

ICT – connecting the food system

ICT in agriculture and food systems is still on the rise, links farmers to the market, to scientists with regard to weather and farm management practices, and provides access to money transfer and information for consumers also reaching remote areas. Our authors present two case studies of existing ICT that connect stakeholders in the food system and describe new ICT-based solutions that are currently being piloted.

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In recent years, there has been a tremendous increase in the use of Information and Communication Technologies (ICT) in Africa. In addition, financial services are fast-evolving thanks to ICT innovations, for example mobile money transfer used by smallholder farmers in rural areas in Kenya (M-Pesa) or Uganda (Agrinet) among others (see article on page 42). This has strengthened the dynamics of rural economies, where poor telecommunication and road infrastructure have over decades been predominant. In addition, successful ICT depends on basic infrastructures, a conducive ICT environment, a legal framework and skills for digitising information and digitisation of agriculture.

The recent Malabo Montpellier Panel report (2019) indicates that every ten per cent of Internet penetration might contribute to a 1.35 per cent increase in GDP growth per capita in developing countries. However, the share of the GDP increase can be derived from the agricultural sector itself and will depend on the magnitude of ICT interventions to connect and strengthen the African food systems.

Requirements for digitised services

Digitised services are digital versions of learning, communication, knowledge, skills, data or information. Consequently, the products from digitised services can be training modules, maps, crops production data, environmental data as well as economic data and information. The data have to be collected and then digitised, in order to build upon consistent, traceable and reliable scientific information platforms and tools which are useful for smallholders farming and food systems. Agricultural digitisation refers to the utilisation of digital technologies, innovations and data to transform business models and practices across the agricultural value chain.

There is an important amount of produced digital data. However, their conversion or transformation from this level to agricultural digitisation might require specific knowledge and skills of computer sciences and program-



Receiving governmental e-vouchers on mobile to buy farm inputs in remote areas.

Photo: Jörg Böhling

ming coupled with telecommunication skills, multi-stakeholder sectorial approaches in food systems, with special attention being given to a socio-economic view of coordination and connection through ICT. This data operationalisation has the power to transform rural economies that are mostly agricultural-driven. The use of ICT links the farmer to the outside of his or her community and generates access to farm inputs and knowledge and markets, improves agricultural productivity and enhances overall agricultural sector performance through timely and actual up-to-date information (e.g. weather forecasts and early warning systems, commodities and inputs prices, release of new varieties of seeds, fertilisers, pesticides,

machines and technologies, or the outbreak of new diseases). Nevertheless, a lack of knowledge to operate and use ICT properly, combined with associated high maintenance costs, might be limiting factors for smallholder farmers to use ICT solutions. In this contribution, we are presenting some key ICT tools that have improved smallholder's livelihood, food security and income and some with potential future impact in the African food systems through potential multi-stakeholder coordination between the International Maize and Wheat Improvement Center (CIMMYT), the International Institute of Tropical Agriculture (IITA), the International Rice Research Institute (IRRI) and other CGIAR centres.

Coming soon...

Pilots of ICT solutions, currently tested by CIMMYT, IITA and IRRI

Disease Surveillance App (IITA) – the ICT-based surveillance tool is based on a citizen-science approach and helps banana farmers in East Africa to combat the spread of Banana Xanthomonas Wilt (BXW), a bacterial disease that affects banana plants and leads to a total loss of infected banana stands. Structurally, the tool has four modules, namely threat/impact of BXW, stepwise diagnosis, management/control of BXW, and proven agronomic practices for banana production. This digital innovation is envisioned to serve the dual purpose of empowering farmers while strengthening the capacity of local institutions (e.g. the Rwanda Agricultural and Animal Resources Board).

Mobile-based [near-] real-time food price crowd-sourcing (IITA) – the commodity food price is considered as one of the critical indicators of food security because it impacts affordability and nutritional choices of consumers, especially those in the low-income countries. By using open data kit-based survey tools through smartphones, prospective volunteers were enlisted to submit geo-referenced prices of four commodities (rice, beans, maize, and soybeans) from the farm-gate to the consumer gate in Nigeria. This citizen-science approach leverages on eclectic digital tools and platforms to crowdsource food price data. Also, the price data covers markets within both rural and urban areas, which can be very useful for the assessment of price transfer along the rural-urban spatial continuum.

