Digitalizing the African livestock sector

Status quo and future trends for sustainable value chain development

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Acronyms

AGRA	Alliance for a Green Revolution in Africa
ASF	Animal-source foods
AI	Artificial intelligence
AIT	Animal identification and traceability
App	Application
ATS	Animal traceability solutions
BMZ	Federal Ministry for Economic Cooperation and Development
CEO	Chief executive officer
CGIAR	Consultative Group on International Agricultural Research
COVID-19	Coronavirus disease 2019
CTA	Technical Centre for Agriculture and Rural Cooperation
EDE	Ending Drought Emergencies
EPUB	Electronic publication
ERP	Enterprise resource planning
EU	European Union
FAO	Food and Agriculture Organization
FPMA Tool	Food Price Monitoring and Analysis (FPMA) Tool
GDP	Gross domestic product
GHG	Greenhouse gas
GIS	Geographic information system
GIZ	German Corporation for International Cooperation GmbH
GODAN Initiative	Global Open Data for Agriculture and Nutrition Initiative
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HD	High definition
IADB	Inter-American Development Bank
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and communications technology
ICT4Ag	Information and communications technology for agriculture
IDRC	International Development Research Centre
ILRI	International Livestock Research Institute
IT	Information technology
IVR	Interactive Voice Respone
KALRO	Kenya Agricultural & Livestock Research Organization
KB	Kilobyte
LAN	Local Area Network
LiDAR	Light Detection and Ranging
LTE/4G/5G	Long Term Evolution/4th Generation/ 5th Generation
LW	Live weight
ML	Machine learning
NDVI	Normalized Difference Vegetation Index
NFC	Near Field Communication
NGO	Non-governmental organization
OIE	World Organization for Animal Health
PAYG	Pay as you go
PCI	Project Concern International
PLF	Precision Livestock Farming
ProCIVA	Green Innovation Centre Benin
QR code	Quick Response code
RD	Responsible data
RFID	Radio frequency identification
SAMS project	Smart Agriculture Management Services project
SCBF	Swiss Capacity Building Facility
SD card	Secure Digital card
SMS	Short Message Service
SNV	Foundation of Netherlands Volunteers
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNAP-Benin	National Union of Professional Poultry Farmers of Benin
UN OCHA	United Nations Office for the Coordination of Humanitarian Affairs
USAID	United States Agency for International Development
USD	US-Dollar
USSD	Unstructured Supplementary Service Data
WAN	Wide Area Network
WHO	World Health Organization
Wi-Fi	Wireless networking technology
WLAN	Wireless Local Area Network
WTO	World Trade Organization

Preface

Livestock has a fundamental role in supporting the livelihoods of millions of rural households in Africa and is a key element in contributing to food security on the continent. The livestock sector is also the backbone of many African economies and the projected strong increase in demand for animal source foods offers tremendous opportunities for economic growth and the creation of new jobs in livestock value chains. To tap this potential, the sector will need to increase its productivity and invest in the expansion of value chains – while simultaneously finding solutions to challenges such as climate change, biodiversity loss and a degrading resource base. Heat, droughts, decreasing water resources and the spread of diseases have a negative impact on livestock productivity and require adaptation strategies to cope with a changing environment. At the same time, the sector needs to promote the sustainable production of animal source foods to mitigate its own contribution to climate change and natural resource degradation.

Digitalization has a great potential to support the development of a productive, climate-resilient and low-emission livestock sector in Africa. It is already revolutionizing the way livestock value chain actors work, connect and do business together. The impact of digitalization is probably most incisive for livestock keepers in remote rural areas who get unprecedented opportunities to access information, modern production inputs, services and markets.

For the Federal Ministry for Economic Cooperation and Development (BMZ), digital technologies have a crucial role in promoting the implementation of the Agenda 2030 for Sustainable Development. BMZ is supporting the efforts of its partner countries to harness the potential of a digital transformation by supporting the development of digital infrastructure and, above all, investments in people's abilities, in education, and in creating good general conditions for the fair and open development of a digitalised world.

As early as in 2015, the BMZ launched its Digital Africa initiative, thus creating an innovative tool for firmly linking development cooperation and the digital world. Under the umbrella of the initiative, BMZ supports projects that use digital technology to achieve development goals. One focus area is the promotion of *homegrown* digital innovations that target the African agriculture and food sectors. Many start-ups already provide innovative digital solutions that address challenges related to market access, service provision, processing and logistics but have not yet reached scale. This is where BMZ comes in. It promotes business development or expansion through tailor-made measures and facilitates access to investment and partnerships for growth. In the new BMZ 2030 reform strategy, digital technology will continue to be a defining element of value-based and forward-looking development cooperation.

This report gives valuable insights into the dynamic and fast-growing field of digital solutions for sustainable livestock value chain development in Africa. It can help end users and project implementers to identify digital solutions which best support their efforts of building sustainable livestock value chains. Testimonials of the founders of digital start-ups show an impressive creativity in finding simple digital solutions to solve complex problems of livestock value chain actors – and also point out where support is still needed to continue and expand their endeavours.

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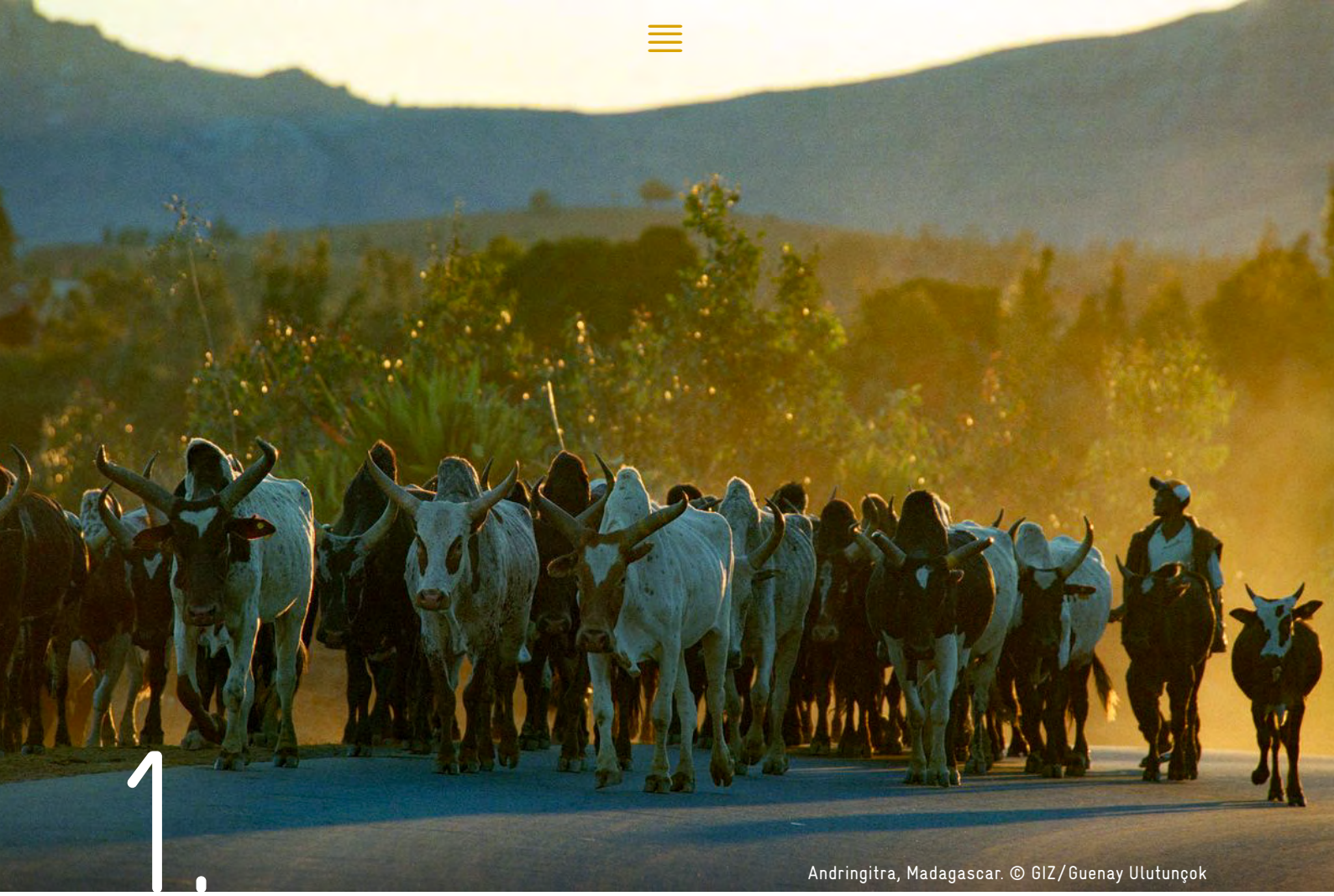


Andringitra, Madagascar. © GIZ/Guenay Ulutunçok

1. Development trends in the African livestock sector

1.1 Introduction

Livestock is an indispensable element of the livelihoods of millions of rural households in Africa. Livestock provides nutritious food, employment, income, insurance, fertilizer, draught power and energy, as well as numerous other benefits. Especially for women in rural areas, livestock is an asset of fundamental importance. It is easier to acquire than land and has a crucial role in enabling women to provide food security for their families as well as resources for their children's education. Pastoralism, the most traditional form of livestock farming, is the primary livelihood of an estimated 268 million people in Africa's drylands[1] – providing food and income in regions where environmental conditions are sometimes too harsh for crops to grow.

Driven by population growth, urbanization and rising incomes, the demand for animal-source foods (ASF) is rising fast on the continent. Some estimates indicate that consumption of milk will triple across sub-Saharan Africa between 2000 and 2050, while that of pork, poultry meat and eggs will grow as much as sevenfold[2]. The projected strong demand for ASF offers tremendous opportunities for economic growth and the creation of jobs in livestock value chains. At the same time, the sector faces major challenges to meet the rising demand for ASF. It will need to increase its productivity and simultaneously invest in the establishment and expansion of value chains. Moreover, Africa has to achieve these targets while simultaneously adapting to the negative impacts of climate change. Climate change is already affecting livestock husbandry in many regions through droughts, floods and the spread of pests and diseases. However, the livestock sector is also contributing to climate change because in many African countries, it is a significant source of national greenhouse gas (GHG) emissions.

Digitalization offers a range of innovative tools and solutions to support the transformation of African livestock systems towards more productive, climate-resilient and low-emission systems, and to build livestock value chains that contribute to reaching countries' targets on poverty reduction, food security and sustainable economic growth. The sector's digital transformation is already underway and very dynamic, providing digital solutions that are as diverse as their underling technologies, target groups and value chains. Information and communications technology (ICT) applications – which are the focus of this study – range from simple Short Message Services (SMS) to remind livestock keepers of upcoming due dates for vaccinating their cattle, over the provision of satellite-based vegetation maps to guide pastoralists to the best grazing grounds during droughts, to complex platforms to virtually aggregate ASF produced across the country.

ICT fundamentally changes the way value chain actors work, connect and do business together. Its impact is probably most incisive for livestock keepers in remote rural areas who traditionally belong to those groups with the most limited access to information, modern production inputs, services and markets. If well designed, ICT can provide them with tools to improve their farm management, to connect with other segments of the livestock value chain and to access services that are needed to build sustainable production systems.

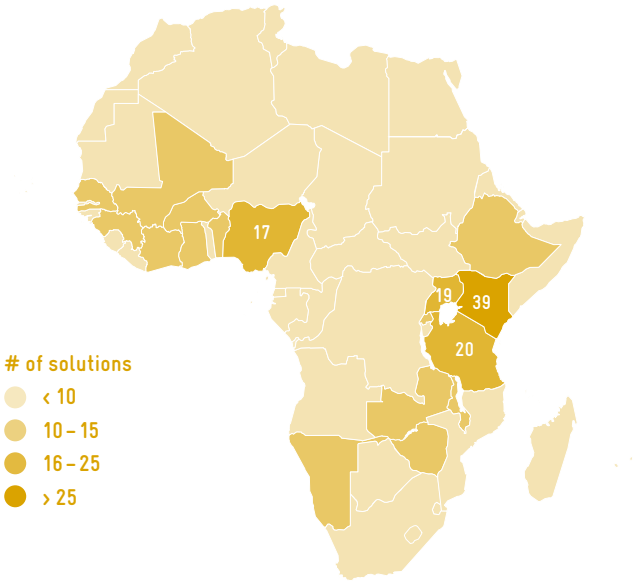
Despite the benefits of digitalization, it will not be the sole driver but rather one element of a transformation towards a more productive, climate-resilient and low-emission African livestock sector. The analysis of successfully implemented ICT solutions carried out for this study shows that those solutions which generally work best are user-centred and flexible, can build on a functioning enabling framework and combine the right mix of digital and physical elements.

This report presents an overview on the current state of development of digitalization in African livestock value chains. For newcomers in the field of digitalization, the report starts with an overview on ICT for agriculture and explains the most important technologies. The next chapter defines fields of application for the use of ICT within livestock value chains and provides short profiles of solutions which are available in Africa for each field. To give a better understanding of how digital applications work in practice, interviews with inventors and implementers of digital applications complete each section. They give insights into their motivation for developing these ICT solutions, their mode of operation, underlying business models and potentials and barriers for their implementation and upscaling. The last chapter provides an overview on opportunities as well as the risks and challenges of using ICT to promote sustainable livestock value chain development and closes by offering ten recommendations on how to best use ICT in this field.

1.2 Methodology

This report presents a comprehensive overview on the quickly growing market of digital applications which target African livestock value chains. Over 60 applications have been identified through Internet research. Most applications have been found in Kenya, followed by Tanzania, Uganda and Nigeria (see Figure 1).

Figure 1: Availability of digital applications for the livestock sector across Africa



Source: own elaboration

Not all of the identified applications are inclusively designed for livestock value chains, but all are relevant for the use within at least one segment of such value chains, and many applications have at least one livestock-specific module.

The report is based on a simplified concept of a livestock value chain which consists of six segments: **(1) Production, (2) Aggregation, (3) Processing, (4) Wholesale, (5) Retail and (6) Consumption.**

Figure 2: Overview on use categories and use sub-categories of digital applications for livestock value chains

Source: own elaboration

To provide a good, easy to navigate overview on available digital applications, six main **use categories** and thirteen **use sub-categories** are defined with relevance for different livestock value chain segments. The main use categories include **(1) Information and knowledge generation, (2) Livestock farming practices, (3) Financial services and insurance, (4) Market access, (5) Supply chain management and (6) Macro agricultural intelligence** (see Figure 2).

In Chapter 3, the collection of digital applications for each use category and sub-category is presented in the form of **short profiles**. These give an overview on services provided, target groups, underlying technologies and the countries where the applications are available. Of these applications, 18 are presented in more detail in the form of **showcases**. The showcases are based on interviews with their inventors who give insights into the motivation for the development of applications, their functions, underlying business models and lessons learned during development and implementation. To find potential interview partners for this report, the companies and organizations behind the 60 applications were contacted and interviews were conducted with those who were willing to participate. Figure 3 gives an overview on the digital applications that were identified for each use category. Some of them appear in more than one category since they cover different services. In Chapter 3, the short profiles of these applications are allocated to the use category in which the main service is offered.

Figure 3: Overview on digital applications for African livestock value chains

CATEGORIES/AREAS OF APPLICATION

Information and knowledge generation

Information and advisory services

- CowTribe
- Daral
- DigiCow
- EcoFarmer
- Esoko
- Farmers Pride
- Food Price Monitoring and Analysis Tool
- Garbal
- iCow
- iShamba
- Jaguza
- M-Farm
- myAnga

Digital learning

- AgroMarketDay
- Arifu
- Ethno e-empowerment
- Moodle
- SimPastoralist

Livestock farming practices

Precision livestock farming

- AfriScout
- Jaguza

Farm management

- Budget Mkononi
- CowTribe
- DigiCow
- E-Lunda
- Hlibna
- iBreed
- iCow
- UsomiLulu

Financial services and insurance

Payments, savings and credit

- Agri-wallet
- DigiCow
- eGranary
- Esoko
- Juhudi Kilimo
- M-Pesa
- myAgro

Crowdfarming

- BaySeddo
- Farmcrowdy
- Livestock Wealth
- Thrive Agric

Insurance

- ACRE Africa
- EcoFarmer
- Esoko
- Index-based Livestock Insurance (IBLI)

Market access

Input market integration

- Agrikore
- CowTribe
- Farmers Pride
- Livestock247
- UsomiLulu

Off-take market integration

- Agro Market Day
- Herdy Fresh
- DigiCow
- eMilk
- Hlibna
- Jaguza
- Livestock247
- M-Farm
- Mifungo Trade
- Selina Wamucii
- Sokoni
- UsomiRubi

Supply chain management

Aggregation and logistics

- Agrimanagr
- Inspira Farms
- iProcure
- UsomiRubi
- WeightCAPTURE

ERP, traceability and certification systems

- Animal Traceability Solutions (ATS)
- Daral
- eProd
- iProcure
- Metajua
- Namibian Livestock Identification and Traceability System (NamLITS)
- SAP Rural Sourcing Management Platform
- WeightCAPTURE

Macro agricultural intelligence

Census, registration of livestock and livestock establishments

- Animal Resources Information System (ARIS)
- ATS
- Daral
- NamLITS

Disease forecasting, monitoring and disaster response

- Event Mobile Application (EMA-i)
- Global Animal Disease Information System (EMPRES-i)
- Global Early Warning System for Major Animal Diseases, including Zoonoses (GLEWS)
- SILAB for Africa
- UNOSAT Mapping

Source: own elaboration

Technology at the animal market in Kaabong, Uganda. © Petra Dilthey, ethno e-empowerment (eeem.org)

2. The ABC of information and communications technology for agriculture

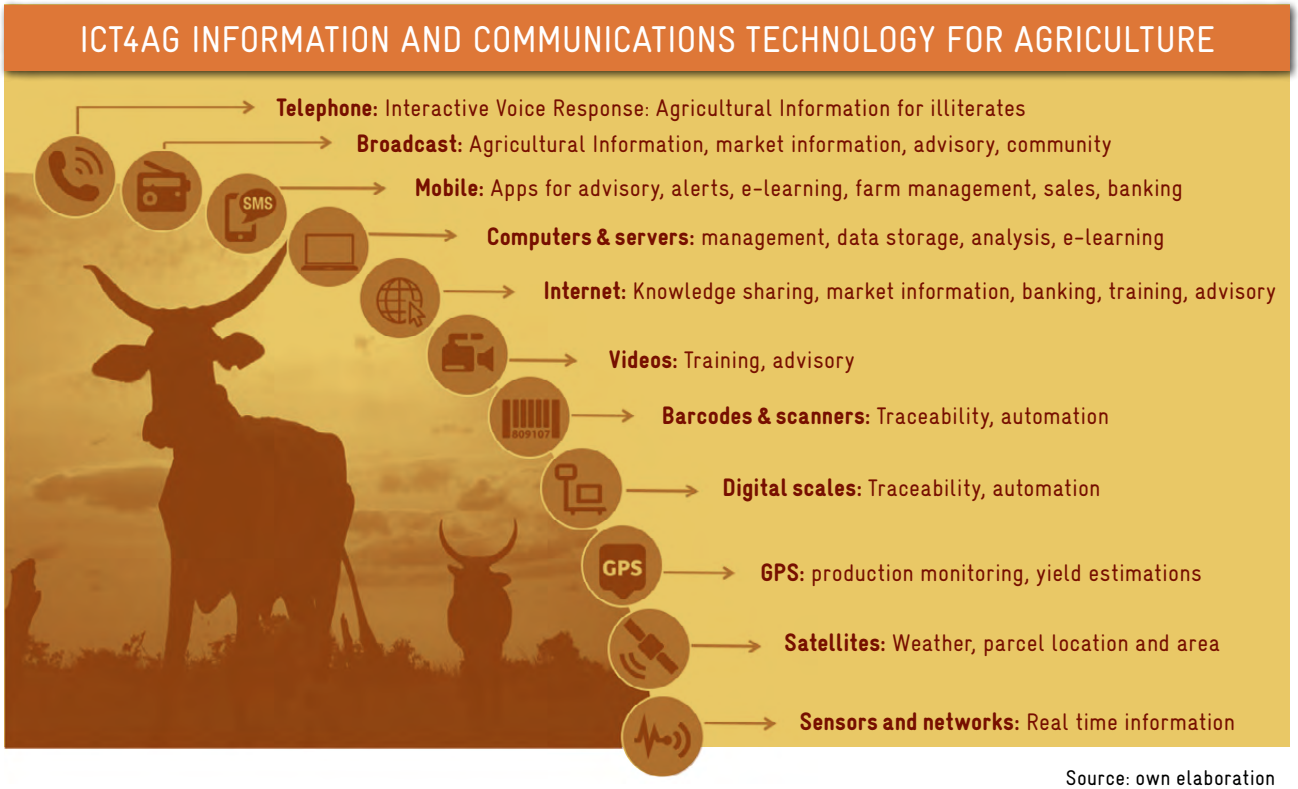
2.1 Overview

ICT for agriculture, ICT4Ag, digitalization for agriculture (D4Ag) or **e-agriculture**, are synonyms for the integration of electronic technologies with a focus on promoting agricultural and rural development through improved information and communication processes. The number of available technologies is large, and new ones are constantly being added. The following overview of the currently available technologies is an attempt at adding some structure to the field but does not claim to be complete in either depth or breadth. It highlights technologies that are important in the context of livestock value chain development, with a special focus on innovation and the potential to promote climate-resilient and low-emission livestock value chain development.

