help in several ways, including understanding the condition of crops, optimizing use of inputs, highlighting risk areas, assessing yield and efficient farm management.

One of the areas in which drones have been used, is taking images of crops. Drones can take high resolution images below cloud level, which is much more detailed than what satellite images can get. Different type of images can be taken through different types of cameras. Multispectral camera can capture near infrared wavelengths, which can indicate crop changes that human eye cannot detect easily. Thermal cameras or sensors can capture temperature, which can indicate the presence of water or need for irrigation. Standard cameras which take high resolution images are useful in mapping the farms, and can show crop details even in small farms. Images have been used to get crop yield estimation in a few projects, including research projects by University of Lund ([luniversity.lu.se](http://luniversity.lu.se)) and Swedish University of Agricultural Sciences ([www.slu.se](http://www.slu.se)) initiated research projects in Kenya and Ghana. Images can be used to identify risk of crop failure, which International Potato Center (CIP; [www.copotato.org](http://www.copotato.org)) researched in South America and Africa with potato farmers. IWMI used drones in Sri Lanka to detect paddy fields that are low-lying and are therefore prone to flooding. This data can be used for crop monitoring and disaster mitigation. Another disaster risk reduction program using drones is by FAO ([www.fao.org](http://www.fao.org)) in Philippines where drones can detect water stress and lack of nutrition in crops.

Several uses of drones are emerging in the field of agriculture, and over time with the technology spreading and the costs coming down it has potential to impact smallholder farmers at a large-scale.

### Requirements:

- Expertise in using drones and the required software.
- Drone type has to be based on requirements.

- Camera/sensors/scanners have to be attached to the drone to capture required data.
- Specialized information processing software is needed to turn raw data into usable information.

### Highlights:

- It can provide higher quality images than satellite images at a considerably lower cost, but it is still quite high for use by small holder farmers.
- It can enable precision agriculture even for smallholder farms.

### Considerations:

- Drone regulation: different countries have different regulations on the use of drones, which might pose a challenge in using them.
- Local language training and technical support is essential for introducing this new technology to farmers.
- It needs electricity/power, and often internet, to both fly a drone and process the information that it collects.
- It needs technical expertise locally for repairing of drones, sensors and cameras.
- The type and quality of data that can be collected is still a concern. Different types of cameras and sensors are needed to collect accurate data. Weather and time of the day play a big role in getting high quality images.
- Mapping small farms can sometimes be a challenge, as they may not have very clear boundaries.

### Case Study: STARS project, West Africa, East Africa and Bangladesh

The STARS (Stirring Transformation for Agriculture through remote sensing) project ([www.stars-project.org/en/](http://www.stars-project.org/en/)) done in West Africa, East Africa and South Asia is one of the research projects investigating how high-resolution images can help smallholder farmers. In Bangladesh, the STARS project used this technology for farmers in the coastal zone of Bangladesh. While groundwater in these areas is not suitable for irrigation due to salinity, surface water may be suitable. To support farmers to optimize irrigation schedule, drones were used to visualize fields and their boundaries. Multi-spectral cameras were used to measure ground cover, leaf area index and stress factors. Specialized thermal cameras attached to drones assessed crop photosynthesis activities and canopy temperature. It can help farmers to find out whether the surface water is suitable for irrigation and when to irrigate their crops, particularly during the dry months

### 13. Internet of Things and Sensors

Much like satellite imagery, sensors have been in use in agriculture for a while. There are several types of sensors that are used in agriculture, including location sensors (GPS to collect data about position of farms), optical sensors (to collect data about soil and plant color), electrochemical sensors (to determine pH and soil nutrient levels), soil moisture sensors, thermal sensors and light sensors amongst several others. Sensors can be satellite, remote or ground-based. Ground sensors are often hand-held, mounted on tractors or are free-standing in the field. Remote sensors can be attached to devices such as drones, and satellite sensors are with satellites. Each type of sensor performs a different function. For instance, ground sensors can collect data on soil, or measure weather. Remote and satellite sensors can help collect data as mentioned in the sections above on drones and satellite-based GIS. Ujuzi Kilimo<sup>20</sup> ([www.ujuzikilimo.com](http://www.ujuzikilimo.com)) in Kenya uses sensors to determine soil needs. This data is used to provide advice to smallholder farmers on fertilizer application, seed management and crop management, which can help farmers to increase their harvest and save costs.

Internet of Things (IoT) means enabling internet-based communication between devices, which can be used with sensors. Sensors collect data which usually cannot be collected manually. This data is transmitted via internet to a server or cloud-based system. Data is then analyzed and the farmer can access information through an internet-connected smart phone, tablet or computer. Farmers receive the analysis in a simple and easy to understand form to take appropriate action. Eruvaka ([www.eruvaka.com](http://www.eruvaka.com)), based in India, provides such a solution to manage ponds. It helps farmers monitor the fish feed, adjust the feed based on water quality and weather data and schedule feed. Illuminum Greenhouses ([illuminumgreenhouses.com](http://illuminumgreenhouses.com)) in Kenya is using IoT with smallholder farmers. It installs greenhouses with automated drop irrigation kits in which humidity and soil moisture sensors are powered by solar energy. Crops are irrigated only when necessary, conserving water and helping farmers save on their water bill. Farmers receive all the information through an SMS.