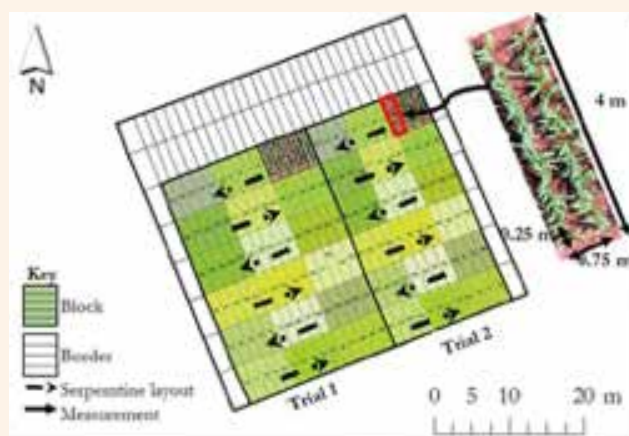
Use of drones in agriculture (CIMMYT) – equipped with sensors, multispectral cameras and GPS receivers, drones can support farming systems efficiently. CIMMYT is using drones in Africa aiming to provide decision support to farmers through consistent data collection, reduction of the time and financial effort required to collect and analyse data and thus predicting variables for yield, biomass and other traits. Indicators such as the Normalised Difference Vegetation Index (NDVI), chlorophyll rate, leaf area index, water/nitrogen stress, flowering, etc. are crucial for CIMMYT scientists to provide decision support to farmers and seed companies on crop senescence, vigour, plant counting, pesticides/ fertiliser sensitivity and yield prediction.

a) Farm crop senescence – through drone imagery, crop aging can be determined. This categorisation, especially with time series data, enables the evaluation of crop stress severity and might support farmers either to start a farm harvest or schedule the appropriate timing for crop harvesting. The key advantage of the drone approach is that it is faster and cheaper compared to the methods commonly used which are essentially manual and/or by require scoring, and are therefore often subjective, time-consuming and expensive.

b) Plant counting – plant count evaluates the yield component attribute and germination rate, which is difficult to assess. This is labour-intensive work that can be facilitated by drones. The Figure on the left shows how plant counts are performed using drone imagery. The process can be automated and used routinely to conduct plant population assessments. The results can help to reduce seed production and yield estimation costs, which can incentivise farmers to adopt more improved seed.

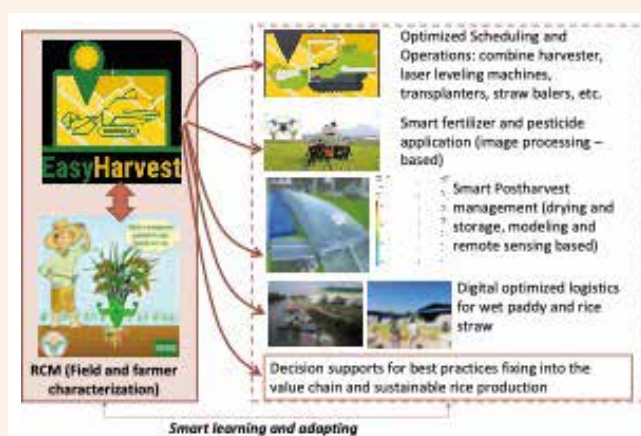
3D printer (IRRI) – 3D printing has a huge potential to address the problems in existing spare part supply chains of agricultural machineries in developing countries such as long delivery times, availability, low quality and high cost of parts, or even parts that don't fit. Farmers will benefit from timelier and better quality in machinery contract service provision and machinery owners from reduced downtime and cost. Even the original equipment manufacturers can benefit from savings by not stocking parts that are rarely needed. A locally developed 3D printing service network should be in place to take advantage of the technology. Intellectual property and rights management will have to be a key component of any business model since copying other companies' parts would in most cases violate the latter.

App for optimised scheduling of combine harvesters (IRRI) – EasyHarvest provides a platform for farmers in selecting best options to book services such as combine harvesters at their own convenience, using their smartphone or the computer. Service providers and farm managers would be able to anticipate and optimise scheduling for more effective and efficient use of machines, higher net profits and sustained business operations. This App Platform is further being developed to connect and benefit farmers, service providers, consumers and the environment by potentially reducing rice harvesting costs by at least 10 per cent, post-harvest losses by 2-5 per cent and greenhouse gas emissions by 5-10 per cent thanks to less loss and waste.



Crop senescence using drone imagery (left).
Figure: CIMMYT

Screenshot of EasyHarvest application (right).
Figure: IRRI



DIGITISED SERVICES IN AFRICAN FOOD SYSTEMS

Two case studies are described in the following – an e-voucher system in Nigeria to reach out to remote small-scale farmers providing government subsidies for fertiliser and seeds as well as a radio-based awareness campaign for a better nutrition with high protein maize in Ethiopia.