HARDWARE DEVICES

The classical **cell phone** is the simplest and cheapest among the available types of **mobile end devices**. It is used for making phone calls, sending and receiving **SMS** and voice messages. Some devices already have an integrated camera, a calendar, etc., but those are difficult to handle as the keyboard is limited. A **feature phone** extends these functionalities by adding a better screen, a full web browser and optionally a **Global Positioning System (GPS)**. The **smartphone** is a high-end mobile device. With specific operating systems (Android as number one) and Long Term Evolution / 4th Generation / 5th Generation (LTE / 4G / 5G) Internet speed, they are closer to a computer than to a feature phone. Modern smartphones feature a large touch screen, wireless

Figure 4: Overview on ICT for agriculture



Source: own elaboration

networking technology (e.g. Wi-Fi or Bluetooth), high definition (HD) cameras and GPS. Smartphones allow users to edit documents, use social media, handle email and create spreadsheets. They are used as a navigation device as well as music and video player. Moreover, they can run third-party programmes and thus are configurable to any personal need. In Africa, smartphone use is still limited as prices are relatively high, both for the device and for the data. A **tablet** is a small computer, larger than a smartphone, usually with a very responsive touch screen but without the mobile phone features. Tablets have Wi-Fi and frequently mobile data but rarely a GPS. Like smartphones, they run mobile operating systems (Android, iOS etc.) and thus allow third-party software to be run.

Traditional computers, both **desktops** and **notebooks** (also known as laptops), still play the main role for all office workflows: word processing, communication, spreadsheets, designer software and database applications. They usually need a computer as an end device. Moreover, specific software for modelling, mapping and image processing is usually developed for computers. Computers are very flexible and can easily be extended by **sensors**, additional monitors, input devices, scanners and printers. In the African context, notebooks have the great advantage of running on battery in case of a power outage. For particularly dirt-intensive environments, there are robust solutions with casings, keyboards and touch screens that are insensitive to dirt and water.

Servers are powerful computers dedicated to simultaneously working on multiple requests. They provide content for web sites and mobile apps and offer data and applications to multiple users connected via any type of network. They can offer professional data backup systems, provide Internet security and email functionality. They are at the basis of any **cloud computing, machine learning (ML) and artificial intelligence (AI)**. Because these multi-processor devices need cooled compartments, expert maintenance and performant Internet connection, they are often operated in large numbers at server farms and provided to numerous clients for rent.

A **sensor** is a hardware device with the purpose of detecting events or changes in its environment. It communicates information to other electronics for processing. That way, various environmental parameters can be electronically and automatically measured such as humidity, pressure, temperature, wind speed, light, etc. In the agricultural context, sensors are used for meteorological observations, for monitoring water levels, flow and quality, and for quantifying biomass to detect water stress or infes-

tations. Sensors can measure soil parameters, chemical residuals or simply the weight of produce. In livestock management, sensors are used, for example, to measure temperature and the weight of animals or the fat content of milk. Sensors are key to automation and are therefore a valuable part of ICT4Ag. A camera can be considered as an optical sensor, and digital image processing can make information that is invisible to the human eye visible. Most sensors operate from a fixed position, but the GPS sensor does the opposite: it measures the three-dimensional position on earth or in space.

Remote sensing is the science of earth observation from sky where sophisticated sensor technology, mounted on **satellites, airplanes** or **drones**, records various physical parameters. Multi-band images deliver colour images not only of visible light but also of invisible bands such as infrared and ultraviolet. The combination of different bands allows the spatial distribution of physical parameters such as temperature, humidity or the Normalized Difference Vegetation Index (NDVI) to be determined. This index quantifies vegetation by measuring the difference between near-infrared light (which vegetation strongly reflects) and red light (which vegetation absorbs). This helps to detect biomass, water stress, pest infestations and thus the health status of a crop. Laser-based sensor technologies such as Light Detection and Ranging (LiDAR) can help to monitor the crop height and the Leaf Area Index (LAI). In livestock management, remote sensing is used to count animals, to monitor animal distribution and to identify the best grazing grounds. Satellite data is usually very expensive, especially if images are taken on demand, but more and more satellite data is becoming available for free (e.g. MODIS, Sentinel a and 2, Landsat 7–8, SPOT 5–7).

On a larger scale, monitoring technologies help to evaluate the impact of productive activities on the environment. Water use and resulting resource depletion can be monitored remotely, as can erosion or loss of biodiversity. While satellites follow their orbit and therefore pass a specific area in a defined interval, airplanes and **drones** can be operated on demand. The latter usually fly very low and are therefore less sensitive to weather events, which results in a higher image resolution. Based on this data, remote-sensing technologies provide crop classification maps, land use maps, digital elevation models and much more. They can detect the nearest open water pond, the most easily accessible grazing grounds, and even livestock health can be monitored by mounting sensors on collars worn by animals. However, these technologies are expensive, sensitive and need a high level of expertise for operation and data processing. They use coordinate systems to make data visible on topographic maps or to overlay it with other data sources.

Geographic information systems (GIS) are special database systems that can handle spatial data in two and three-dimensional space. They have become indispensable in agriculture for monitoring, forecasting and decision support. They usually run on computers, with large screens and colour printers attached, but light systems are also available for tablets and smartphones, mainly for mobile data collection. They serve for the preparation of maps but also support all sorts of geospatial analyses such as the calculation of population densities, tracking of animals, management and monitoring of the environment, routing of multi-modal transport and so on. They are useful for understanding spatial relationships and making them comprehensible via maps.

INFORMATION STORAGE AND INFORMATION EXCHANGE

Databases are at the core of any ICT system. They help to structure, organize, store and analyse large amounts of information generated through ICT. A database management system is the software that usually offers the tools for users to interact with data. It consists of a backend, the technical data access layer which hosts all data, and a frontend, the user interface. In modern systems, data is centrally hosted on a server (which may run in the cloud) and accessed from a user interface from a different computer via a network, from a website or from a mobile app. An **information system** adds the users as well as their roles and tasks to the technical database and thus adds value to the collected information. If the information system supports business or organizational decision-making, it is called a **decision support system.**

In sum, with the emergence of phones and smartphones, access to technology has changed. Most farmers worldwide have access to at least a simple phone, and smartphone penetration is increasing rapidly. ICT can help to streamline the dissemination of information, especially if the number of recipients is large.

COMMUNICATION

Bulk SMS messaging helps to disseminate SMS messages to a large number of mobile phones. All recipients may receive the same message, but bulk SMS messaging also allows one to send custom-tailored messages, providing individual, localized content. It can be used, for example, to send localized weather forecasts, reminders on vaccination due dates, or individually configured SMS messages that list the amount of milk delivered by the recipient farmer during the current week.

Bulk SMS messages can be realized by either using a website of an SMS service provider on the Internet or by installing desktop software, which will communicate with an SMS gateway. Both solutions allow uploads of as many phone numbers as required. Some desktop software offers to schedule the sending of SMS messages at a pre-defined time and / or to a specific group of recipients (e.g. all cattle farmers of a certain region).

In case of low literacy among recipients, voice mailing can be used where pre-recorded audio messages are sent to a target group. It works similar to bulk SMS messaging but does not allow the automatic configuration of custom-tailored messages to individual farmers. The administration of a voice-mail system is more complex as messages must be pre-recorded before they can be sent. The development of speech output systems has not progressed far enough yet for African idioms to be rendered in sufficient quality.

The Unstructured Supplementary Service Data (USSD) technology offers a way for bi-directional communication. USSD technology is well known by users of prepaid cellular phones as it allows to query the available balance. The technology provides specific information on demand to the user. The farmer can dial a number and will be guided through a menu, e.g. "… for the weather forecast, press 3". This technology is dramatically more complex and expensive than SMS services as it requires a USSD server which must be developed and maintained, usually by a mobile phone provider. **Interactive Voice Response (IVR)** technology allows callers to navigate through content by using their voice. It is even more complex than USSD as there are normally several idioms spoken in the same region.

Videos and **audios** are still valuable tools for training and learning purposes. Since literacy rates are usually the lowest among smallholder farmers in remote areas, the community radio and local television programmes still play an important role in the dissemination of information. Nowadays, videos and audios can also easily be streamed to mobile devices, and streaming can be an additional channel for the same information.

ICT offers a wide range of **transmission technologies**. Different generations of mobile networks offer different bandwidths and data transfer performance – the newest is often not immediately available in most African countries. General Packet Radio Service (GPRS), 3G, LTE, 4G, and the new 5G, are standards for data transmission. Even the old GPRS allows the transmission of sensor data to servers. In case of an emergency, mobile networks frequently break down, while the old-fashioned radio transmitter still works, or the modern – albeit expensive – satellite data services. Local Area Networks (LAN), wireless networks like Wireless LAN (WLAN) or Wi-Fi, or Wide Area Networks (WAN) all offer their own technical advantages, and the appropriate technology can be found for each specific case.

MOBILE APPS, WEB APPS AND WEB SERVICES

A **mobile app** is a programme prepared for mobile devices such as Android, iOS or Windows phones or tablets. A **native app** only runs on a specific operating system, meaning that an Android app cannot run on an Apple iPhone. It is an independent programme which can run offline, while a **web app** runs in a web browser and therefore needs permanent Internet connection. Behind most apps is a web server which communicates at least from time to time with the programme on the mobile device.

All apps are made for a specific purpose. There are apps to support activities carried out within each segment of a livestock value chain, including, for example, apps to support farm management, to provide diagnostics, advice, training and learning content, to facilitate payments and traceability, and much more.

SOFT TECHNOLOGIES

Traceability, which is very important in the agricultural sector for certification and export, can be achieved through **barcodes, Quick Response (QR) codes, Radio**

Frequency Identification (RFID) chips and matching scanners, which help to identify farmers, animals or agricultural products. **Farmer registries** and **livestock databases** make use of these codes, while scanners, digital scales, tickets and stickers streamline processes help to implement traceability. The digitization enables traceability for a large number of livestock value chain actors and products and gives new insights into processes which can be valuable for their optimization. **E-payment** by using smartphones, feature phones and Near Field Communication (NFC) chips can be made available to many users who previously had no access to bank accounts and these technologies.

Blockchains are continuously growing lists of blocks of information, each containing the information of the previous block in an encrypted format. Thus, they can hold information from different sources and cannot, or not easily, be counterfeited our hacked. They are seen as a way of introducing or strengthening transparency and trust.

AI is difficult to grasp because it is constantly changing. It applies to intelligence demonstrated by machines (computers) and thus the term is often used for any device and algorithm which mimics human learning behaviour. Classical examples are speech recognition or autonomously operating cars. **ML** is used for computer algorithms which automatically improve through experience. Blockchain, AI and ML risk being misused because they are frequently misunderstood as placeholders for modernity and innovation. They are not a panacea for every problem, but properly applied, they can help alleviate or even solve many problems. Blockchain technology can introduce transparency and trust along the value chain. AI and ML help to derive sophisticated management data from huge data sets which sensor networks provide. They enable, for example, hyper-localized weather forecasts and thus can significantly improve early warning systems.

However, all three need performant computer processors and Internet, storage devices and power supply. Thus, they are not always applicable in the context of African livestock value chains. The installation and operation of such systems is expensive and needs many resources. Cloud computing allows the outsourcing of these problems to competent service providers. It offers a flexible way to allocate resources, and it is irrelevant where the infrastructure is installed. Through the Platform as a Service (PaaS) solution, end users can use apps which directly communicate collected data to a cloud-based database where the data gets processed, analysed and made available for decision makers via a web portal. End users access this data via their computer or smartphone browsers. No data is stored in-house, no database is installed, and no experts are needed to maintain the system.

MODELS AND SIMULATION GAMES

Weather, plants and animals have been subjects of simulation and modelling ever since computers existed. Modelling of nutrient requirements of animals, of livestock herd dynamics or of the impact of livestock maintenance on the environment are topics of more recent date. Models play an important role in understanding complex relationships and in predicting future events. Serious games and simulation games try to gamify complex relationships in order to make them more easily understandable for their target group. Serious games or applied games are board or computer games which are designed for educational purposes and for inducing behavioural change.

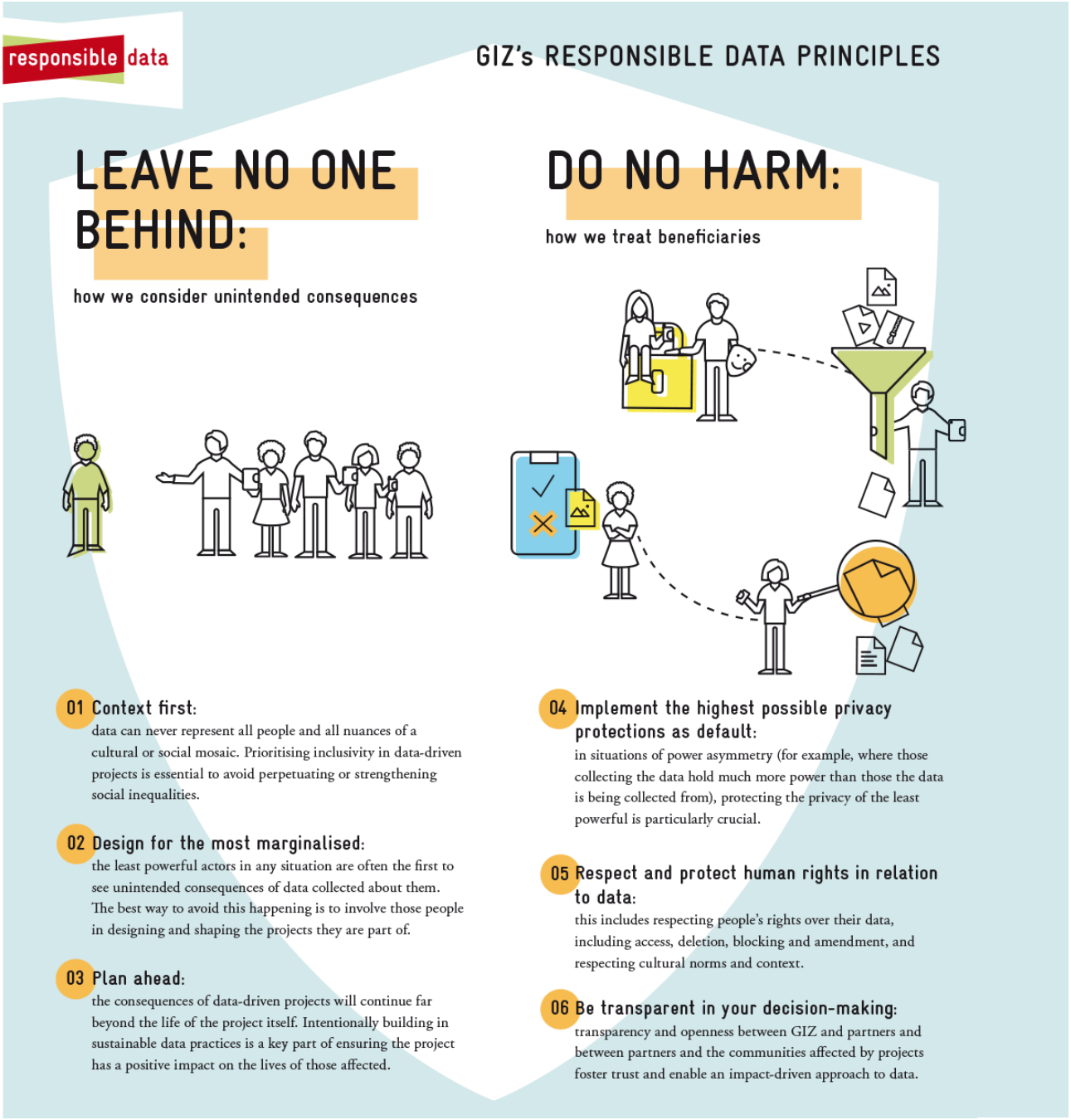
2.2 Responsible data guidelines

Data is the basis of ICT. Data is collected, handled, stored, analysed, crossed-referenced with other data, distributed and made available to a large user community for a wide range of purposes. Data can be collected and processed fully automatically, and ML algorithms can draw conclusions and make decisions. Hence, the use of ICT is associated with challenges and risks: data can fully or partly concern personally identifiable information; data is not necessarily generated by those who own it; and data can be sold to third parties for doubtful purposes. A solid regulatory framework is important to guarantee responsible data (RD) handling by all sides. According to the RD community, "RD is a concept to outline the collective duty to prioritize and respond to the ethical, legal, social and privacy-related challenges that come from using data in new and different ways in advocacy and social change".

Many multilateral organisations and countries worldwide have developed guidelines for the responsible handling of data. The European Union's (EU) General Data Protection Regulation (GDPR)[3] for instance, does apply for all EU member states. The United Nations Office for the

Coordination of Humanitarian Affairs (UN OCHA) offers a set of principles, processes and tools that support safe, ethical and effective management of data in humanitarian response work, and so do the United States Agency for International Development (USAID) and others.
If there is weak or no regulation available in a country, guidelines have to be developed or adopted to avoid data misuse. For such cases, GIZ has developed **RD principles** (see Figure 5), which can be used whenever local data protection principles are absent. RD Guidelines, particularly tailored to the agricultural context, are published by the Global Open Data for Agriculture and Nutrition (GODAN) Initiative[4] and by the Consultative Group on International Agricultural Research (CGIAR)[5]. Toolboxes with step-by-step checklists are available from GIZ or from the Protection Information Management Initiative[6] a collaborative project bringing together UN, NGO and other protection and information management partners working to respond to protection needs in situations of displacement.

Figure 5: GIZ's RD principles



Source: GIZ

Pastoral nomads in Mali. © GIZ/Dirk Betke

3. The ICT landscape: fields of application and showcases

3.1 Information and knowledge dissemination

3.1.1 Information and advisory services

DESCRIPTION

Farmers in rural areas often lack access to up-to-date agronomic information and advice. While many countries have established agricultural extension services, it is still difficult to reach out to all farmers with a need for advice. Digitalization and the roll-out of telecommunication and Internet infrastructure provide new opportunities to scale-up information transfer and to reach out to all participants of livestock value chains, even to those in remote rural areas. **The type of information and advisory services can range from general information delivery to specific case- or location-dependent advice.** They include topics such as livestock management solutions, pest and disease management, weather information, market price and market access information and financial advice. Many digital information and advisory services cover different thematic fields and are embedded in applications which offer various (related) services. Smartphone apps, for example, can be used to detect and diagnose animal diseases. Livestock keepers can report symptoms of sick animals via text messages or photos and receive (pre-recorded) advice from veterinarians. GPS-based localization makes it easier for veterinarians to visit livestock keepers when necessary. This advisory service can be a standalone service or be embedded, for example, in a platform which offers earmarked savings for quality veterinary supply from selected vendors.

Weather forecasts and early warning systems are crucial for pastoralists and (semi-) extensive livestock keepers to

make informed decisions on herd and feeding management. These services make use of meteorological data and predictive models to forecast weather and climatic conditions such as temperature and precipitation. They can support decision making, for example, on the search of alternative grazing grounds or fodder sources or the reduction of the herd size in case of an imminent drought. With rapid advancement of such data collection and analyzing technologies, the accuracy of forecasts is improving quickly at decreasing costs. The dissemination of information takes place through various ICTs including text messages or smartphone and web apps. With technological and infrastructural improvements, information can be distributed in near real-time.

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **INFORMATION AND ADVISORY SERVICES**

Food Price Monitoring and Analysis (FPMA) Tool → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide information on domestic and international food prices	All agricultural value chains	• Farmers • Cooperatives • Extension service • Agrodealers • Agroindustry • Finance sector • Public sector	Web application	89 countries worldwide

DESCRIPTION OF SERVICES: The **FPMA Tool**, developed by FAO's Global Information and Early Warning System, provides domestic and international food price data and analyses, including for livestock products, and issues early warnings for price developments which might affect food security.

Garbal → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Improve resilience among climate-affected pastoralists with tailor-made information services	Livestock	Pastoralists	• Call center • SMS • USSD • Remote sensing	(Northern) Mali

DESCRIPTION OF SERVICES: **Garbal** is an information platform for pastoralists and provides tailor-made information services on biomass availability and quality, on surface water availability, herd concentration and market prices.

iCow → SHOWCASE 1 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Increase farmers' productivity through knowledge provision and access to other agricultural players	• All agricultural value chains • Special focus on dairy and poultry	• Farmers • Agrodealers	• Mobile application • SMS • Voice messaging • Web site	Ethiopia, Kenya, Tanzania

DESCRIPTION OF SERVICES: **iCow** is a mobile phone platform that delivers knowledge, tools and services to farmers through different products. Products include an offline Wiki, custom-tailored information services, farm management tools and a virtual marketplace.

iShamba				→ Website
OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Support farmers to improve farm management and increase yields through information services	All agricultural value chains	Farmers	• SMS • Call center • Social media	Kenya
DESCRIPTION OF SERVICES: **iShamba** is a farmer information service that provides personalized farming advice, weather forecast and market price information. Moreover, farmers receive recommendations on crop and livestock management as well as information on farming events and training opportunities in their region.				

myAnga		→ SHOWCASE 2		
OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Strengthen climate resilience of pastoralists through improved access to weather information	Livestock	Pastoralists	Mobile application	Kenya
DESCRIPTION OF SERVICES: **myAnga** is a mobile application for pastoralists that provides near real-time weather information as well as forecasts, for example, on moisture levels and drought conditions.				