It is not the availability of sensor technology that has been a challenge, but the appropriate use of it, particularly in low-resource settings. Sensors themselves are getting cheaper, but using them in areas with limited electricity and internet connectivity is challenging. A proper analysis of data gathered through sensors is also essential for farmers to use that information – which is still in its nascent stages for several types of sensors.

---

<sup>20</sup> Translates from Swahili to Precision Farming

## Requirements

- The right sensors and its installation are primary.
- High amount of technical capacity is needed to both set up sensors, particularly with IoT, and manage it.
- Strong internet connectivity is important for sensors to transmit data.

## Highlights

- Sensors can collect data which is manually impossible.
- Very precise data can be collected, which can be helpful to optimize resources, manage the farm and increase yield.

## Considerations

- Upfront installation costs are quite high and out of bounds for most farmers.
- Internet connectivity and electricity in rural areas is a big challenge to effectively deploy IoT-based sensors.

### Case Study: ACI E-fisheries, Bangladesh

ACI Bangladesh's E-fisheries project, uses IoT and sensors for managing fish farms. Several farms incur high costs because of overfeeding. To address this, sensors are installed in ponds for better management by sensing the fish's appetite. The machine can start feeding the fish automatically. It can also adjust the amount of food. The farmer can control this manually as well. The information from the sensors is analyzed and this information is sent to the fish farmer on their smartphone or laptop, from where they can control fish's feeding. This mechanism can reduce the costs by up to 21% for the farmers, though the upfront costs are high. Efforts are on to bring these costs lower to make it more affordable for farmers.

# Using ICT4AG in Practice

## AIS, Bangladesh

ICT4Ag in Bangladesh is progressing at a fast rate and several innovations are underway, designed and implemented by several organizations. Agriculture Information Services (AIS) in Bangladesh is an agency under the Ministry of Agriculture, which aims to reach farmers with the help of various media.

It has been involved in promoting several technologies, from the traditional to the innovative for farmers in Bangladesh. This got a further push after the Digital Bangladesh initiative. The traditional media that AIS produces include brochures and pamphlets on agriculture technology, a program on National TV which focuses on agriculture and radio program on Bangladesh Betar. While these media have found an interested audience, strides have been made in including newer technologies to provide more precise and timely information to farmers. Community Rural Radio Krishi 98.8 is a community radio established by AIS in Borguna's Amtoli. It connects with experts and local farmers on a daily basis, where farmers do not just listen to agricultural programs, but can also call in and talk to experts directly.

An IVR-based solution that AIS is running is the 16123 call-center for farmers across Bangladesh. There are around 14 experts available on agriculture, livestock and fisheries. The call center receives approximately 250 calls on a daily basis, on a variety of topics which the experts reply to. While this is a centralized call center, the more localized Krishi Bondhu Phone Seba (3331), being developed by a2i will also be implemented by AIS to overcome issues that centralized call centers face (See IVR: Case Study above for details).

With the advent of smartphones in rural areas, agriculture-focused mobile applications have been developed by a2i, and promoted by AIS. Krishoker Digital Thikana<sup>21</sup> or Farmers' Digital Address is a mobile app which has comprehensive information on cultivation of major crops. Pests and diseases are a major issue for farmers and the mobile app Krishoker Janala<sup>22</sup> specifically addresses this. It has a pictorial database of crop pests and diseases, which can help farmers easily identify what has affected their crop and how to address it. Pesticide Prescriber provides precise information on pesticides and which pesticide should be applied when, to which crop and in how much quantity. These are available both on mobile phones and computers.

Agricultural Information Communication Centers (AICC), which have computers connected with internet, serve as a center-point for farmers to access information

---

<sup>21</sup> Translates from Bengali to Digital Address for farmers

<sup>22</sup> Translates from Bengali to Window for farmers

and use the above-mentioned apps, even if they do not own their own mobile phones or computers. Further, the centers are equipped with projectors, which are used to disseminate agriculture-related videos. AICC also receive the newsletter every month, which member farmers can read. AICC combines both online and offline activities for farmers' group in the village.

It was with farmers' groups of various AICCs that GeoPotato project was first piloted (see Satellite-based GIS: Case Study). The farmers found the early warning messages for spraying fungicide very timely and helpful, which led to a better yield compared to earlier years.

AIS continues to develop and implement technology-based solutions for farmers in collaboration with both government and non-government agencies, bringing in better extension services for Bangladesh's farmers. It aims to help Bangladesh move out of the Least Developed Country Category, by providing better services to farmers – the 64% of their population, whose improved incomes can accelerate the process.



# FEED THE FUTURE

The U.S. Government's Global Hunger & Food Security Initiative



**USAID**  
FROM THE AMERICAN PEOPLE

Digital Green



INTERNATIONAL  
FOOD POLICY  
RESEARCH  
INSTITUTE