E-vouchers for fertiliser and seeds in Nigeria

In 2012, the Nigerian government initiated and started implementing the Growth Enhancement Support Scheme for a duration of five years. The scheme aimed to provide efficient large-scale input subsidies to poor smallholder farmers through input-smart subsidy schemes. The past initiatives had failed because of huge corruption, with seeds and fertilisers never reaching the farmers in need. By systematically registering every single farmer in the targeted area, the programme reaches more farmers than before. The new programme mostly subsidised fertiliser and seeds to improve smallholder farmers' agricultural productivity and food security, and to enhance income generation. Registered and entitled farmers in the e-wallet (e-voucher) system received notification and information on their mobile phones allowing them to buy specified quantities of fertiliser and seeds at their nearest agro-dealer for subsidised prices. Through the e-voucher, subsidies of 50 per cent for two 50 kg bags of NPK and urea fertiliser and 90 per cent on a 50 kg bag of improved seeds were allocated. Within five years, 20 million smallholder farmers were targeted nation-wide by the programme. According to the government, 90 per cent of targeted farmers were reached through the fertiliser e-voucher programme, while the cost of distributing the subsidised fertiliser was cut by 60 per cent. Empirical evidence shows that e-voucher farmers increased maize yield by 26.3 per cent, with a similar increase in income generation compared to the farmers who didn't participate. Significant welfare increase was reported on food and non-food consumption expenditures per capita of 30.7 per cent. In turn, this reduced the poverty headcount ratio among e-voucher participants of the programme to 17.7 per cent.

Improving nutrition through the radio

Implemented from 2012 to 2019, CIMMYT's Nutritious Maize for Ethiopia project aimed

at addressing the high risk of lysine deficiency in young children and women in maize-dominated agricultural production systems. Thus, quality protein maize (QPM), a type of maize having increased levels of lysine and tryptophan, has been related to better nutritional outcomes in children's growth on a maize-based diet. The project was implemented in 36 major maize growing districts (woredas) in four regions of Ethiopia (Oromia, Amhara, South and Dimtse Woyane Tigray). Within the woredas, a target of 50 per cent of the population were to be reached through radio podcasts on QPM and its nutritional benefits for them to be aware of and adopt QPM in their daily life.

To achieve this, the project partnered with Farm Radio International (FRI) in collaboration with four local radio stations and implemented the radio-based awareness creation. The radio stations have the potential to reach out to a large audience that are growing about 90 per cent of the total maize in Ethiopia. Around 66 per cent of the farm households and 61 per cent of spouses headed households had access to radio-based awareness creation, while taking gender-balanced access into account.

Per radio, the programme reached a broader audience than other conventional extension approaches. The strategy of the participatory radio programming (PRP) approach made use of farmers' voices and feedback mechanisms on the 30-minute programmes that were broadcasted twice weekly over twelve to 16 weeks in each season. In total, 320 individual episodes were created and broadcasted during the project years. Also separate male and female community listener groups (CLGs) were established in the target districts as a way of connecting and interacting with audiences. Radios were handed over to the CLGs. The members met weekly to discuss PRP topics and gave feedback to the group representative on broadcasts aired recently.

For women with limited to no access to radios and/or no individual choice whether to participate in programme, CLGs were particularly useful in creating opportunities. Using a 'beep-2-vote' polling technique whereby farmers responded to simple 'yes' or 'no' questions on the radio by calling a different mobile phone number then hanging up (vote registered as an unanswered call), the number of farmers planning to plant QPM or looking for seed could be determined and conferred to the relevant services. The results show that awareness of QPM increased substantially in

male household heads (79%), followed by female household heads (64%) and spouses (58%). The common male knowledge on nutrition and protein also increased, albeit from a higher baseline than the women's usually lower baseline. The women's knowledge was similarly improved. Several survey respondents indicated a high level of participation in QPM events; an increased awareness was associated with direct participation in field demonstration visits (45–75% of respondents) and field days including food preparation demos (10–30%). The radio broadcasts were ranked as the most important indirect source of QPM information, whereas low listenership was associated with low levels of radio ownership.

What next?

From the highlighted applications of ICT-based tools and techniques within the CGIAR system and across countries, it is evident that collaborative efforts to tackle the environment and socio-economic challenges can be improved through digitised data, information and knowledge from all stakeholders across countries and organisations. This appeals to more coordination among the CGIAR institutes to seize and capitalise the potential of functional and available ICT tools for a holistic farming system approach, that consolidates, integrates and packages solutions in the benefit of smallholder farmers across crops diversification, value chains, interdisciplinarity, CGIAR mandates and trans-continental for a better world through science and technology of ICT for research and development.

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