Tablet teacher in Karamoja. © Petra Dilthey/ethno e-empowerment (eeem.org)

Livestock keeper in Kenya. © GIZ/Dirk Ostermeier

SHOWCASE 1: iCow

One platform, many uses

Interview partner: Su Kahumbu Stephanou, Founder and CEO, Green Dreams TECH Ltd

What is the story behind iCow?

Su Kahumbu Stephanou grew up on a farm in Kenya. Later, she started several farming projects herself, but not all of them were successful. She experienced difficulty when trying to obtain valuable information for her projects and even more so when trying to find relevant information for her local context. This led her to design several digital knowledge products for smallholder farmers. In 2010, the iCow mobile platform won the Apps4Africa hackathon – it was one of her ideas.

How does iCow work?

Launched in 2011, **iCow is a mobile phone platform that delivers knowledge, tools and services to farmers through different products.** The evolution of iCow is user-driven, farmer-centered and thus steered by the needs of smallholders. The platform is the product of the Kenyan social enterprise Green Dreams TECH of which Su Kahumbu is the founder and CEO.

iCow products are designed with the goal of providing smallholder farmers with verified agronomic information, which is free, easy to understand and easy to access. "iCow is designed for low-end feature phones. Users receive all content in SMS format", Mrs. Kahumbu explains. This is one of the success factors of the application because for most African smallholder farmers smartphones are too expensive to acquire and to charge and too fragile to be used in a farming context. However, an Android version of iCow is available, and it is the go-to agricultural content provider on KaiOS.

Currently, the platform offers four SMS-based products. The **Farmer Library** is designed as an offline

Wiki for agriculture and livestock where farmers use USSD-codes to search for content and receive relevant information via SMS. **Smart Tools** aims to improve farmers' management decisions by providing custom-tailored advice, for example, on the soil type and suitable fodder crops for the location of a smallholder's farm. **Kalenda** is a tool which sends farmers reminders for actions to be taken in a specific production system and topic area. For livestock, it is available for cattle and poultry. Individual animals or a flock of birds must be registered to receive timely information on best practices, hygiene, vaccinations, nutrition, etc. If subscribed to **Mashauri**, a user receives several SMS messages per week with information on a topic of his or her choice. Moreover, iCow provides a marketplace, **iCow Soko**, that connects farmers, input providers, buyers and veterinary service providers. "iCow teaches regenerative, restorative, conservation agriculture. We are very selective about the input and the input providers that we have on the platform. They must be aligned with our ethos", Su Kahumbu explains.

What is the business model behind iCow?

Today, the iCow feature phone version has about 130,000 users in Kenya, Ethiopia and Tanzania. The service is provided for free due to a partnership with the telecommunication provider Safaricom. Initially, services were sold but the Green Dream TECH staff realized that farmers who most needed advice were the ones who could not afford the services. When the enterprise started to offer them for free, daily feedback messages from farmers increased from 80 to 3000. iCow receives knowledge content from research organizations and financial support from different donors. Su Kahumbu believes that governments should invest in digital information services. "If you look at the costs of conventional extensions services, digital services are much cheaper and more efficient", she explains. iCow currently has a data base of 1.6 million farmers and has delivered over 105 million SMS messages to farmers in East Africa since 2015.

Take-away messages

For Su Kahumbu, ICT is not a panacea but one tool to support farmers in building sustainable agricultural systems. "Find your customers, once you have identified them, try to help them solve their problem and if this requires the use of ICT, use ICT, but do not create solutions for the sake of using ICT", she recommends. Moreover, she stresses the importance of providing farmers with information that is practical and easy to understand. "Do not just provide weather information – provide weather information with concrete advice attached to it". Another important feature of the enterprise is its focus on farmers' needs and its flexibility to react to changing circumstances. In response to the COVID-19 pandemic, for example, the enterprise is scaling up digital veterinary services and channels monetary donations to farm households in need.

When asked about an outlook on developments in the field of digitization in the African livestock sector, Mrs. Kahumbu believes that early warning systems for animal diseases and pandemics will become more important. Moreover, information on genetics and breeding should be included in digital information services to help African livestock become more resilient to a changing climate. As far as technology is concerned, she believes that the new KaiOS operating system will gain importance in the African farming context since it offers a new, robust technology between the feature phone and the smartphone.

> "Do not just provide weather information – provide weather information with concrete advice attached to it".
>
> Su Kahumbu Stephanou,
> Founder and CEO,
> Green Dreams TECH Ltd

Officer explaining the myAnga app to livestock keepers. © myAnga

SHOWCASE 2: myAnga

A weather information system for pastoralists

Interview partner: Frankline Agolla, Co-founder and Director, Amfratech Limited

What is the story behind myAnga?

In Northern Kenya, pastoralists are accustomed to the extreme climatic conditions of semi-arid and arid regions. However, extreme weather events that result from climate change are putting additional strain on this situation. More and more often, relief food must be distributed in the region. Since this solution is not sustainable, the Kenyan government has developed the Ending Drought Emergencies (EDE) strategy.

The EDE strategy includes a framework for drought risk management through early response to climate risks, among other measures. Within this framework, the Technical Centre for Agriculture and Rural Cooperation (CTA) conceptualised the Enhancing Market Response to Resilience in Livestock Value Chain in Eastern Africa (CLI-MARK) project, which intends to strengthen climate resilience amongst pastoralist communities. One of its components is enhanced access to weather information for pastoralists to enable them to make informed decisions based on predicted weather patterns. **The myAnga app ("my weather" in Swahili) provides timely information on weather and forage conditions.**

How does myAnga work?

The myAnga app has been developed by Amfratech, a Kenyan ICT telecommunications firm which provides the free agri-weather platform with information in English and Swahili. Its advice is based on data from aWhere, a US-based near real-time agri-weather information service provider, which was funded by CTA for this project.

Mr. Frankline Agolla, co-founder and director of Amfratech Limited, is offering IT services including the development and rolling out of mobile systems in the GSM arena. With a permanent staff of three and additional developers on a need-to-need basis, Amfratech's vision is to develop simple solutions which impact humanity through science, innovation and technology. The company was contracted by CTA for the development of the myAnga app. Since 2019, the application is available on Google Play Store for free. It provides daily, localized weather observations from the past seven days, daily weather forecasts for the next 15 days, rainfall distribution over the past 30 days as well as expected moisture and drought conditions. Weather information and advice are given by experienced agri-meteorologists individually for every ward (the lowest administrative unit in Kenya). The services are currently available for the Marsabit and Isiolo counties of Northern Kenya only, but around 20 million pastoralists live in the region. Currently, the app has 500 SMS and 220 Android mobile app subscriptions. Usually, pastoralists subscribe for the SMS service and receive a weekly SMS message in 5 different local languages (Borana, Gabra, Samburu, Rendille and Swahili) with 7-day forecasts of weather and pasture conditions for informed decision making. Leaders and interested agents subscribe for the smartphone version which provides deeper information and better navigation functionalities. Through social networks, television and radio ads, attempts were made to expand the customer base.

> "Other necessary elements for enhancing the resilience of the pastoralist communities and their livestock value chains of Northern Kenya through ICT are better market access and animal identification and traceability".
>
> Frankline Agolla,
> Co-founder and Director,
> Amfratech Limited

Take-away messages

According to Mr. Agolla, the major barriers for the proliferation of myAnga, and digital technologies in general, are low literacy levels and low technology adoption rates among pastoralists, as well as the sheer size and low population density of the target area. The low financial status of the target group is what makes it difficult to develop a suitable business model for myAnga, and the sponsorship by CTA is soon coming to its end. He predicts that the pastoralists themselves will not be willing or able to pay for the service; however, the reduction of climate-related risks, and thus the saving of cattle and lives, would make it a worthwhile investment for government agencies and / or development partners in that such an effort would reduce the necessity of relief aid. In this context, Amfratech is currently reaching out to county governments and the National Drought Management Authority, whilst working with the Kenya Livestock Marketing Council (KLMC), Takaful insurance, aWhere, and the International Institute of Rural Reconstruction (IIRR) amongst other local partners. Another option would be to bundle the service with other services for the same target market.

"Other necessary elements for enhancing the resilience of the pastoralist communities and their livestock value chains of Northern Kenya through ICT are better market access and animal identification and traceability", Mr. Agolla says. With **MiFugo Data**, Amfratech has already a new product in the pipeline. The solution targets digitalization of Kenyan livestock markets to support livestock farmers in getting fair and better prices through digital identification and weighing of their animals.

3.1.2 Digital learning

DESCRIPTION

Digital learning is the combined use of computer devices, software, and educational theory to facilitate learning for different target groups. It is a way to reach out to thousands of students at a low cost and to facilitate self-paced learning. Many digital learning approaches allow content to be downloaded for offline use, which is an important feature for many users in a developing country context where data packages are expensive, or where an internet connection is unavailable. Digital learning encompasses concepts such as e-learning, e-textbooks and gamification.

A list of national African online learning platforms and tools is provided on the COVID-19 education response website[7] of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The Food and Agriculture Organization of the United Nations' **(FAO) elearning Academy**[8], for example, offers free online courses on agricultural topics (e.g. on climate-smart livestock systems[9] with a download option for offline learning. The World Bank Group's **Open Learning Campus**[10] also offers free online courses on various topics such as e-Learning on Digital Agriculture[11]. Moreover, the gamification of training content is a promising digital learning tool as it promotes active participation of a target group and memorable learning experiences.

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **DIGITAL LEARNING**

Arifu → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide a digital content and interactive learning platform for free	All agricultural value chains	Farmers	• SMS • Social Media	Kenya, Tanzania, Nigeria, Zambia, Rwanda

DESCRIPTION OF SERVICES: **Arifu** is a chatbot-based learning platform that is free of charge. It offers an interactive learning experience on various agricultural topics ranging from financial management over input use to best farming practices.

Ethno e-empowerment (eeem.org) → SHOWCASE 3 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Bring new educational opportunities with multimedia e-learning programmes to illiterate communities	Livestock	Pastoralists	eBooks	Kenya, Uganda

DESCRIPTION OF SERVICES: **eeem.org** provides educational programmes which integrate videos and other rich media content that rely on tablet-based eBooks as a learning tool. The eBooks cover a large variety of situations, sceneries and tasks of nomads' everyday life.

SimPastoralist

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Digital game to enhance the understanding of index-based insurance	Livestock	• Pastoralists • Public sector • Finance sector	Mobile application	(Northern) Kenya, Uganda

DESCRIPTION OF SERVICES: **SimPastoralist** is a digital game which explains the concept of index-based insurance to pastoralists. While the players gain experience with selling, buying and insuring livestock over several seasons with occasional droughts, the data collected in the background provides valuable insights about farmers' decision-making behaviour in different situations.

Moodle → SHOWCASE 4

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide an open source learning platform	All agricultural value chains	Educators	• Web application • Mobile application	Worldwide

DESCRIPTION OF SERVICES: **Moodle** allows educators, of any kind, to create a private space online, filled with tools that easily create courses and activities, all optimised for collaborative learning.

Tablet teachers with equipment, Loiyangalani, Kenya. © Petra Dilthey/ethno e-empowerment (eeem.org)

SHOWCASE 3: ethno e-empowerment (eeem.org)

Starting an educational revolution with eBooks for nomadic people in Africa

Interview partners: Dr. Petra Dilthey and Uli Schwarz, Founders, up4change.tv

What is the story behind eeem.org?

The members of pastoralist communities of Northern Kenya have – for various reasons – limited access to the Kenyan educational system. Since their illiteracy rate is high, it makes them dependent on oral transmission of knowledge. The integration of new knowledge into their livelihood strategies can be difficult. However, changes in traditionally known climatic patterns increase the pressure on pastoralist communities to find and implement appropriate adaptation strategies.

Anthropologist Dr. Petra Dilthey and environmental consultant Uli Schwarz produced films since 2010 about the life of pastoralists in Northern Kenya. The attainment of many hours of good video material gave rise to the idea of producing teaching materials in the form of eBooks that could be understood by illiterate pastoralists. The project was developed outside their regular working jobs: proposals were written, additional material produced and existing material transformed. After two years, they were able to present their first prototype of an eBook based on iOS at the eLearning Africa Conference in Addis Ababa. With the help of a BENGO grant and money from their own foundation, they were able to start a pilot project with ten tablets in the Marsabit county of Kenya.

How does eeem.org work?

Eeem.org is a project of the video production company **up4change.tv**, which documents social change with videos, provides information and background, and

supports social change in developing countries through its own projects. **The mission of eeem.org (ethno e-empowerment) is to bring new educational opportunities with multimedia e-learning programmes to illiterate communities** around the world, while the main target group are marginalized pastoralist communities of the northern parts of Kenya and Uganda.

Eeem.org makes complex topics understandable via eBooks. The eBooks mainly work with videos, graphics and audio messages, all of which were created for the context of Northern Kenyan communities. Since the release of the first eBook, eeem.org produced several eBooks on various topics, some of which are livestock-related: **Grazing Zone** is an eBook supporting basic reading and counting skills, **Animal Health** explains diseases, their symptoms and treatments, **Drought Resilience** explains how to prepare and protect pastoralist livelihoods against droughts and **Livestock Management** aims to introduce sustainable herd management practices.

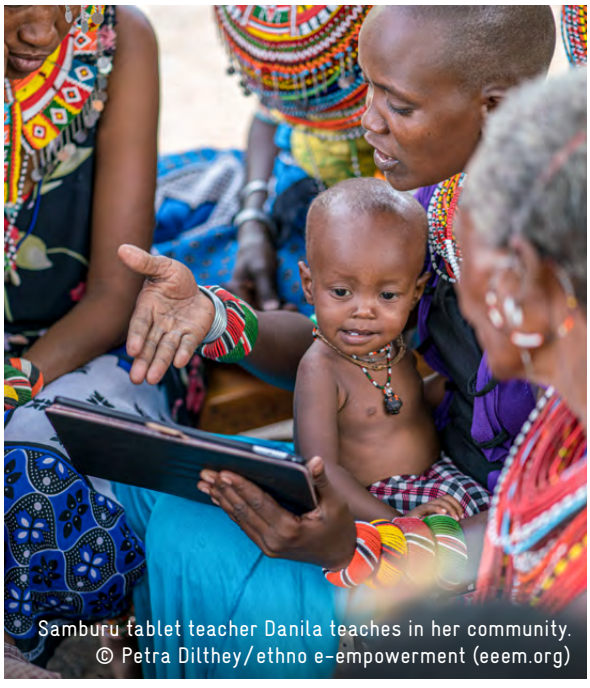
What is the technology behind the eBooks?

All eeem.org eBooks are based on Apple's iOS, iPads and the software iBooks Author. The project delivers iPads with solar panel chargers to selected educators in the communities. The contents are installed as eBooks in EPUB format and most of the iPads' functionalities (such as web browsers, etc.) are deactivated. The contents are presented interactively, but once installed on a device, the eBook is somehow static. "The update of contents and installation of additional contents is not yet possible remotely because of a lack of internet access", Mrs. Dilthey says. Together with an IT developer and an e-learning specialist, the two founders continually try to improve their teaching materials. Currently, a new GIZ project is planned in Uganda where eBooks will be developed for Windows computers and Android devices.

Take-away messages

According to Petra Dilthey, the key to success is the fact that all video materials were, and still are, produced in close collaboration with the local communities. This increases the recognition value and acceptance. "It is not understandable that projects still produce old-fashioned manuals and documents. At the end of the day, development organizations should make all contents available in digital format. An eBook is a good tool to reach out to the poorest and marginalized communities. Our project demonstrates that even illiterate and non-technology communities can make use of high technologies, and that these technologies can help to bridge the digital divide". The number of pastoralists in East Africa is high – which is an indicator for a high potential to scale-up the project. However, it must be kept in mind that the handover of eBooks must be accompanied by awareness raising and training.

> "Our project demonstrates that even illiterate and non-technology communities can make use of high technologies, and that these technologies can help to bridge the digital divide."
>
> Dr. Petra Dilthey,
> Founder, up4change.tv



Samburu tablet teacher Danila teaches in her community.
© Petra Dilthey/ethno e-empowerment (eeem.org)

Farmer Modeste Dayato feeding his chicken. © GIZ/Klaus Wohlmann

SHOWCASE 4: Moodle

E-learning for poultry farmers in Benin

Interview partner: Tanja Dorn, Component Coordinator, GIZ

How does Moodle work?

The **Green Innovation Centre Benin** (Centres d'innovations vertes pour le secteur agro-alimentaire, **ProCIVA**), established as part of the special initiative **ONE WORLD – No Hunger** of the German Federal Ministry for Economic Cooperation and Development (BMZ), is using e-learning technology for capacity building of smallholder farmers in Benin. The Centre also wants to use this tool to promote capacity building of poultry farmers. Poultry-specific content is under development for the Centre's own e-learning portal[12], since there are very few courses available for this sub-sector. ProCIVA Benin chose the **Moodle** platform for the development of its poultry e-learning modules. "Moodle is an open-source software, no license fees have to be paid which makes the project financially sustainable", Mrs. Tanja Dorn, responsible component coordinator at GIZ, says. "Once registered to the platform, users can install an app on their smartphone which allows them to access contents easily without being online – internet fees are expensive and every minute costs money". A learning module typically has three chapters with 2–3 pages, each followed by an online test with ten questions for the student farmer.

To enrol for a course, the user has to download Moodle Mobile from Google Play or Apple Store, enter the web address of the Centre and follow a few steps described on the website. Farmers can access courses for free and receive badges for completed courses once they pass the exam with at least 80 % of correct answers. All courses are offered on the Centre's website as well, where farming content is complemented by topics such as health, nutrition and climate change.

For all poultry-related activities, ProCIVA Benin partners with the National Union of Professionnal Poultry Farmers of Benin (Union Nationale des Aviculteurs Professionnels du Bénin, UNAP-Bénin). Currently, three e-learning modules are available for poultry farming. Moodle offers administrator tools to easily add new courses and content. "Creating e-learning content is not an easy task", Mrs. Dorn explains. "Content has to be tailored to the capacities of the target group. Local languages may need to be used, and photos and graphics can help to make content more understandable". Currently, options are being discussed to link the Moodle-based learning content from ProCIVA Benin with **atingi**[13], the e-learning platform of the **Africa Cloud**[14].

3.2 Sustainable livestock farming practices

3.2.1 Precision livestock farming

DESCRIPTION

Precision livestock farming (PLF) enables farmers to automatically and continuously monitor the health and welfare status of animals and / or their environment. An important aspect of PLF is the enabling of real-time management which helps to secure improved health, welfare and yields as well as to reduce the environmental impact of livestock husbandry. Current technologies allow producers to monitor individual animal feed consumption, feedlot movement, temperature, lameness, milk production, meat composition and quality, and weight gain.

PLF is based on information-sensing devices such as wireless sensor networks or remote sensing devices. Typically, a sensor network is set up which continuously collects relevant information on a farm. In the simplest case, the farmer receives an alert, if a certain threshold value is reached. But computers allow to collect large amounts of data (big data), to complement it by other information available on the web, such as weather data. Machine learning algorithms then can try to understand correlations and to identify trends to optimize production, increase resource use efficiency, prevent diseases, or forecast hazards. The goal of the exercise is to alert farmers even before a problem occurs.

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **PRECISION LIVESTOCK FARMING**

AfriScout → SHOWCASE 5 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide pastoralists with current information on water and vegetation conditions	Livestock	Pastoralists	• Mobile application • Remote sensing	Ethiopia, Kenya, Tanzania

DESCRIPTION OF SERVICES: **AfriScout** provides up-to-date pasture and water availability maps and weather information to pastoralists via a mobile application service. It assists farmers with migration decisions, improves pasture management, and reduces the risk of herd loss. It also features crowdsourced geolocated warnings on conflicts and diseases.

Jaguza → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide real time livestock information to farmers in the community via digital technologies	Livestock	• Farmers • Extension service	• Mobile application • Web application • SMS • USSD • IVR • AI • GIS • Internet of Things • Drones	Uganda

DESCRIPTION OF SERVICES: **Jaguza** is a herd and farm management application that enables farmers to track and monitor their animals via sensors. Moreover, a mobile application provides farming advice, market information, access to online veterinaries as well as a virtual marketplace for livestock.

Pastoralist checking grazing maps on his AfriScout app. © AfriScout

SHOWCASE 5: AfriScout

The shepherd's eye in the sky

Interview partners: Chris Bessenecker, AfriScout Founder & VP Strategic Initiatives, Project Concern International (PCI), a Global Communities Partner; Jennifer Waugaman, AfriScout Co-Founder and Managing Director

What is the story behind AfriScout?

A quarter of a billion African pastoralists move their herds over long distances in search of pasture and water for their animals. They base their decisions on indigenous knowledge, word of mouth, and sending scouts; however, these traditional methods can be unreliable given that weather patterns are becoming more unpredictable and extreme weather events more frequent due to climate change. On average, pastoralist families in Eastern Africa are losing over a third of their herds every year – a huge economical loss.

"I wondered why those whose lives depend on it, do not have access to modern information portals on weather and the environment". Chris Bessenecker, founder of AfriScout, says. "I had the idea of making satellite imagery available to pastoralists. I found USAID's Development Innovation Ventures and Google.org as partners to help me provide this information to pastoralists and test if it would support them in making better migration and grazing decisions".

From this proof of concept, AfriScout was born. **The AfriScout mobile service provides pastoralists in Kenya, Tanzania and Ethiopia with access to digital forage maps of their community rangelands, using localized satellite imagery and crowd-sourced indigenous knowledge.** The app acts as the "shepherd's eye in the sky" by supporting the implementation of climate-smart management practices for rangelands and by improving the lives of the people and animals that rely on them.

How does AfriScout work?

AfriScout is a native Android app, which shows grazing conditions within predefined community rangelands. Pastoralists use the digital forage maps to better plan and coordinate grazing and to post alerts of relevant grazing hazards such as animal disease, conflicts, or restricted grazing access, among others. To further avoid conflicts and protect conservation and wildlife areas, a pastoralist gets suggestions only within the borders of customary rangelands that have been validated by host communities and local authorities.

> "Risk reduction and improvement of food security are fundamental necessities and cannot be directly offset by business models."
>
> Chris Bessenecker, AfriScout Founder & VP Strategic Initiatives, Project Concern International (PCI), a Global Communities Partner

The app is fully functional offline. The latest release displays vegetation and surface water resolution down to 10 m² and simultaneously reduces the data burden to only 20 KB per map update, allowing cheap and fast downloads on unstable 2G networks. AfriScout is integrated into seven mobile money operators across three countries.

© AfriScout

Today, the software is used by over 100,000 users while most of them are registered for the free three-month trial period. Only 3,888 pastoralists pay subscriptions, 20 US dollars (USD) per year. A three-year study has shown that pastoralists who used AfriScout earned on average about 67 USD more per cow per year than those who did not use the app. The service is completed and functioning in six counties in Kenya, in four districts of Tanzania and in 16 woredas in Ethiopia. It is available in English, Swahili, Qafarara and Oromifaa, but the app generally works without using a lot of words. The pastoralists are used to navigating over large distances, and they know their territory, which makes them knowledgeable users of the maps.

What is the business model behind AfriScout?

Only few pastoralists have smartphones and not all of them can afford the data bundles and frequent charging. It is known and accepted by AfriScout that one user account is shared on average with seven other families. A market study revealed that AfriScout could operate the business without losses if 25 % of the pastoralists with smartphones subscribed.

Full financial payback is far from being achieved. AfriScout is trying to gain more customers through radio announcements and social media. Today, the AfriScout social enterprise is a subsidiary of Project Concern International (PCI), a Global Communities partner. PCI is a global development organization that drives innovation from the ground up to enhance health, end hunger, overcome hardship and strengthen women and girls.

According to Mr. Bessenecker, risk reduction and improvement of food security are fundamental necessities and cannot be directly offset by business models. Governments or multi-national organisations could make such services cheaper or freely available, and the losses prevented would far exceed their costs.

Sensor to record weight and temperature in a beehive. © GIZ/SAMS project

SHOWCASE 6: Smart Agriculture Management Services (SAMS) project

The honeybee, big data and machine learning

Interview partner: Stefanie Schädlich, Project Coordinator, GIZ

What does the SAMS project do?

Ethiopian beekeepers have limited access to modern beehive equipment and bee management systems. Due to these constraints, the development of the apicultural sector is far behind its potential. The SAMS project aims to integrate big data and machine learning algorithms into honey production in Ethiopia (and other countries). **The project develops and refines an open-source RS technology and user interaction interface to support beekeepers in managing and monitoring the health and productivity in their bee colonies and to extend their income sources and business possibilities.** Moreover, it promotes the production of bee products and the strengthening of resilience to environmental factors. The project receives funding from the EU's Horizon 2020 research and innovation programme. Eight partners from five countries collaborate under GIZ project management.

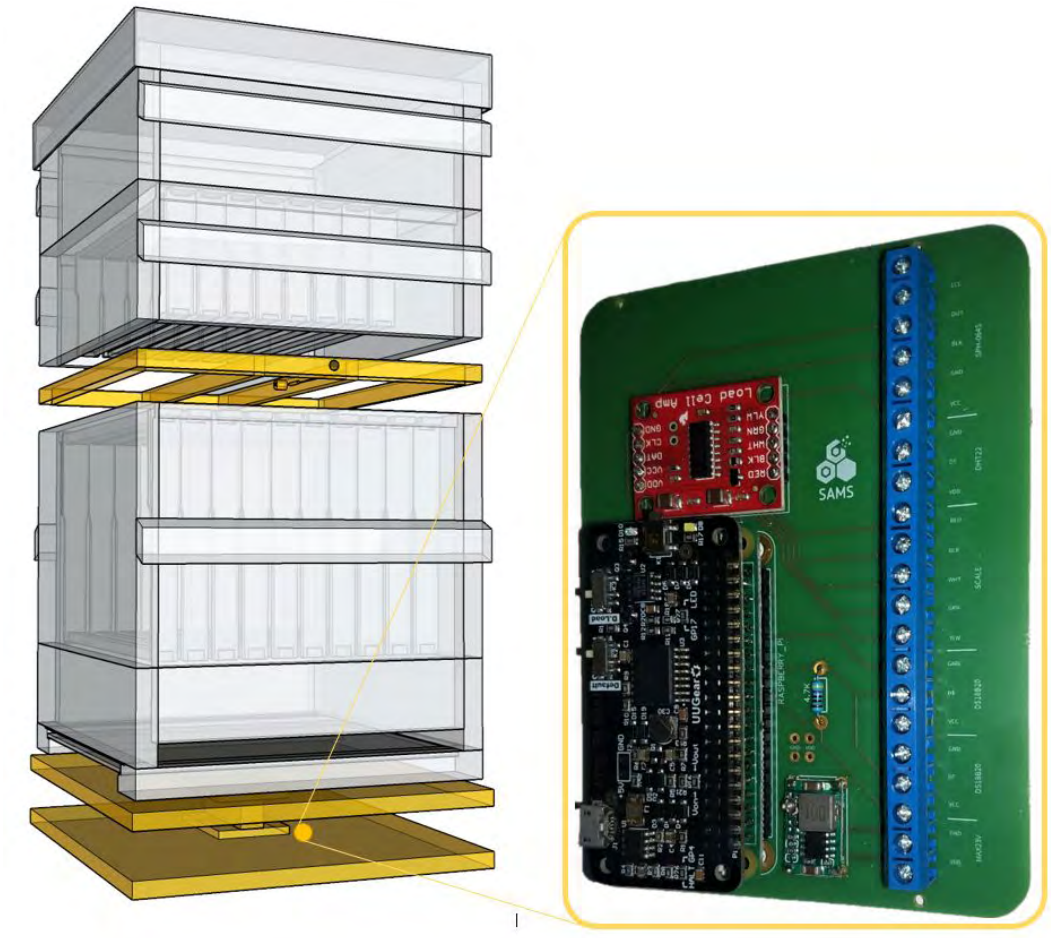
What is the technology behind SAMS?

Sensors in specifically designed beehives record weight and temperature in predefined intervals. The data is sent to a cloud-based analysis algorithm, the SAMS data warehouse. This data, integrated with other data such as a localized flowering calendar, provides the ground for the SAMS decision support system. This is a server-based system which is used for automatic data analysis, sending the status of the respective bee colony to the beekeeper who uses a smartphone and the SAMS mobile app to access the information.

How to make the technology accessible and usable?

"The SAMS user-centred design approach allowed us to consider the end users' expectations and demands from the very beginning", says Mrs. Stefanie Schädlich, project coordinator from GIZ. "It is not easy to translate between the IT specialists, those who adapt the monitoring systems to local conditions and who know how to programme the fuzzy-logic algorithms, and the beekeepers, those who so far have had little contact with such technology and who sometimes cannot read and write. Thus, many iterations were necessary to finally come up with a suitable monitoring system and a locally adapted app design". Other, more technical hurdles were, for example, the difficulties of transmitting monitoring data from bee colonies due to insufficient 3G mobile network coverage in wooded hills, the frequent breakdowns of the data transmission networks and the lack of IT expertise near the Ethiopian installation sites. It was concluded that a Secure Digital Memory Card (SD Card) option for local storage of measurements is necessary to mitigate the data transmission problems. In this case, real-time decisions cannot be made, but historical behaviour of the colony is available.

The SAMS consortium is not going to implement a final working mobile application for the beekeepers but will leave that as a possibility for the business development process. The developed design and front-end are available as open-source software programmes and any interested individual will be able to access, implement, and make use of it for their own purposes. The software is available through **Github**, the world's leading software development platform.



SAMS beehive with integrated sensors. © GIZ

3.2.2 Farm management support

DESCRIPTION

Successful farm management is the ability of a farmer to allocate available resources in a way that maximizes her or his profit. In this context, **accurate and easy to use farm management support tools are essential for planning, analysing and monitoring processes to optimize farming activities.** When it comes to running their businesses, most African smallholder farmers still rely more on their experience than on proper management tools. Until recently, the barriers to access modern farm management tools were extremely high: they required investment in computers and software packages, access to electricity, a high level of education, computer literacy and special training. This situation is beginning to change with the availability of cheap feature phones which offer farm management apps tailored to the needs and skills of African smallholder farmers. Some apps are even provided in local languages. Depending on their level of complexity, apps may not be a full replacement of computer-based farm management software, but they still offer smallholder farmers unprecedented opportunities to track and analyse their farm operations and to support their decision making. Available management apps which target the African livestock sector facilitate, for example, herd management, animal performance tracking, the calculation of nutrient and feeding requirements, budgeting as well as many other activities.

Farmer Rose Thauseni in Lilongwe, Malawi. © GIZ/Jörg Böthling

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **FARM MANAGEMENT SUPPORT**

Budget Mkononi → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Support the financial planning of agribusinesses	• All agricultural value chains • Special focus on broiler chicken	Farmers	• Mobile application • Web application	Kenya

DESCRIPTION OF SERVICE: **Budget Mkononi** is a budgeting tool for farmers to support them in planning and estimating their costs and income. Users can identify the basic costs and elements required to set up and run their farming enterprise, along with revenue flows and timelines. The tool is specifically targeted at youth in order to encourage them to view farming as a viable and sustainable career venture.

DigiCow → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Digitizing the dairy sector for farmers in Kenya	Dairy	• Dairy farmers • Agroindustry	• Mobile application • Social Media	Kenya

DESCRIPTION OF SERVICE: **DigiCow** allows farmers to register their animals, clients and staff, to record their breeding, sales, breeding, feeding and health information and to analyse real-time reports in order to make informed, data-driven decisions. Moreover, the app provides a marketplace for dairy cows, access to short-term loans and a chatroom feature where farmers can interact with each other and consult experts.

E-Lunda → SHOWCASE 7 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Facilitate record keeping at dairy farms	Dairy	Dairy farmers	Mobile application	Uganda

DESCRIPTION OF SERVICE: **E-Lunda** supports dairy farmers to track the performance of their herds. The app includes features such as herd information and production records, as well as expenses and sales records. Properly managed records allow for easy assessment of daily milk yields and quality, tracking of animal specific data as well as diseases.

eWeigh → SHOWCASE 8 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Estimation of live weight of cattle for better management	Cattle	• Farmers • Extension service	Mobile application	Kenya

DESCRIPTION OF SERVICE: **eWeigh** is a simple app that helps farmers estimate the live weight of their cattle. This single measurement can help farmers effectively manage their stock and is critical for making informed decisions on aspects of animal husbandry such as feed rations, market value, administration of veterinary drugs and mating times.

UsomiLulu → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Support farmers to maximize profits by increasing yields and productivity	All agricultural value chains	• Farmers • Extension service	Mobile application	Kenya

DESCRIPTION OF SERVICE: **UsomiLulu** is a data driven decision support platform for farm management. Moreover, it provides a cellphone driven purchasing and delivery service for farm inputs.

The E-Lunda user interface. © E-Lunda

SHOWCASE 7: E-Lunda

Supporting livestock farmers' management decisions

Interview partner: Dr. Peter Khisa Wakholi, CEO of OMNI-Tech

What is the story behind E-Lunda?

In Uganda, many young people go to school with the goal of escaping the traditional agricultural life of their parents. They want to move to the capital, start a business or work for telecommunication firms and banks. However, without a functioning agricultural sector, a country's economy cannot work. Nowadays, African agriculture is under pressure to meet the demand of a growing population and to find effective solutions to mitigate climate change. There is an expectation that the introduction of modern, innovative ICT-based tools can make agriculture more attractive and, thus, specifically attract the youth to this sector.

OMNI-Tech, a young Ugandan IT consultancy company, has several apps on the market. They are based on KENGA, a cloud-based mobile data collection platform, which initially was built for the Dutch NGO SNV to easily capture, track, manage and report on development interventions by using robust performance indicator data. Two of OMNI-Tech's apps are made for livestock value chains: E-Lunda targets cattle meat and dairy farmers ('Lunda' means 'rearing' in Luganda) while E-Lunda Poultry is a management support tool for poultry.

How does E-Lunda work?

E-Lunda, an Android app, was released in August 2018 after an intensive year of development. **E-Lunda allows farmers to create and keep animal identification records, to receive vaccination and treatment advice, to track gestation and to keep record of all diary related data such as milk production per cow, milk sales and consumption data.** The app works offline, all data is locally stored on the device, and the

cloud is used for backup and communication. Previous attempts with USSD-based information delivery failed due to high costs and low acceptance among farmers. "In Uganda, people like to use smartphones, but due to low literacy rates among the farming communities, the apps have to be simple and user-friendly by using symbols instead of too much text", mentions Dr. Peter Khisa Wakholi, CEO of OMNI-Tech. OMNI-Tech approaches potential users of E-Lunda mostly through networks such as the Dairy Farmers' Network Uganda.

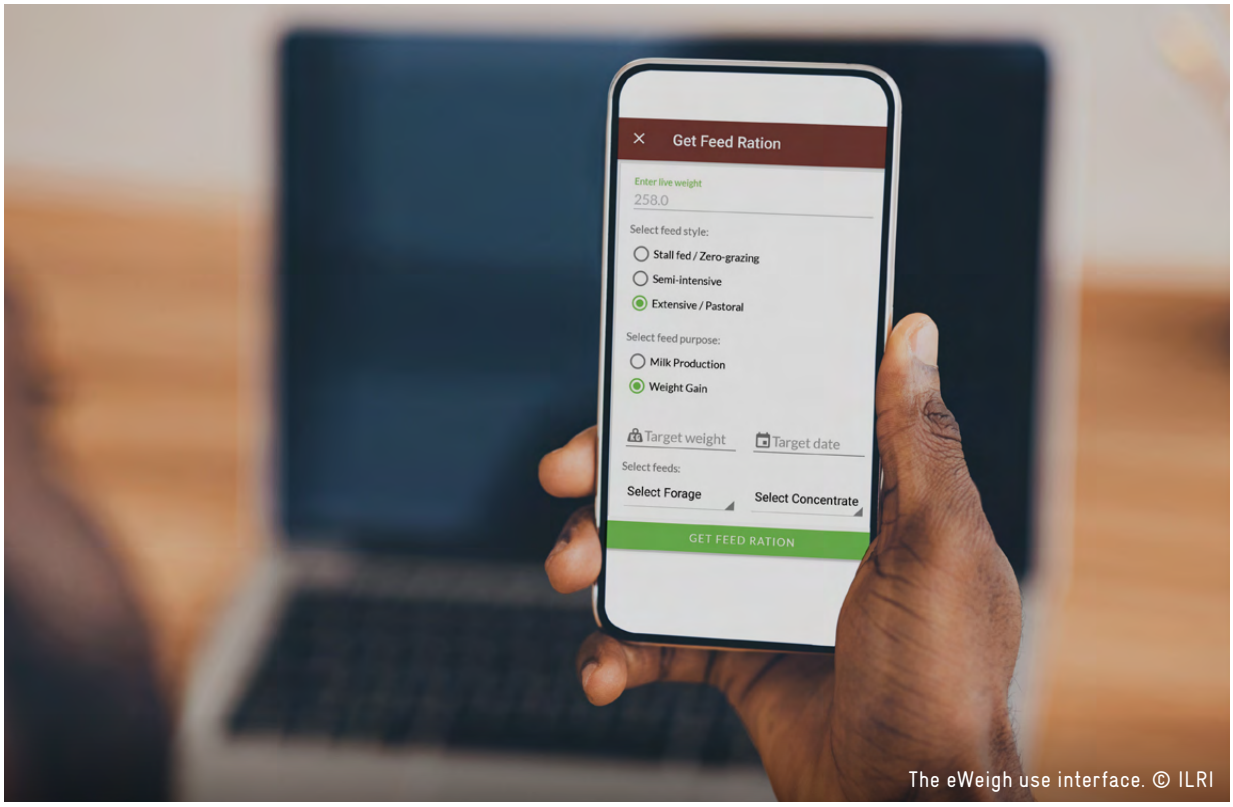
The app currently has around 600 subscribers who pay a monthly fee of 1 Euro. Often, it is a lead farmer or cooperative leader who is the subscriber and shares his or her account with other farmers. OMNI-Tech is evaluating options for establishing a feasible and sustainable business model for E-Lunda. A mixture of different models will likely be the solution: E-Lunda will be extended by a market linkage platform for trade with agricultural products. That way the current system of subscription-based payments by farmers, lead farmers and cooperatives will be extended by a transaction-based model. Additionally, the market platform will allow ads to be placed and paid by input providers and off-takers. Through a free base version with additional services / content paid (a so-called freemium-model), new users can be attracted to use E-Lunda.

Take-away messages

"OMNI-Tech follows a participatory development approach where enhancements to an app are made based on user comments and requests", Dr. Wakholi says. "The E-Lunda app helps farmers to appreciate the value of timely quality information. Information of milk amounts, prices and animal health allows them to better make and understand decisions". During his PhD studies in Norway and his work as a university lecturer at Makerere University in Kampala, he understood the high value of information. "The knowledge we have about the individual smallholders allows organizations to send him or her custom-tailored and fine-tuned information. Moreover, farmers who need to take a loan, for example, can provide full records of their business performance as credentials to the bank via the app".

> "The knowledge we have about the individual smallholders allows organizations to send him or her custom-tailored and fine-tuned information."
>
> Dr. Peter Khisa Wakholi, CEO of OMNI-Tech

The success of the E-Lunda app prompted OMNI-Tech to develop a similar app for the poultry sector. Most functionalities were already programmed for E-Lunda and could be re-used for the poultry app. By modular IT development, costs for the development of apps for other value chains can be reduced to a minimum. But according to Mr. Wakholi, partnering with the right networks is an equally important key to success. For the dissemination of the poultry app, SR Afro Chicks & Breeders Ltd, which runs the Poultry Association of Uganda, and Biyinzika Poultry International are already on board.



The eWeigh use interface. © ILRI

SHOWCASE 8: eWeigh

A digital scale for livestock

Interview partner: Dr. Lutz Merbold, former Head of Mazingira Centre, ILRI

What is the story behind eWeigh?

When selling their animals at livestock markets, African farmers are at a disadvantage compared to buyers because they have no tools to determine the correct weight of their animals. Moreover, on informal livestock markets, vendors and buyers often rely on visual judgement to estimate the weight of cattle, sheep or goats. Knowing the live weight (LW) of an animal not only helps farmers to negotiate a fair sales price but is also an important indicator for livestock management. It can be used to determine the nutritional requirements of an animal, the right time for reproduction or the correct dose of veterinary drugs. However, buying a scale is too expensive for most African farmers.

How does eWeigh work?

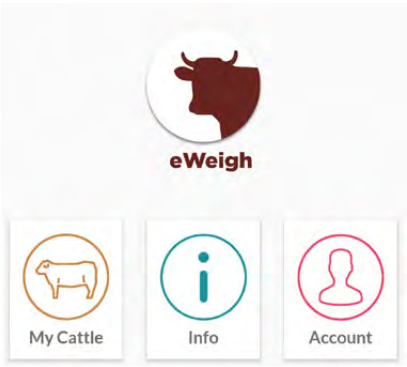
At the International Livestock Research Institute (ILRI), researchers from the Mazingira Centre have developed the mobile app **eWeigh to provide farmers with an inexpensive and easy-to- handle tool to estimate the LW of cattle.** The app uses an algorithm that is based on the heart girth as a proxy measure for LW. For its estimation, a farmer has to register an animal on the app and specify its breed, sex and heart girth. The LW can be monitored over time and three additional modules – **Feed, Dosages and Mating Guide** – provide information that support farmers with livestock management decisions. To get recommendations on a feed ration, for example, the livestock keeper can specify her or his management system and select available forages and concentrates from a drop-down list. A target weight can be determined for an individual animal and the app allows to monitor its weight gain over time.

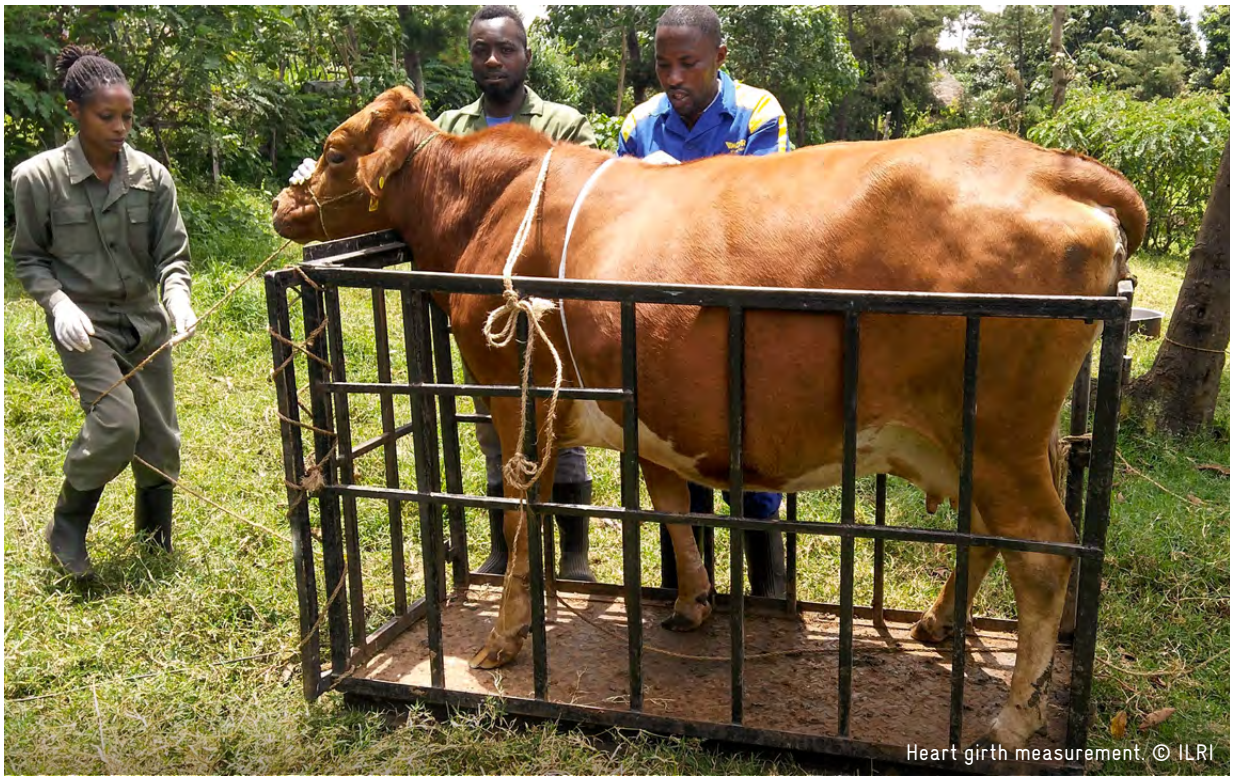
"The special feature of the eWeigh app is that it uses an algorithm that was developed with data from animal measurements in East and West Africa", Dr. Lutz Merbold, former Head of Mazingira Centre, explains. "To build a tool that accurately estimates the LW of cattle, it is important to use data of local breeds and production systems and to reflect local environmental conditions. There are dozens of algorithms to measure the LW of livestock, but the one that is used for eWeigh is one of the few that reflects the circumstances of livestock keepers in East and West Africa", he adds.

"The special feature of the eWeigh app is that it uses an algorithm that was developed with data from animal measurements in East and West Africa"

Dr. Lutz Merbold, former Head of Mazingira Centre, ILRI

eWeigh was developed by a Kenyan programmer in collaboration with scientists from ILRI. The app has currently 300 active users and there are plans to add new modules that provide guidance on animal health and climate-smart livestock practices and measures. "In Kenya, digitization is a fast-growing and dynamic field and developments have gained additional momentum due to the Covid-19 pandemic", Dr. Merbold mentions. "Digital solutions will have an important role in supporting local livestock production to sustainably meet the growing demand for animal-source foods".





Heart girth measurement. © ILRI

3.3 Financial services and insurance

3.3.1 Payments, savings and credit

DESCRIPTION

Mobile finance applications for private or business use allow one to send, spend, save and borrow money via mobile phones. For people in rural areas, improved access to banking services creates new opportunities, as it allows for the accruing of capital, reduces transaction costs and facilitates investments. In some countries, e.g. Kenya, general digital banking solutions, such as electronic wallets, are widely used, while other solutions specifically target farmers and livestock owners. Offering services comparable to a bank account, application providers can either cooperate with a bank or take over its function. Besides payment services, many applications offer access to credit and pay out loans digitally, which helps to overcome logistical difficulties in remote areas and reduces transaction costs. Furthermore, many applications support the creation of savings by offering incentives or separately locked accounts, where users can commit themselves to save a certain amount regularly. The building of savings helps to ease consumption and enhance resilience against (climate-induced) shocks, such as droughts or diseases. Other possible functions include insurance services, pension schemes, the inclusion into savings groups, and training for financial literacy.

Input financing allows for payments on layaway (i.e., via piecemeal instalments in advance or as a loan afterwards) for feed, fertiliser, seed and training packages via mobile phone and constitutes an alternative to classical savings or taking loans. Access to high quality inputs and services can improve the health and productivity of animals, which contributes to higher incomes and resilience against climate shocks. During dry seasons, farmers can be supported through the opportunity of buying additional feed and medicine for animals. Some providers allow for the pooling of investments and therefore offer discounted rates while decreasing risk. Input financing can be integrated within a marketplace system, where farmers can find providers of agricultural inputs, offered in combination with tailored extension services, or can increase the uptake of combined insurance services. Applications can also be used to provide e-vouchers for inputs by governments.

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **PAYMENTS, SAVINGS AND CREDIT**

Agri-wallet → SHOWCASE 9 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide finance to all actors in agri-food supply chains	All agricultural value chains	Farmers	• Mobile application • Web application	Kenya, Tanzania, Rwanda, Benin

DESCRIPTION OF SERVICE: **Agri-wallet** develops and implements innovative mobile wallets that help vulnerable people save money earmarked for specific purposes.

eGranary → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide access to certified inputs, market linkages and capacity building to farmers	All agricultural value chains	• Farmers • Agrodealers	Mobile application	Kenya

DESCRIPTION OF SERVICE: **eGranary** offers input financing in combination with extension services and improved market linkages through the eGranary digital platform.

Esoko → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Increase farmers' access to digital services and support other actors in agricultural value chains to reach out to and connect with farmers	All agricultural value chains	• Farmers • Cooperatives • Extension service • Agroindustry • Public sector	• Callcenter • SMS • IVR • Social Media	Ghana, Tanzania, Malawi, Burkina Faso

DESCRIPTION OF SERVICE: **Esoko** offers a variety of digital services including an e-wallet for farmers that is linked to credit, insurance and pension services.

Juhudi Kilimo → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide transformative financial solutions to rural smallholder farmers	Livestock	Farmers	Mobile application	Kenya

DESCRIPTION OF SERVICE: **Juhudi Kilimo** provides livestock loans (among other loan products) that enable farmers to acquire a wide range of farm animals and to invest in high breed livestock.

M-Pesa → Website

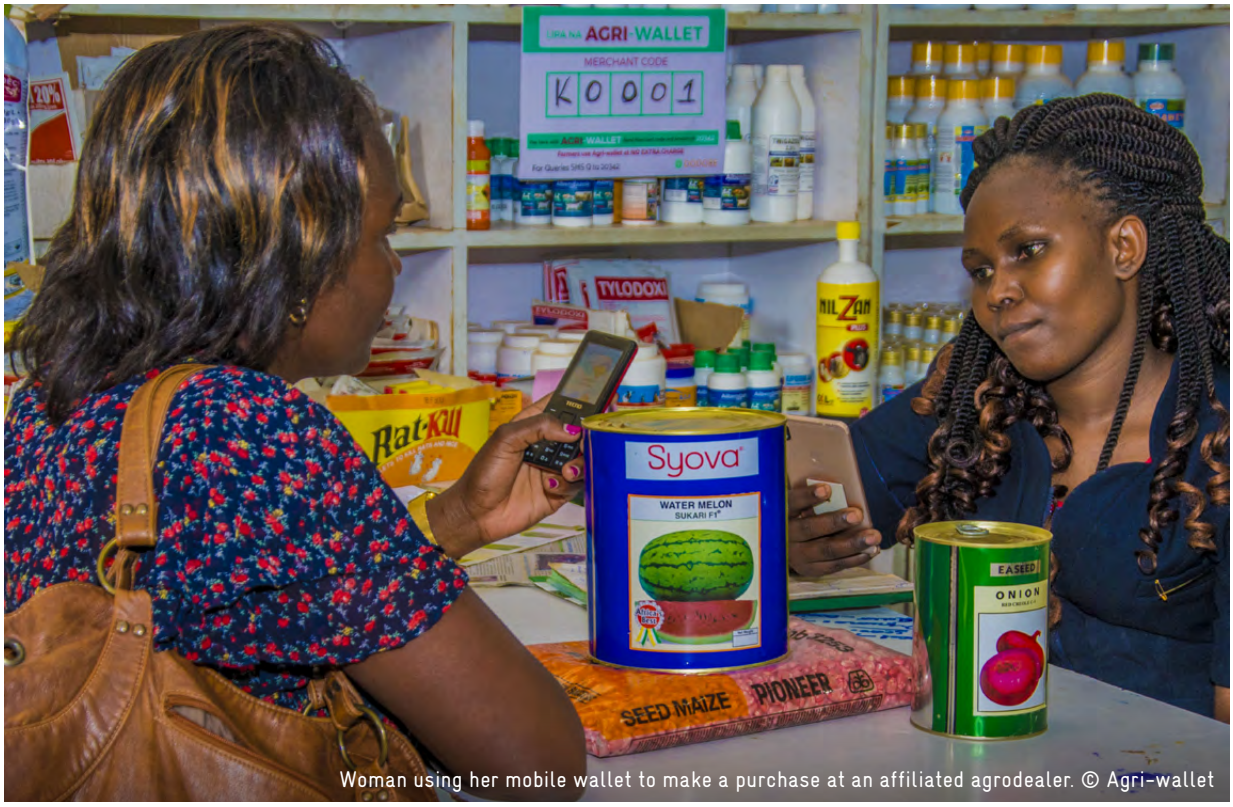
OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide a mobile money service to people with limited access to a bank account	All agricultural value chains	Farmers	Mobile application	• Worldwide • African focus countries: Kenya, Rwanda, Tanzania, Uganda

DESCRIPTION OF SERVICE: **M-Pesa** provides people with a safe, secure and affordable way to send and receive money, top-up airtime, make bill payments, receive salaries, get a short-term loan as well as other services.

myAgro → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Move smallholder farmers out of poverty through access to saving accounts and high-quality inputs	All agricultural value chains	• Farmers • Agrodealers	Mobile application	Mali, Senegal, Tanzania

DESCRIPTION OF SERVICE: **myAgro** is a unique mobile layaway platform which allows farmers to use their mobile phones to purchase high-quality seeds (for climate-resilient crops) and fertilizer in small increments. Moreover, myAgro provides agricultural trainings to all farmers who invested in myAgro packages, sharing harvest-improving agricultural techniques tailored to specific regions.



Woman using her mobile wallet to make a purchase at an affiliated agrodealer. © Agri-wallet

SHOWCASE 9: Agri-wallet

Simple and affordable access to finance for smallholder farmers

Interview partners: Susan Ndung'u, Manager for Programme/Product Development, Dodore Kenya Ltd.; Sijmen de Hoogh, founder, Dodore Kenya Ltd.

What led to the development of Agri-wallet?

For most smallholder farmers in Africa, lack of access to finance is one of the main obstacles to professionalizing and expanding their business. Often, they do not receive their payments immediately upon selling their produce but only weeks later, when the buyer has resold the goods. Farmers frequently lose a full planting season or production cycle because the money for buying inputs is not yet at hand. Loans would remedy this problem, but access to formal loans from financial institutions is limited. Banks claim that the provision of loans to smallholder farmers is too risky because the money is not used for investments or passed on to other people in need of cash. This, together with the lack of collateral, makes it unattractive, if not impossible, for financial institutions to provide loans to smallholder farmers. Dodore Kenya Ltd, a Kenyan company based in Nairobi, wants to solve these problems through innovative mobile wallets.

How does Agri-wallet work?

"As part of an 'ecosystem' with earmarked credit, Agri-wallet helps farmers to save and in turn enables them to access short-term loans without the conventional stack of paperwork. This kind of credit ecosystem is comparable to a voucher system, combined with a savings element. Currently 35 % of the farmers who use the wallet, save money", says Susan Ndung'u, responsible for programme and product development at Dodore Kenya Ltd.

With 25 employees, the fintech solution Agri-wallet offers simple and affordable access to finance for smallholder farmers: it helps farmers to borrow money to buy agricultural inputs and to pay back their loans digitally. Moreover, the solution connects farmers, off-takers, input suppliers, financial institutions and insurance companies to mutually benefit from each other. It enables smallholder farmers to buy quality-inputs for their businesses. For buyers, it offers transparent supply chains, and for suppliers it brings clients searching for quality farm inputs.

"Agri-wallet delivers funds to the farmers", Mrs. Ndung'u explains. "Instead of waiting for weeks for payments, Agri-wallet bridges financial gaps with loans which can only be spent for purchasing inputs from selected suppliers. It comes in tandem with education and knowledge for the farmer and promotes literacy".

> "Instead of waiting for weeks for payments, Agri-wallet bridges financial gaps with loans which can only be spent for purchasing inputs from selected suppliers".
>
> Susan Ndung'u,
> Manager for Programme/Product Development, Dodore Kenya Ltd.

Today, the system has 25,200 registered farmers, 125 merchants (agrodealers) and 61 buyers. Agri-wallet is not limited to specific value chains. However, the type of input supplier determines the group of participating farmers. It currently operates in four African countries with various value chains: Kenya, Tanzania, Rwanda and Benin. In Tanzania it specifically supports the poultry value chain. The Agri-wallet management team is keen on partnerships to bring its products to more countries.

What is the technology behind Agri-wallet?

Agri-wallet offers three tools of different technological level to three stakeholder groups: Farmers communicate with Agri-wallet via SMS and thus need only a simple mobile phone. They sell to registered off-takers and can receive cash through M-Pesa (a SMS-based Kenyan mobile payment system) or Agri-wallet tokens. These tokens are earmarked for purchasing input supplies from merchants that have been vetted and selected by Dodore.

The input suppliers and agrodealers use the Agri-wallet app to register farmers and thus need smartphones. Once part of the system, farmers can place their orders by SMS and pay cash, with M-Pesa or Agri-wallet tokens. Participating agrodealers are recommended by farmers and Agri-wallet ensures quality through a proper know-your-customer process. The off-takers are selected and verified by the company's business development team. The Agri-wallet Web application allows one to make payments and monitor accounts and thus helps to build-up a system for evaluating and monitoring the credit worthiness of farmers.

The service itself is free for farmers. However, if farmers use an Agri-wallet credit, they have to pay interest rates. Agrodealers pay a platform fee and for credits. Converting Agri-wallet tokens into cash money also has a fee.

Take-away messages

"The right financial partners were key to getting the Agri-wallet system running", explains Sijmen de Hoogh, who founded Dodore in 2013. Partners for the implementation of the system are inter alia, SNV, the Fund for Rural Prosperity (Mastercard Fund), Rabobank Foundation, IDH Farmfit Fund, FMO and others.

According to Susan Ndung'u, Agri-wallet helps farmers to better manage their farms. "In a broader sense, digitalization will bring education and knowledge to the farmers and, above all, it will have a positive social impact", she mentions.

3.3.2 Crowdfarming

DESCRIPTION

Crowdfarming is based on the idea of crowdsourcing, which is the practice of obtaining capital or input by gathering finances or services from a large number of people, typically via the internet. Crowdfarming enables farmers to get funding for farming activities, e.g. raising cattle, and bridge the period until earnings are generated from selling the animal product. This smooths farmers' income and spending, thus increasing resilience against extreme weather events, like droughts. Investors can finance animals, whole farms, or technology projects (e.g. precision farming) and receive a return at the time of sale. As their assets are tangible, investors can visit the animals, or farmers can send updates on their development. Platform providers determine the duration of the investment cycle and return on investment and can insure the invested funds. Another business model which has been on the rise in Europe enables customers to buy the meat of an animal, e.g. a cow, before it is slaughtered and provides the investor with the animal products afterwards. Services for farmers often include improved market integration, advisory services and insurances.

Crowdfarming. © GIZ/Alex Kamweru

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **CROWDFARMING**

BaySeddo → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide a simple and secure platform for agricultural investments	• Poultry • Rice • Vegetables	• Farmers • Investors	• Mobile application • Social media	Senegal

DESCRIPTION OF SERVICES: **BaySeddo** raises capital for investments in modern farming technologies. The investment period is usually 6 to 12 months. After the completion of the production cycle, investors are paid back and receive a return.

Farmcrowdy → SHOWCASE 10 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Make smarter decisions through an ecosystem of products and services	• Livestock • Crops	• Farmers • Investors	• Mobile application • Social Media • GPS	Nigeria

DESCRIPTION OF SERVICES: **Farmcrowdy** links investors willing to invest in agribusinesses with farmers who have land and labour but need financial support. At the end of the respective production cycle, the farm sponsor receives his or her initial investment plus the return on this investment.

Livestock Wealth → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Support farmers to grow and maintain assets until ready for market	• Livestock • Crops	• Farmers • Investors	• Mobile application • Social media	South Africa

DESCRIPTION OF SERVICES: **Livestock Wealth** enables private investors to invest in livestock and crop farming. Investors choose an asset with different investment periods and expected return. Farmers then receive the capital and buy the asset back when they sell the product. Livestock Wealth also provides information on markets and improves market access by linking. farmers to buyers.

Thrive Agric → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Empower farmers and build an Africa that feeds the world and itself	• All agricultural value chains • Specific focus on poultry	• Farmers • Investors	• Mobile application • Social Media	Nigeria

DESCRIPTION OF SERVICES: **Thrive Agric** connects farmers with investors. Investors select a farm or a specific product from a farm in which they would like to invest. Investors receive regular updates on the status of their investment. At the end of a production cycle, investors are paid back their initial investment with a return. The investments and the farms are insured against major harvest shortfalls or animal mortality.

Abuja, Nigeria. © GIZ/Thomas Imo/photothek.net

SHOWCASE 10: Farmcrowdy

Connecting investors and farmers to boost food production in Nigeria

Interview partner: Tomiwa Ogunmodede, Manager and Digital Brand and Marketing Expert, Farmcrowdy

What is the story behind Farmcrowdy?

Smallholder farmers in Nigeria often have enough land and labour, while access to finance is rather difficult. Moreover, they mostly have no access to mechanization, and the acquisition of quality input is challenging. Lack of market access and transport problems prevent especially producers of fresh produce like milk and meat from improving and expanding their businesses. These observations led to the development of Farmcrowdy.

"Empowering smallholder farmers is our priority and a way of contributing to increasing domestic food production and food security", says Mr. Tomiwa Ogunmodede. He is Farmcrowdy's digital brand and marketing specialist and part of the six-headed management team. **"Farmcrowdy links investors, willing to invest in agribusinesses, with farmers who have land and labour but who need financial support.** Sometimes this occurs over large distances since investors and consumers mainly live in the south of Nigeria, while cattle husbandry mainly takes place in the North". Farmcrowdy was founded in September 2016, and its first products were available in November of the same year.

How does Farmcrowdy work?

Farmcrowdy is one of the leading agritec platforms in Nigeria. Through the Farmcrowdy app, investors can identify a farm of their choice and sponsor as many units as they want and can afford. Farms ready for

sponsorship get selected in a two-step process: First, Farmcrowdy identifies a state or location with high potential for agricultural or livestock farming as well as the appropriate production system for the given setting; second, Farmcrowdy reaches out to farmer organizations or lead farmers in order to identify experienced and committed farmers. Groups of farmers can then be addressed with services such as trainings on good agricultural practices, localized weather information, and pest and disease early warning information, Moreover, aggregation and negotiation with off-takers is facilitated through more than 100 aggregation centres in eight Nigerian states. Farmcrowdy assigns technical field specialists to provide trainings and advice to each participating farm and to thus guarantee that investments made are paying back. Through the Farmcrowdy app, the website and through personal site visits, sponsors can track the development. After the end of the respective production cycle, the farm sponsor receives his or her initial investment plus the return on this investment.

Farmcrowdy employs 46 team members including a team of in-house IT developers. Since its launch, Farmcrowdy has empowered over 25,000 smallscale farmers across Nigeria through more than 4,000 farm sponsors and over 80,000 individual sponsorships. On the Farmcrowdy website, figures are presented for successfully closed projects: for poultry, values between 6 and 14 % of returns have been achieved in time spans of three to six months; over 3 million chicken and 2,000 fit-for-slaughter bulls were reared; and three cattle projects achieved on average returns of 12–14 % in six months. Sponsorships are only possible for holders of Nigerian bank accounts since exchange rate fluctuations and costs for currency exchange make it difficult to open the market to other nations.

Farmcrowdy's business model

Farmcrowdy's business model is very diversified. Besides the product described, Farmcrowdy runs the marketing platform **AgriSquare**, which connects people who offer and search for products, jobs and technology. They also run **Farmcrowdy Food**, an online platform for food marketing. Moreover, Farmcrowdy operates its own meat processing center in Lagos and organizes sourcing, processing and sale. According to Mr. Ogunmodede, the Nigerian government provides a wealthy environment for business development, good access to Internet in urban centers as well as access to capital for investments.

Take-away message

"Nigeria is a very particular country", Tomiwa Ogunmodede says. "Food is generally produced in the North but consumed in the South. This gap can be closed by new technologies. Agriculture generally can become much more efficient with the introduction of modern digital technologies. In the future, data collection and traceability will play a huge role", he believes. "A dairy sector, for instance, is almost non-existent in Nigeria and digital dairy solutions can be an impulse to establish this sector".

> "Nigeria is a very particular country. Food is generally produced in the North but consumed in the South. This gap can be closed by new technologies".
>
> Tomiwa Ogunmodede, Manager and Digital Brand and Marketing Expert, Farmcrowdy

3.3.3 Insurance

DESCRIPTION

Insurance schemes aim for reducing vulnerability to external shocks, such as extreme weather events or diseases, which worsen under the influence of climate change. In arid and semi-arid regions of Sub-Saharan Africa for example, the death of livestock represents a threat to the livelihood of pastoralists.

Index-based insurances target vulnerable groups in remote areas, such as pastoralists, and offer a risk sharing mechanism. They use satellite data to monitor vegetation, creating a drought index to make mobile lump-sum payments if the index drops too low. Since the insurance pays out when the forecast index anticipates high animal mortality, it allows farmers to buy feed in advance and avoid worst-case scenarios. Additionally, the application includes information on livestock and weather data. The use of satellite data has issues with recognizing different kinds of vegetation and in making exact, region-specific forecasts. Therefore, the use of drones is being tested to increase data validity.

Different technologies for the identification of individual animals can be used in the context of insurance products to reduce the risk for insuring animals. In extensive or pastoral production systems, identification technology can provide exact information on the condition of animals in terms of age, health, vaccines, and geographic location. While this technology has not been used in the African context yet, the use of RFID chips was tested in India.

The access to data via ICTs is mobilized by Business-to-Business solutions to lower risks of insurance services or other banking services, like credit providers. Data collection can be realized through satellite, RS, or farm management apps, where farmers enter their data and obtain advice in return. Moreover, financial service providers can gather information on the financial background of lenders and generate automatic credit ratings. Big data analysis and machine learning allow for the analysis of farm and geographical or climate data to calculate risks. Decreased risk due to an improved database facilitates the expansion of service providers to less accessible areas and can increase the supply of services to marginalized groups. Some insurance providers also offer insurance coverage to financial investors and to farmer financing intermediaries to insure against risks of disaster, for example, based on precipitation.

A cattle herd close to Suru, Nigeria. © GIZ/Thomas Imo/photothek.net


© GIZ/Helmut Viertel

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **INSURANCE**

ACRE Africa

→ SHOWCASE 11

→ Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Link farmers to insurance products to secure their investments	• Livestock • Crops	• Farmers • Finance sector	• Web application • Social Media	Kenya, Rwanda, Tanzania

DESCRIPTION OF SERVICES: **ACRE Africa** is a service provider that works with local insurers and other stakeholders in the agricultural insurance value chain. The company undertakes risk assessment, product development and risk monitoring to facilitate access to crop and livestock insurance products for smallholder farmers.

EcoFarmer

→ Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide multiple services to increase productivity across agricultural value chains	All agricultural value chains	• Farmers • Finance sector	• Mobile application • SMS	Zimbabwe

DESCRIPTION OF SERVICES: **EcoFarmer** is a mobile platform for farmers. It provides weather index-based insurance as well as bundled ICT-based services, including livestock and farming advice, real-time, location-based weather information and alerts.

Index-based Livestock Insurance (IBLI)

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Insure pastoralists against livestock mortality	Livestock	• Pastoralist • Finance sector	• Mobile application • Remote sensing	Kenya

DESCRIPTION OF SERVICES: **IBLI** strengthens the resilience of pastoralists in remote areas against drought by insuring livestock mortality losses. A vegetation index is created using remote sensing satellite data. If the index drops below a baseline, a drought indicator warns pastoralists and mobile lump-sum payments are paid out via M-Pesa. The app attempts to anticipate droughts to realise payments, enable pastoralists to buy fodder and prevent livestock mortality. It also includes information on livestock regarding health and feeding.

ACRE Africa's Data Associate training farmers at a weather station. © ACRE Africa

SHOWCASE 11: ACRE Africa

Protecting smallholder farmers with technology against the vulnerabilities of climate change

Interview partners: Farid Wangara, Principal Officer, Agriculture and Climate Risk Enterprise Ltd. (ACRE)

What is the story behind ACRE Africa?

Due to a changing climate, insurances are becoming more important for smallholder farmers in Africa. However, it is very difficult for insurance companies to reach a single smallholder farmer, and likewise it is almost impossible to assess potential risks for an individual case. Risks from climate change are site and product specific, and farmers' preparedness and coping strategies are dependent on their knowledge, production system and available resources, among other factors. Smallholder farmers are often unwilling to take on the additional expenditures that insurances initially incur, so behavioral change is not easy to achieve.

How does ACRE Africa work?

ACRE Africa is a pioneer in the agricultural InsurTech landscape in Africa with innovations that enable effective agri-insurance solutions. ACRE Africa acts as a platform for its partners to reach out to farmers, to assess their situation and to offer them suitable and tailored agri-insurance products. Being in operation for over five years, ACRE Africa works with key stakeholders in agriculture including financial institutions, input providers, farmer groups, insurance companies and development organizations.

ACRE Africa links insurance providers with smallholders by using a network of cooperatives and veterinary services. Farid Wangara, ACRE Africa's Principal Officer, states that "insurance products were available in 2009, but it was difficult and expensive to reach the individual farmer. This is why ACRE Africa developed various mobile applications to reach smallholder farmers and to onboard them using mobile phones". A livestock-specific app is available which features location enabled farmer profiling, a network of local veterinary service providers, mobile money integration and claims notification. A livestock indemnity cover for dairy shields farmers against losses occasioned by

deaths from accidents, diseases or natural hazards such as floods or droughts. Farmers can also obtain a gestation cover for calving cows. That way, ACRE Africa offers integrated risk management solutions, complemented by weather and satellite data, to help farmers to mitigate weather-related risks.

Key challenges in the implementation of ACRE Africa have been the low literacy levels of farmers, their lack of access to smartphones and scarce knowledge on how to use them. So-called 'Village Champions' have a pivotal role in addressing this problem by taking on the role of connectors between farmers and the insurance system. The Champions are extension workers specialized in good agronomic practices, financial education, risk management and mitigation strategies, as well as insurance. If farmers are interested in getting support, they can send a message to ACRE Africa via USSD. The system identifies the nearest Champion and forwards the request so that the farmer can be contacted. If the Champion manages to onboard the farmer, he collects his or her data with the app and receives a commission. This has improved efficiency by eliminating paperwork. To reduce risks, it is ideal if the Champion is already the farmer's veterinary or extension service agent who is familiar with the farm and its livestock. The model of Village Champions is steered under ACRE's *"Getting Farmers Insurance Ready – Bridging the protection gap"* project, funded by the Alliance for a Green Revolution in Africa (AGRA).

ACRE offers its services in Kenya, Rwanda and Tanzania and is currently expanding to Senegal, Nigeria, Mozambique, Malawi and Uganda. In Kenya, the company has trained 450 Village Champions who work directly with farmers and who were thus able to cumulatively reach over 1,800,000 members by 2020. In Kenya, Tanzania and Rwanda farmers have spent over 181 million USD on insurance against a variety of weather-related risks. To be able to offer low premiums, ACRE needs to sell more products to a higher number of customers.

For the setup of its services, ACRE Africa collaborates with various well-known organizations and institutions, among them are ILRI, Kenya Agricultural & Livestock Research Organization (KALRO), CGIAR, Swiss Capacity Building Facility (SCBF), Grameen, Syngenta, AGRA, World Bank, Vision Fund, Mercy Corps as well as other insurance companies and mobile service providers.

What is the technology behind ACRE Africa?

For modelling its agri-insurance products, ACRE Africa runs a network of 80 automatic weather stations in Kenya and 25 stations in Rwanda. The data collected is combined with satellite-based remotely sensed weather data from ARC2-Data and historical data from the past 30 years. Farmer profile data is collected digitally and a combination of tools like drones, bulk SMS, USSD and mobile money are key in delivering services to these farmers. An internal ACRE Africa unit is dedicated to modeling specific localized risks.

Take-away message

According to Farid Wangara, ACRE Africa is successful because its board consists of members with a philanthropic mindset. Generally, the development of insurance products is expensive, but ACRE Africa tries to develop its products in a price-sensitive manner so that smallholder farmers can afford them. Sensitization of potential customers on the importance of insurance products as well as robust internal risk management strategies are additional keys to success.

The challenges ACRE Africa faced over the years are all related to the fact that farmers need more information and training on the use of insurance products since the latter are very complex and diverse. Insurance penetration is still very low in Kenya – 90 % of Kenyans with low literacy levels have never heard of the concept of insurance.

Asked for future developments in digitalization in Africa, Mr. Wangara says "Insurances will become part of input and loan provision, maybe bundled with e--advice and trainings. A combination of various services with insurance provision might be the key to success. Technology is a booster for development, but for African farmers, feature phones and USSD technology will still be an important technology for the next five to ten years".

3.4 Market access

3.4.1 Input market integration

DESCRIPTION

Lack of information and access to remote distant markets often makes it difficult, particularly for smallholder farmers, to buy high quality inputs at fair prices. Additionally, some technologies and inputs that are crucial for improving productivity require high investments. **Various applications have therefore focused on the provision of inputs to farmers in remote regions via virtual marketplaces or distributers who reach out to farmers taking the last mile.** Virtual marketplaces allow for direct trading between farmers and input suppliers. Applications often offer this service combined with (pooled) input financing, insurance, and extension services. Leasing services for machinery enable farmers to mechanise production but have been developed mainly for tractor (ploughing) services so far. In the livestock sector, services also include vet care and vaccines.

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **INPUT MARKET INTEGRATION**

Agrikore → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide a trusted environment for business transactions in agriculture	All agricultural value chains	• Farmers • Finance sector • Agrodealers	• Web application • Blockchain	Liberia, Nigeria

DESCRIPTION OF SERVICES: **Agrikore** is a blockchain based smart-contracting, payments and marketplace system that provides a platform to enhance transparency. It integrates supply chain management with financial service provision and offers more flexible but secure transaction enabling. Risks are lowered for financial institutions and insurances as transparency increases.

Cowtribe → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Contribute to the transformation of animal health services through technology	Livestock	• Farmers • Agrodealers	• SMS • Social Media	Ghana

DESCRIPTION OF SERVICES: **CowTribe** delivers vet care services, animal vaccines and other livestock services and information to last-mile farmers in Africa via phone. The system allows for tracking health statistics of each animal, gives reminders when to vaccinate animals, and facilitates all the logistics and supply processes to reliably deliver these vaccines to the farmer.

Farmers Pride → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Leveraging on technology to offer a more efficient last mile marketplace platform to smallholder farmers	All agricultural value chains	• Farmers • Agrodealers	• Mobile application • Social Media	Kenya

DESCRIPTION OF SERVICES: **Farmers Pride** is a market platform which allows access to quality inputs, reliable information and finance for smallholder farmers. It offers improved market linkages by connecting farmers to quality input and credible service providers. The platform informs and links farmers to services like livestock and crop insurance, animal identification solutions, disease monitoring and reporting techniques.

3.4.2 Off-take market integration

DESCRIPTION

As for input market integration, there are various services that aim to improve market access of smallholders and pastoralists in rural areas to sell their livestock products. Agricultural e-marketplaces are market linkage solutions that require little or no human intermediation and that bring individual buyers and sellers together via virtual trading marketplaces. E-commerce services include online retailers selling aggregated agricultural products to consumers. These systems offer not only a market opportunity for ASFs, like meat, eggs and dairy products, but also a more efficient distribution of manure from local animal to local crop farmers. Improved market access enhances opportunities for income generation, increasing resilience against climate change and contributing to food security.

Platforms create value by facilitating exchange between two or more interdependent groups, such as producers and potential aggregators, processing companies, retailers and end customers. Many service providers of e-sourcing platforms take over the logistics along the supply chain, facilitate payments and organize delivery.

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **OFF-TAKE MARKET INTEGRATION**

Agro Market Day → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provision of a virtual marketplace	All agricultural value chains	• Farmers • Cooperatives • Agrodealers • Agroindustry	• Web application • Video	Uganda

DESCRIPTION OF SERVICES: **Agro Market Day** is an online marketplace for inputs, produce and living animals. Buyers and producers can register to trade via the platform. It also provides online courses and contacts to technical assistants, especially for aquaculture. It also provides information about market prices in local markets and information about disease outbreaks.

eMilk → SHOWCASE 13 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Dairy cooperative management software	Dairy	• Cooperatives • Agroindustry	• Mobile application • Web application • SMS	Kenya

DESCRIPTION OF SERVICES: **E-Milk** integrates a cloud-based dairy management system that aids dairy cooperatives to fully automate their management.

Herdy Fresh → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Connecting farmers with urban customers	Focus on Livestock, fish and seafood	• Farmers • Consumers	• Mobile application • Web application	Kenya

DESCRIPTION OF SERVICES: **Herdy Fresh** is sourcing meat and fish directly from local farmers and delivering the products to customers in Nairobi, Kenya. Local farmers can get their products verified to become suppliers and can slaughter animals only when meat is ordered. By shortening transportation time and distance, infrastructure costs are reduced.

Hlibna

→ SHOWCASE 14

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provide a management system for Délice-Danone as well as information services for dairy farmers	Dairy	• Farmers • Agroindustry • Veterinary agencies	• Mobile application • Web application • SMS	Tunisia

DESCRIPTION OF SERVICES: **Hlibna** is management system that provides Délice-Danone with comprehensive data about their producers and the milk volumes delivered, while offering tools to smallholder farmers to support their farm management and animal health care.

Livestock247

→ Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Connecting pastoralists and buyers	Livestock	• Pastoralists • Agroindustry	• Mobile application • Social Media • Call center	Nigeria

DESCRIPTION OF SERVICES: **Livestock247** is a livestock market platform integrating offtake and input markets to create transparency in livestock trade between producers and processors. It also delivers market information and offers a forum on knowledge exchange concerning livestock. It aims to mitigate the dissemination of zoonotic diseases through the provision of fit-for-slaughter and traceable livestock to customers.

M-Farm

→ Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Connecting farmers and buyers	Grains and vegetables, livestock	• Farmers • Consumers	• Web application • Social Media	Kenya

DESCRIPTION OF SERVICES: **M-Farm** is an online marketplace for farming produce connecting farmers and consumers directly. Moreover, the platform provides current market price information and aims to provide farming support in the future.

Mifugo Trade

→ Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Connecting livestock farmers and customers	Cattle	• Farmers • Agroindustry	Web application	Kenya

DESCRIPTION OF SERVICES: **Mifugo Trade** digitizes livestock trade for pastoralists in order to avoid middlemen. The platform is an online livestock exchange that directly connects livestock farmers and buyers. The start-up uses a network of trained agents equipped with smartphones who visit livestock sellers, evaluate animals, and upload relevant sales information to the platform. Buyers can then bid for animals online. Mifugo Trade is planning to integrate a range of payment solutions – such as mobile money payments, escrow options and invoice discounting – to facilitate payments and cut out cash transactions.

Selina Wamucii

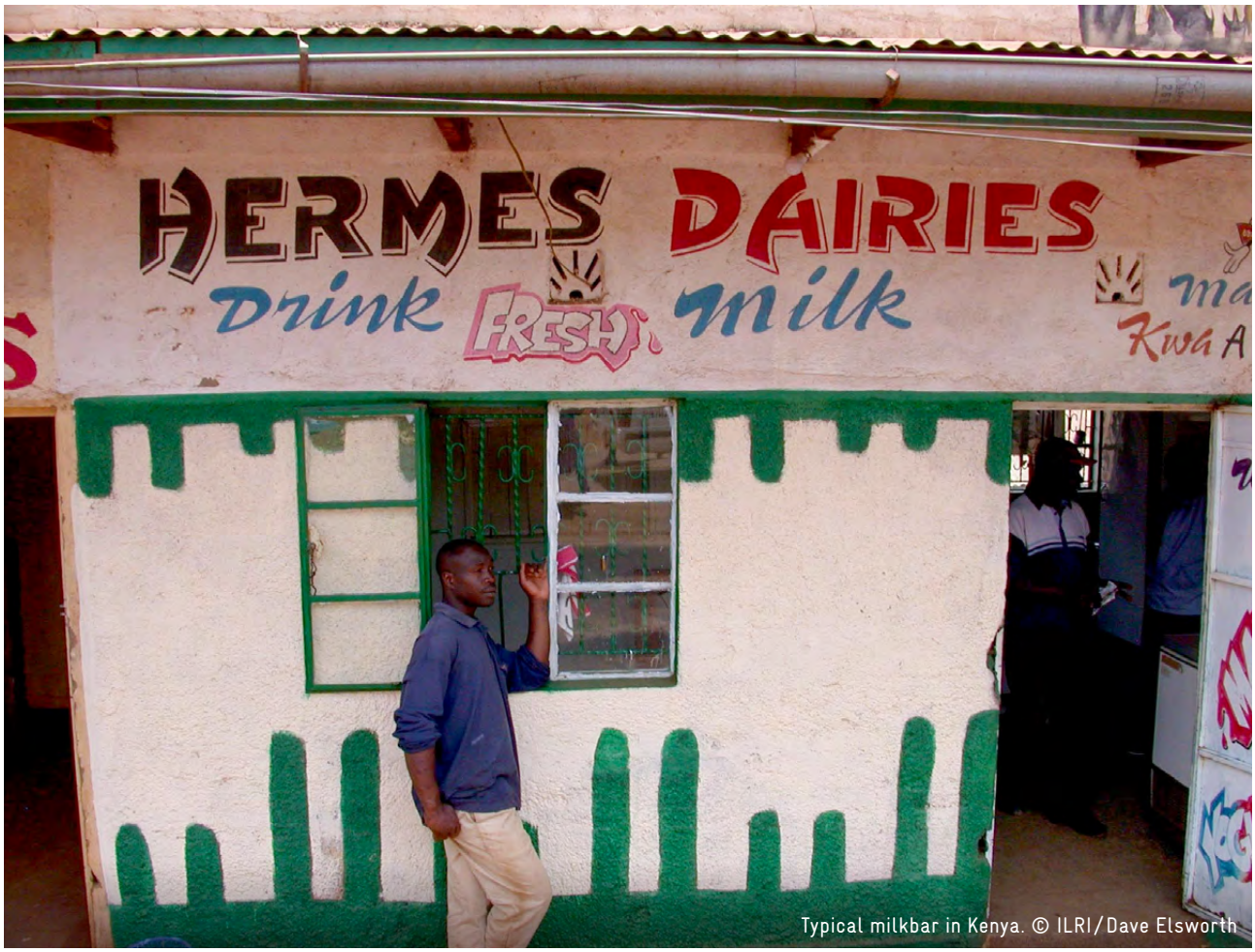
→ Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Connecting farmers and customers through a platform	All agricultural value chains	• Cooperatives • Agroindustry • Buyers	• Web application • Social Media	• All Africa • Focus on: South Africa, Morocco, Egypt, Ethiopia, Ghana, Ivory Coast, Kenya

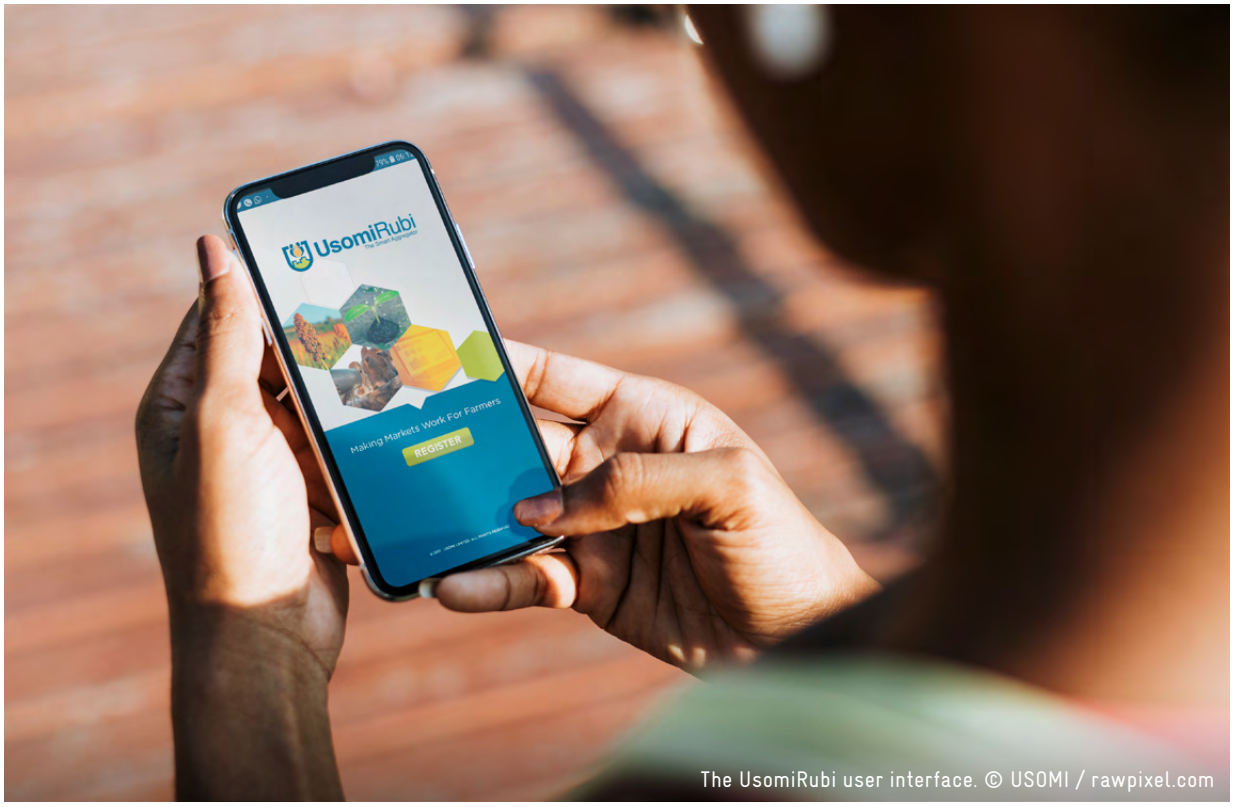
DESCRIPTION OF SERVICES: **Selina Wamucii** offers a platform where farmer groups and cooperatives can offer their produce. Customers from all over the world can access and buy the offered products. The marketplace is integrating smallholder farmers, pastoralists and fishing communities into local and global supply chains.

Sokoni				→ Website
OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Virtual marketplace with an option for upfront negotiation between pastoralists and traders	Livestock	• Pastoralists • Agroindustry • Buyers	Mobile Application	(Northern) Kenya
DESCRIPTION OF SERVICES: **Sokoni** is a livestock marketplace that directly links pastoralists and traders in order to avoid large price variations, unnecessary traveling of pastoralists and asymmetrical bargaining power. The app is still in the development phase.				

UsomiRubi	→ SHOWCASE 12			→ Website
OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Virtual aggregation platform for produce	• All agricultural value chains • Special focus on poultry	• Farmers • Agroindustry • Retailers	Mobile Application	Kenya, Nigeria, Tanzania
DESCRIPTION OF SERVICES: **UsomiRubi** is a platform that virtually aggregates produce from farmers across East Africa to help them access markets and receive better prices by benefiting from economies of scale. Purchase is through a bidding process which ensures that producers get the best prices available. Additionally, Rubi allows farmers to access service providers via its platform.				



Typical milkbar in Kenya. © ILRI/Dave Elsworth



The UsomiRubi user interface. © USOMI / rawpixel.com

SHOWCASE 12: UsomiRubi

The smart aggregator for farmers' produce

Interview partner: Dr. Denis Mujibi, CEO, USOMI Limited

What is the story behind UsomiRubi?

Dr. Denis Mujibi, a Kenyan animal scientist, has a long history in working with livestock farmers in Eastern Africa. At some point in his career, he realized that the scope of many projects which intend to promote sustainable livestock systems was not far-reaching enough. There was a strong focus on enhancing the uptake of best practices, but other important aspects of a successful livestock business, such as the provision of technical services and information on market access, were neglected. He observed initial joy over an increase in production quickly turn into frustration when livestock farmers did not manage to sell their products at a good price. "Farmers must be able to fill a truck to offer a volume large enough to attract formal buyers and to have some negotiating power", Dr. Mujibi explains. These observations together with the rapid diffusion of mobile phones in the region led to the development of UsomiRubi.

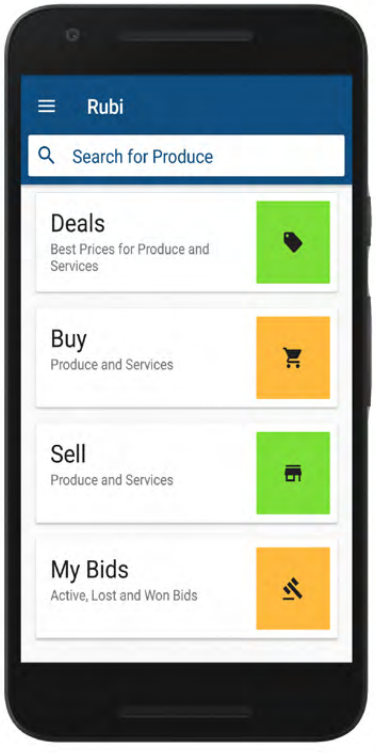
How does UsomiRubi work?

UsomiRubi is a platform that virtually aggregates produce from farmers across East Africa to help them access markets and receive better prices by benefiting from economies of scale. The platform is a product of USOMI Limited, an agritech company which was founded by Mr. Mujibi in 2013. Starting capital for USOMI included the desire to support smallholder farmers, a good idea and endless hours of work alongside a full-time job. In 2017, a beta-version of UsomiRubi was launched. It is available as a Web, Android and USSD version.

To link smallholder farmers to the market, USOMI creates a market system of digital elements, physical infrastructure and ground staff. If a farmer wants to sell a commodity, he sends a request using text message (USSD) or a smartphone app. The system alerts one of

USOMI's village-based commodity specialists who is nearest to the farmer's location. The agent verifies the quality and quantity of the commodity and registers it on UsomiRubi if it complies with pre-defined quality parameters. If a buyer is found, the farmer gets a message to transport the commodity to an USOMI-managed aggregation point. Sellers and buyers usually do not meet.

The use of UsomiRubi can be combined with UsomiLulu, another USOMI product, which intends to improve the production side of a farm business. UsomiLulu is a digital DSSplatform for precision farming. A registered farmer can record production data to receive real-time feedback on how well she or he is doing in comparison to expected production parameters. Through timely alerts, farmers can apply corrective measures before diseases, pests and poor management practices affect their farms. This includes weather forecasts and satellite-based soil profiling.



The UsomiRubi user interface. © UsomiRubi

Today, USOMI has 30 employees, including 3 in-house developers, and works with 40 external commodity specialists.

What is the business model behind UsomiRubi?

UsomiRubi is currently available on a non-commercial basis. The app is still "in the learning phase" and new functionalities are permanently added. The idea is that USOMI obtains a margin from the purchase and sales price as its main income source, while the company takes liability for quality control and provision of volume. For participating farmers, USOMI provides information services and training, organizes aggregation and sale, and negotiates better input prices and loan conditions. The company is planning to run its own aggregation centres. "One of our main hurdles for setting-up the market system is the difficulty in accessing finance", Mr. Mujibi states. "Development needs resources, and without appropriate finance, development is put at risk". Today, about 2000 farmers are using the USOMI platforms. Before the SARS-CoV-2 pandemic, the company had a growth target of 10,000 farmers by 2021 – which will now have to be revaluated. USOMI offers its services in Kenya, Tanzania and Nigeria. Moreover, there are plans to launch UsomiLulu in Malawi, Rwanda and Uganda.

> "Development needs resources, and without appropriate finance, development is put at risk".
>
> Dr. Denis Mujibi,
> CEO, USOMI Limited

Take-away message

Mr. Mujibi believes that precision farming will become very important in Africa for improving management of scarce resources in a changing climate. He illustrates his ideas by using pastoralists as an example. "In Kenya, pastoralists face a chronic shortage of forage. ICT will help to manage these resources more sustainably through various precision farming techniques. This will be an important step towards mitigating pastoralists' conflicts over grazing land".

Registering milk sales on the eMilk app. © GIZ

SHOWCASE 13: eMilk

A dairy cooperative management system

Interview partners for eMilk: Levis Kimani, Operations Manager, Intersoft Eagles Systems Ltd; GIZ Zambia: Claudia Witkowski, Advisor, GIZ; Chimuka Nyangu Mulowa, Mwansa Mungela, Technical Advisors, GIZ; Chitongo Dairy Cooperative: Justin Ncube, Board Chairman; Precious Mwaka, Milk Receiver/Accounts Clerk

What is the story behind eMilk?

Levis Kimani spent his youth as a cattle farmer in the Nakuru region in Kenya. Later, he went on to study software development. When he decided to apply his new knowledge to improve the family's cattle business, he did not find appropriate software for herd management on the Kenyan market. There were only three software packages available from overseas – from the Netherlands, the US and Israel – which, albeit professional, were too expensive for a local cattle farmer. This experience led him to found his own software company, Intersoft Eagles Systems Limited, with the goal of developing digital applications for the Kenyan livestock sector. One of its first products was SmartCow, an app to track milk production and health of individual animals.

How does eMilk work?

Today, ten years later, the SmartCow app is a successful tool used by 8,500 livestock farmers. Moreover, the Intersoft Eagles team has grown and increased its product range. With a team of two directors, four developers and four agronomists, the company offers farm management solutions for cattle, goats, poultry and aquaculture as well as management and accounting software for processing centres. Additionally, they reach 3,000 crop farmers with 40,000 hectares of land with their crop management software.

A new product, eMilk, is a dairy cooperative management system which supports milk collection with digital scales and delivery records. The

Android app simplifies administration and accounting of delivered milk, connects to digital scales and mobile printers, functions offline as well as online, provides a farmer registry, and records all deliveries with origin, volumes, dates and time. eMilk is connected to a financial module which provides financial statements that can be submitted to banks as a proof of a farmer's creditworthiness.

eMilk is successfully used by 60 cooperatives in Kenya. In Zambia, as part of the Green Innovation Centre Zambia, GIZ is supporting the use of the system in two dairy cooperatives in the rural communities of Chitongo and Masopo. "We are very happy to have eMilk installed on our Notebook", says Justin Mcube, board chairman of the Chitongo cooperative. "It helps the cooperative to keep record of the milk production and facilitates payments", Ms. Precious Waka, milk receiver and accounts clerk, adds. "Our farmers receive timely information and verification on the delivered amounts of milk by SMS. Nearly everyone has a phone, and they charge it by solar panel or here at the cooperative".

To use the eMilk system, the cooperatives pay for SMS and Internet bundles in Zambia as well as a monthly fee to Intersoft Eagles Systems in Kenya. Exchange rate fluctuations and communication difficulties complicate the collaboration between the Zambian cooperatives and the Kenyan company. The establishment of a network of local service agents, which is a successful strategy in Kenya, has not yet been possible in Zambia due to the small number of customers. However, there is hope that more cooperatives in Zambia will switch to eMilk as the software is more modern than a commonly used dairy information management system, which cannot connect to digital scales and thus needs manual data entry that is time-consuming and prone to errors.

Take-away message

"Next to dairy", Mr. Levis Kimani says, "horticulture will become a very important sector for the development in Kenya within the next few years". Intersoft Eagles Systems is permanently developing new solutions by extending functionalities of existing apps and by developing customized solutions for bigger clients. According to Mr. Levis Kimani, Intersoft's success is based on its user-centred software development. Together with the commercial clients, the company is identifying their software needs. To provide solutions in a way that is easy to understand for farmers, half of the team members are experts in agriculture.

Chitongo milk collection centre. © GIZ

Milk collection. © ILRI/Susan MacMillan

SHOWCASE 14: Hlibna

Software solutions for the diary sector

Interview partners: Wassim Ben Ghodbane, Managing Director, SwibInfo; Abderamen Essaied, Manager of Logistics, Délice-Danone; Henda Hanafi, Office d'Élévage et des Paturages Tunisie

What is the story behind Hlibna?

In Tunisia, about 2–3 % of the population are engaged in dairy farming. Délice-Danone is covering 65 % of the Tunisian market of milk processing, and 65,000 farmers with around 200,000 cows are producing for the company. At some point, the company needed a software to manage and track its growing number of suppliers. Délice-Danone selected a software company – which had no previous experience in the sector – to develop Hlibna. Nevertheless, the close collaboration between the software developers and the client, together with many sprints and the team's interest in agriculture, resulted in the development of a product that is well adapted to the agricultural reality of smallholder farmers. The management system **Hlibna provides Délice-Danone with comprehensive data about their producers and the milk volumes delivered, while offering tools to smallholder farmers to support their farm management and animal health care.**

How does Hlibna work?

"The Android application today allows registration of the farmers and group registration of their cows", Mr. Wassim Ben Ghodbane, managing director of SwibInfo / Tunis, explains. Mr. Abderamen Essaied, logistics manager at Délice-Danone, adds: "Six Délice-Danone agents are equipped with tablets, and through the application they now can digitize all information during their veterinary visits on-site. This information is centrally stored in a cloud-based database and the Délice-Danone administration team can directly access this data through a dashboard and through reports".

The "one-point data collection" helps to reduce work and at the same time increases data quality. Data is available for decision makers in a timely manner. But the system Hlibna is not yet connected with the milk collection centres. The need for integration is evident – at the moment, data on milk volumes sold is collected twice: first at the collection centres and again through the Délice-Danone agents. Thus, a new version is under development which will also allow to send custom-tailored information to farmers.

Asked for development trends in the coming years, Mr. Abderamen Essaied says: "The Tunisian youth nowadays is online and uses social networks whenever possible. In the next years, even the most remote areas will receive a sufficient network coverage, and smartphone penetration will definitely reach a ratio comparable to Europe. Africa, in general, is the emerging continent and its strength comes from labour and technology adoption. At the moment, Hlibna is reaching 2,000 out of the 65,000 cattle farmers, but this number will rapidly grow".

> "The Tunisian youth nowadays is online and uses social networks whenever possible. In the next years, even the most remote areas will receive a sufficient network coverage, and smartphone penetration will definitely reach a ratio comparable to Europe".
>
> Abderamen Essaied,
> Manager of Logistics, Délice-Danone

3.5 Supply chain management

3.5.1 Aggregation and logistics

DESCRIPTION

Digital applications can support the aggregation of perishable livestock produce to improve efficiency and transparency in the value chain. The solutions may cover various parts of the supply chain and offer opportunities for all actors. For example, farmers can profit from improved transparency if an application captures weight data of milk at the farm to ensure that the amount produced is remunerated despite of losses during transportation. Thereby, the connection between farmers and processors is strengthened and fraud reduced. Other solutions aim for a better cold chain and storage, thus reducing food losses and transport costs. Logistic management solutions to manage physical storage, stocks and transport infrastructure allow for operational improvements, efficiency gains and the surveillance of the cold chain. Climate friendly technologies, such as solar panels, can generate energy for cooling facilities in remote areas. Their management can be facilitated by digital solutions, e.g. cloud-based monitoring systems of cooling houses and mobile payments for storing produce.

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **AGGREGATION AND LOGISTICS**

AgriManagr → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
To determine, measure and track the true value of produce	• Livestock • Focus on dairy production	Farmer	Mobile application	Kenya

DESCRIPTION OF SERVICES: **AgriManagr** of Virtualcity helps to organise the collection of milk and increase transparency within a value chain. The procurement process is digitalised by capturing the weight of milk collected in real time at the farm. The produce is also tracked during transport. Thereby, leakage and fraud are avoided, the integration of the value chain is fostered, and quality standards are secured. Farmers receive payments via the mobile payment system M-Pesa.

Inspira Farms → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Provision of pre-cooling and cold chain solutions	• All agricultural value chains • Specific focus on dairy products	Farmer Agribusiness	• Remote Sensing • Web application	Worldwide Rwanda, Kenya

DESCRIPTION OF SERVICES: **Inspira Farms** offers energy-efficient and solar-powered cold rooms and storage solutions for agribusinesses to reduce food waste and create sustainable off-grid storage solutions. Cold rooms can be remotely monitored and steered via a cloud-based application. The company also offers financing solutions for infrastructure investments and developed a pay-as-you-chill model which allows payments by volume stored.

WeightCAPTURE → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
To manage purchases of goods that can be weighed	All agricultural value chains	• Farmer • Buyers • Retailers	• Mobile application • Web Application • SMS	Kenya

DESCRIPTION OF SERVICES: **WeightCAPTURE** combines technologies for temper-proof digital weighing of dairy and other produce with a software that monitors the progress of agricultural products across value chains with digital tracking at key hand-off points. The hardware offered is comprised of a scale, mobile phones, a Bluetooth connector and printer. WeightCAPTURE also provides a supplier management tool and access to credit and insurance.

3.5.2 ERP, traceability and certification systems

DESCRIPTION

Supply chain management systems are designed for agribusiness to make it more convenient, safe, efficient, and profitable to interact with smallholder farmers. These applications assist agribusinesses in managing their off-take or input purchasing relationships with smallholder farmers and integrate new farmers into their value chains. Small-scale farmers thus profit from enhanced inclusion in supply chains. Information management and transparency along the supply chain is crucial to ensure food safety and combat counterfeits as food chains increasingly become complex. ERP Systems are integrated packages of digital services including operational analytics, value chain intelligence, and tools for interacting with smallholder farmers and agent field forces to improve efficiency along the value chain.

Traceability solutions, often integrated in supply chain management systems, use digital technologies such as aerial surveillance, sensors, barcoding, digital scales and blockchain to trace the produce from farm to fork, enhancing transparency for consumers, ensuring quality and offering opportunities for farmers. By tracking and recording information about the origin and the quality of their produce, smallholder farmers in Africa can distinguish their products, add value and gain access to additional (higher value) markets, both at the national and international level. For livestock, traceability of particular animals can be helpful for improved breeding as well as for herd and farm management. Traceability is also crucial for the reliable certification of products based on particular standards. Participating in certification schemes enables small-scale farmers to access new markets with higher prices and potentially generate higher incomes. Some supply chain management solutions offer templates for certification schemes, thus facilitating compliance with requirements and simplifying the certification process.

SHORT PROFILES OF DIGITAL APPLICATIONS IN THE FIELD OF **ERP, TRACEABILITY AND CERTIFICATION SYSTEMS**

Animal Traceability Solutions (ATS) → SHOWCASE 16 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Animal Traceability	Livestock	• Agribusinesses • Veterinary service providers • Governments	Web application	Eastern Europe, Africa, Caribbean

DESCRIPTION OF SERVICES: **ATS** is a platform for professionals working on planning, preparation and operation of animal identification and traceability systems. Dedicated partners are guided to implement an Animal Identification and Traceability (AIT) system tailored to the needs of a specific region or country.

eProd → SHOWCASE 15 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
To address the supply chain management needs and challenges of agribusinesses	All agricultural value chains	• Farmer cooperatives • Extension officers • Food-processors • Exporters	• Mobile application • GPS • SMS	Mali, Burkina Faso, Nigeria, Ghana, Guinea, Uganda, Kenya, Ethiopia, Tanzania, Malawi

DESCRIPTION OF SERVICES: **eProd** is an Enterprise-Resource-Planning (ERP) System designed for aggregators and food-processors to manage a large number of small-scale suppliers. At the same time, it enables farmers to respond to the requirements of demanding markets. It also allows for quality-based payments for dairy, as quality checking technologies are integrated in the system. Further functions are the traceability of produce as well as the management of aggregation and logistic services.

iProcure → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
To re-invent distribution for rural Africa	All agricultural value chains	Agribusiness	• Mobile application • GPS	Kenya

DESCRIPTION OF SERVICES: **iProcure** combines digital logistics surveillance, analytics, and supply chain management tools with a physical network of agri-input agents and warehouses that help agribusinesses aggregate and optimize smallholder input supply chains. It provides last-mile distribution services, business intelligence and data-driven stock management that ensures warehouse supply in rural areas.

Metajua → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Supply chain software for agri-product sourcing	All agricultural value chains	• Farmers • Farmer cooperatives • Agribusinesses • Buyers	• Mobile application • Web application	Tanzania, Uganda, Rwanda, Burundi, Congo

DESCRIPTION OF SERVICES: **Metajua** provides a modular solution with the aim of covering all data flow needs for organizations buying agriculture products from and interacting with smallholder farmers. It collects farm data, and analyses and displays detailed farm information. The system also enables monitoring of procurement, transport, stocking, and storage to ensure quality along the supply chain.

Namibian Livestock Identification and Traceability System (NamLITS) → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Assist producers to comply with livestock identification, traceability and marketing requirements in Namibia	Livestock	• Famers • Government	RFID	Namibia

DESCRIPTION OF SERVICES: **NamLITS** is a state-led database and movement traceability system for permits and health and disease surveillance. Livestock Identification and Traceability Systems (LITS) can enhance livestock husbandry and trade through improved surveillance, management of infectious diseases, and control of livestock movement.

SAP Rural Sourcing Management Platform → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
To build a sustainable and traceable agriculture supply chain	All agricultural value chains	Agribusinesses	• Mobile application • Web application	Worldwide

DESCRIPTION OF SERVICES: **SAP®** Rural Sourcing connects smallholder farmers to the agriculture supply chain and offers full transparency into the source of raw materials. It enables a better management of data through digitally recorded information on producers, their farms, and their communities at every level of the value chain.

Explaining eProd to customers. © eProd Solutions Ltd.

SHOWCASE 15: eProd

A software system, not a software

Interview partner: Jan Willem van Casteren, Director, eProd Solutions Ltd.

What is the story behind eProd?

In 2004, Jan Willem and Almut van Casteren founded the inclusive business Equator Kenya Ltd. They needed a software to manage the data of the large number of smallholder farmers who were selling African Bird's Eye chilis and paprika for the Oleoresin market to their company. To be allowed to export the products to overseas markets, full traceability was required. They decided to develop the necessary software themselves by contracting developers, a procedure which finally resulted in an innovative software product that was fully adopted to the needs of Equator Kenya Ltd. Today, the software manages the data of 8,000 smallholders contracted by the company. They are organized in 350 groups, receive loans, input and training, and supply their produce to the company.

How does eProd work?

Seeing the benefit of the software for their business, Jan Willem and Almut van Casteren decided to commercialize it. In 2014, eProd was piloted successfully for various sectors and business models. **Today, it offers functionalities for contracting, traceability, communication, mobile payments as well as access to loans. Moreover, eProd offers various specific solutions such as yield forecasting models, credit rating, soil testing, reporting, analytics and quality-based payments for milk collection (including sensor technology for quality control).** eProd collects information about fields, farmers, cooperatives, traders, as well as NGOs and allows all kinds of hierarchical combinations. For donors and NGOs, eProd offers a monitoring dashboard where data can be analysed and charted.

eProd is an off-the-shelf product, which can be deployed by configurations (rather than requiring customizations) and be fully operational for the client within five days. It offers numerous application programming interfaces which allow its flexible configuration, integration and extension for various purposes and value chains.

The software is available in a cloud version and a desktop / LAN solution that can function perfectly offline for areas with very poor internet. The mobile app is developed for Android, also functions offline and synchronizes with the central database when internet is available. The cloud version allows global access via the World Wide Web.

> "Quality based payments will be the future in many value chains".
>
> Jan Willem van Casteren, Director, eProd Solutions Ltd.

What is the business model behind eProd?

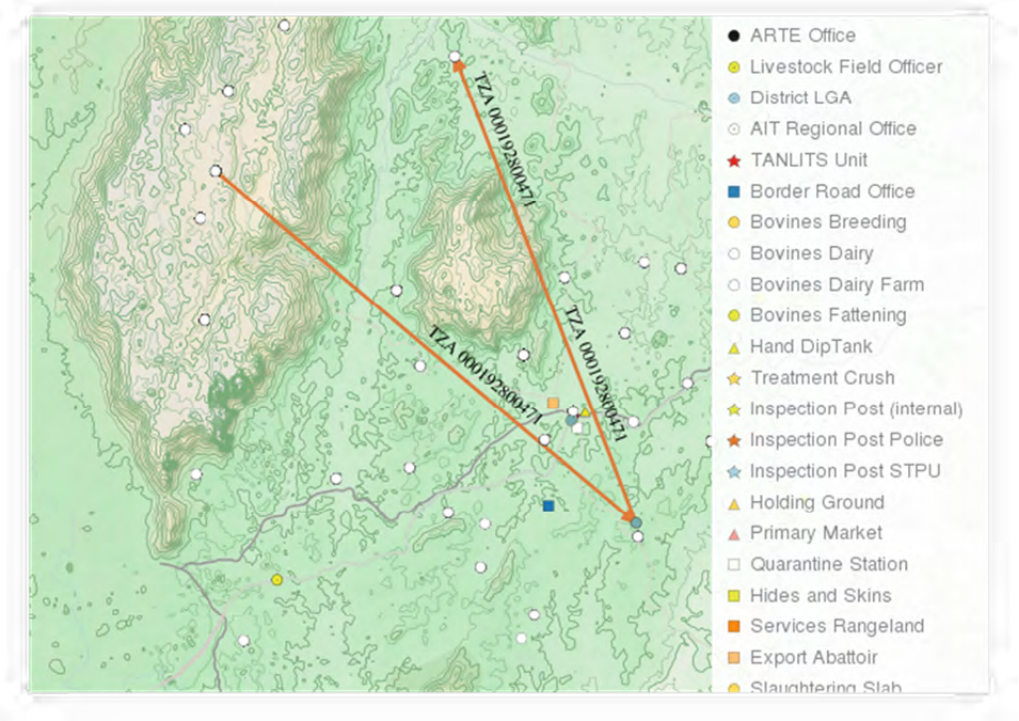
Since March 2015, eProd is commercially available through the Kenyan based company eProd Solutions Ltd. The Kenyan company has subsidiary companies in Tanzania and in Uganda as well as an agency network across Africa. The software is used by 75 clients in 12 developing countries and reaches over 250,000 smallholders, active in over 20 different value chains, including dairy, apiculture, fishpond farming, grains, pulses, oil crops, nuts, coffee and horticulture. Moreover, it would be a small step to make the software usable for other livestock value chains. It is available in nine different languages and more can easily be added.

According to Jan Willem Van Casteren, the success of eProd lies in the fact that it was designed as an integral part of a contract farming scheme, and over the years, the needs of all parties were considered and incorporated into the software. The software not only is flexible and configurable, but it also offers programming interfaces for its integration with other systems, such as financial accountability software or ERP for the food processing industry.

eProd is successfully working fully commercial but offers various pricing models to make the software affordable for different client groups. An interesting model is a lifetime license where the annual subscription fee is tripled for the first year, while for all following years only 20 % of the usual annual fee has to be paid. This model is particularly interesting for donor-financed launches of the software. eProd is also working on a Freemium-model, where basic services are offered for free while additional functionalities have to be paid. eProd is scaling the approach through strategic partnerships with development organizations, private partners and the financial sector. The company is an Africa Enterprise Challenge Fund grantee and collaborates with various development organizations (e.g. DAI, RTI, GIZ) and commercial technical partners (e.g. aWhere, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Wageningen University and Research Center).

Take-away message

"Quality based payments will be the future in many value chains", Mr. Van Casteren believes. He highlights the quality-based milk payment system of eProd, which allows fair and transparent automated price adjustments through integrations with sensor technology. "eProd is ideal to promote a market systems development approach. The quality issues are recorded and appear on the payment overview or in an SMS message from the buyer to the producer", he says. "The system which eProd developed is based on near-infrared spectroscopy and requires only 2–3 seconds to complete its measurements. The sensor is a mobile battery-powered device which seamlessly integrates with the eProd environment".



Map showing animal movements. © ADT Project Consulting GmbH & Dr. Karb GmbH

SHOWCASE 16: Animal Traceability Solutions (ATS) platform

A web portal for guided implementation of animal identification and traceability systems

Interview partner: Dr. Karb, Founder, Dr. Karb GmbH

What is the story behind the ATS platform?

For almost twenty years, the company Dr. Karb Consulting, in cooperation with ADT Project Consulting GmbH, has offered expertise in implementing technical assistance projects related to animal identification and traceability (AIT), animal disease control and capacity building in veterinary and livestock services. The companies develop traceability systems for livestock and veterinary information systems in countries in Eastern Europe, Africa and the Caribbean and for clients such as the EU, FAO, USAID and the Inter-American Development Bank (IADB). Since 2014, Dr. Karb Consulting and ADT Project Consulting have provided the Animal Traceability Solutions (ATS) platform for professionals working on planning, preparation and operation of AIT systems.

How does the ATS platform work?

The ATS platform was developed between 2011 – 2014 and offers a knowledge base in addition to modules based on open-source software (PostgreSQL database, WildFly server, GeoServer, OpenLayers). The platform is implemented as a web portal and is intended to foster international co-operation in this field. **Dedicated partners are guided in implementing an AIT system tailored to the needs of a specific region or country.** They can use content of the platform for free, which is a great opportunity for sustainability in the development context. Dr. Karb Consulting does not offer maintenance contracts for the ATS software; however, it does offer consulting services for the design and implementation of AIS systems. Today, the ATS platform is the basis of national ATS in several countries such as

Tanzania (10,000 animals registered), Jamaica (30,000 animals registered), Ethiopia and Surinam. Other ATS are installed in Balkan countries.

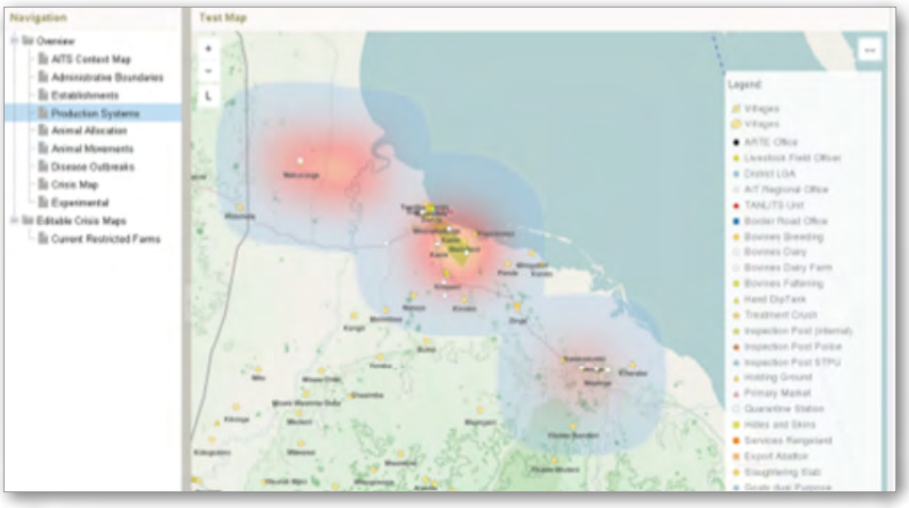
"Animal traceability systems do not yet have a high priority in Africa", Dr. Karb says. "One major obstacle for their development is the difficulty in getting all relevant stakeholders at the table. Frequently, data ownership is unclear, as are the roles and responsibilities of stakeholders. The IT infrastructure in a target country is often a bottleneck for the operationalization of the system, and the acquisition of IT materials can be an additional hurdle. International organisations, such as African Union Inter-African Bureau for Animal Resources, World Organization for Animal Health (OIE) and FAO, are increasing their activities in this field by providing funding for traceability-related projects". Awareness raising on the importance of traceability is a crucial element for the success of AIS development projects. Moreover, technology and capacity transfer to the client are an integral part of the service packages that Dr. Karb Consulting provides.

Take-away message

Dr. Karb believes that platforms for animal registration will become more and more available in Africa within the next ten years, though group identification might frequently be sufficient as a first step. The registration of individual animals might not yet be possible in many African countries since the necessary technology step is a great challenge.

"Platforms for animal registration will become more and more available in Africa within the next ten years, though group identification might frequently be suficient as a first step".

Dr. Karb, Founder, Dr. Karb GmbH



Heat map showing density of livestock © ADT Project Consulting GmbH & Dr. Karb GmbH

3.6 Macro agricultural intelligence

DESCRIPTION

Macro agricultural intelligence solutions include data analytics and digital support system tools that integrate a variety of data sources on farms, livestock, markets or environmental conditions and convert this information into useful country- and value-chain-level insights and decision tools for governments, extension agencies, agronomists, agribusinesses and investors. Tools include, for example, data analytics and monitoring platforms as well as surveillance and forecasting tools, typically focused on animal health, weather or food security.

Livestock keeper in Somalialand, Somalia. © GIZ

SHORT PROFILES OF APPLICATIONS IN THE FIELD OF **CENSUS, REGISTRATION OF ANIMALS AND ANIMAL ESTABLISHMENTS**

Animal Resources Information System (ARIS)

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Information system and surveillance of animal resources data	Livestock	• Veterinary agencies • Government	Web application	Worldwide

DESCRIPTION OF SERVICES: **ARIS** is an information system for storing and analysing livestock data to contribute efficiently to the surveillance and decision-making activities at continental, regional and national level.

Daral → SHOWCASE 17 → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
To offer an identification and alert system to improve farming	Livestock	• Veterinary agencies • Government	• Mobile application • Web application	Senegal

DESCRIPTION OF SERVICES: **Daral** is a Livestock Identification and Traceability System composed of a mobile platform and a web application connected to centralized database. It aims to facilitate an SMS-based, two-way exchange of data between farmers and veterinary and law enforcement agencies.

SHORT PROFILES OF APPLICATIONS IN THE FIELD OF **DISEASE MONITORING, FORECASTING AND WARNING; DISASTER RESPONSE**

Event Mobile Application (EMA-i) → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
• Monitoring of animal diseases • Early Warning and Response System	Livestock	• Veterinary agencies • Government	Web application	Worldwide

DESCRIPTION OF SERVICES: **EMA-i** facilitates the collection of geo-referenced animal disease information from the field. Data is stored offline and ready to be send whenever a network is available. Disease events are then transmitted in real-time to the national platform created in the EMPRES-i database environment, where data is safely stored and can be verified, edited, and validated by local users.

Global Animal Disease Information System (EMPRES-i) → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
Emergency Prevention	Livestock	• Veterinary agencies • Government	Web application	Worldwide

DESCRIPTION OF SERVICES: **EMPRES-i** is a web-based application that has been designed by FAO's Emergency Prevention System (EMPRES) to support veterinary services by facilitating the organization and access to national, regional and global level disease data and information.

Global Early Warning System for Major Animal Diseases, including Zoonoses (GLEWS) → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
To provide an early warning system for health threats and emerging risks at the human-animal-ecosystem interface	Livestock	• Veterinary agencies • Government	Web application	Worldwide

DESCRIPTION OF SERVICES: The overall objective of **GLEWS** is to improve data sharing and risk assessment for animal disease threats for the benefit of the international community.

SILAB for Africa → Website

OBJECTIVE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
To support laboratory diagnostic activities.	Livestock	Veterinary laboratories	Web application	Ethiopia, Uganda, Kenya, Tanzania, Zimbabwe, Botswana, Zambia, Namibia, Cameroon, Mozambique, Nigeria, Senegal, Côte d'Ivoire

DESCRIPTION OF SERVICES: **SILAB for Africa** is a laboratory information management system which increases standardization of laboratory diagnostic processes and sample tracking in several African national veterinary laboratories. It has been adapted to African veterinary laboratories settings and allows for data interoperability, test standardization and harmonization.

UNOSAT Mapping → Website

MAIN PURPOSE	TARGET VALUE CHAIN	TARGET GROUP	TECHNOLOGY	COUNTRY WHERE SERVICE IS OFFERED
High quality map and geospatial data production	Livestock	• Pastoralists • Livestock traders • Interested stakeholders	Remote sensing	Worldwide

DESCRIPTION OF SERVICES: **UNOSAT Mapping** provides and analyses geospatial data. It provides geospatial support to the UN system and other organizations in the areas of disaster response, humanitarian operations, human security and the application of international humanitarian law and human rights.

SHOWCASE 17: Daral

A livestock database for Senegal

Interview partner: Amadou Sow, Founder and Director, Daral Technologies

What is the story behind Daral?

Like many young Africans who grow up in rural areas, Amadou Sow is not only a farmer but pursues other activities as well. Early in 2006, as a farmer with a few cattle, he started a training course to become a computer specialist. During his training, he came across an article that praised the potential of ICT for agriculture. It sparked his interest in using modern technologies to solve age-old problems of livestock keeping in Senegal – some of which are still present today. These include livestock diseases and theft, which both threaten livestock keepers' existence and frequently result in deadly conflicts between neighbouring communities. A few years ago, tracking of livestock was virtually impossible in Senegal; thus it was difficult to establish a database on livestock to monitor the sector.

Mr. Sow finalized his studies and began to search for partners to develop his ideas. He founded the company Daral Technologies (Daral is the Wolof word for 'cattle market') with the vision of establishing an IT system that would enable coherent data collection and provide reliable statistics essential for government decision makers to promote sustainable livestock sector development.

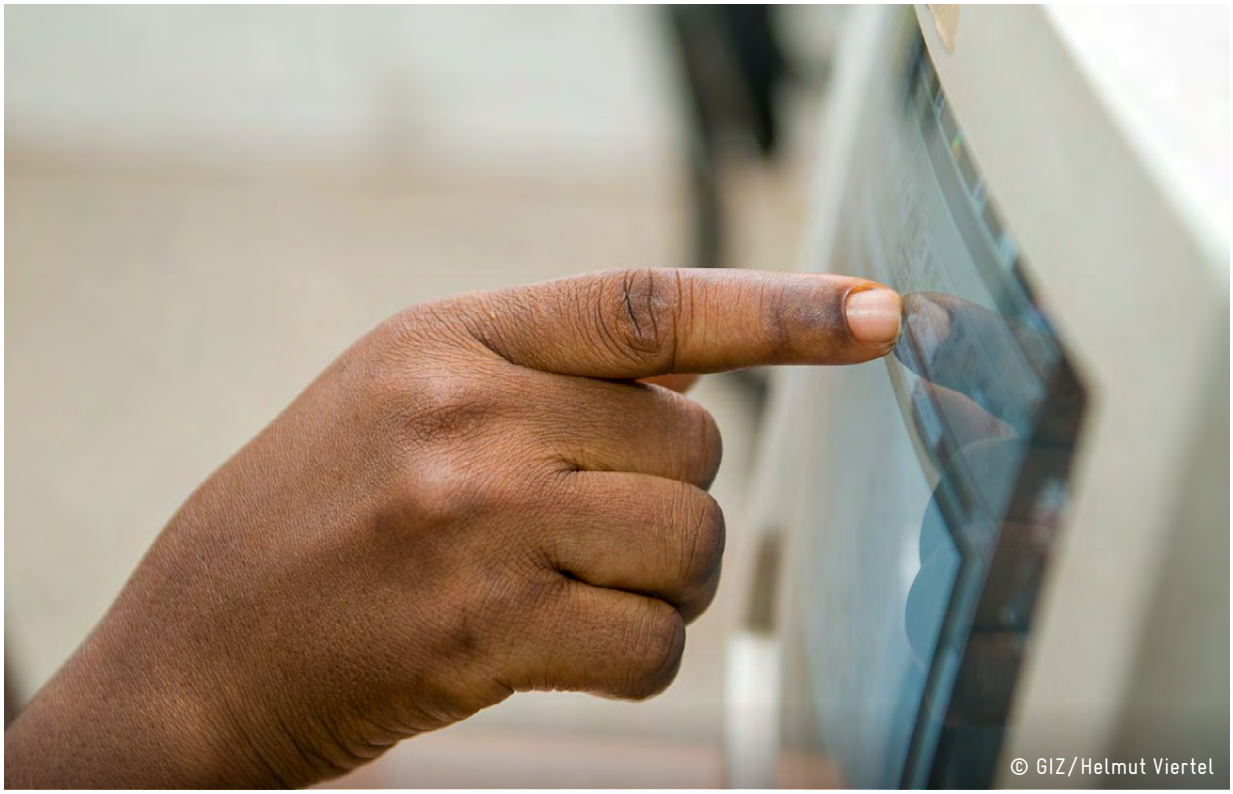
How does Daral work?

Today, Mr. Sow, founder and manager at Daral Technologies, has put his vision into practice. **Daral houses a national database of cattle farmers including livestock census data; it is the most comprehensive data file of cattle farmers in Senegal.** The database has been developed step by step in co-operation with national veterinary authorities. A nose-ring-based

animal identification system aims to provide full identification and traceability of cattle. The system allows a continuous two-way exchange of data between farmers and veterinary and law enforcement agencies. Moreover, Daral provides tools for sending alerts to farmers via SMS about weather events, bush fires and animal diseases. A media library provides videos on best practices in livestock management. Daral is used by 6,200 cattle farmers, and a team of 40 people is permanently working on improving the system.

On the way to this success, Amadou Sow found help from various sides: Daral won the Senegalese Livestock Ministry's competition on social impact solutions; it was also among the winners of the 2013 Kenyan AgriHack; and it received support in the form of IT equipment from Microsoft Foundation. The development of the first version of the database did not take longer than four months, but it was and still is a challenge to scale it up to have a fully operational national livestock inventory. The difficulty is finding financing for further development and expansion of the system and convincing the various stakeholders of the need and benefits for using new technologies. Daral Technologies participates in the **Digital Innovation Accelerator** Programme of the GIZ Innovation Factory, where the team receives support to further develop the company's strategy, to refine its marketing approach and to improve its investment readiness.

> "The difficulty is finding financing for further development and expansion of the system and convincing the various stakeholders of the need and benefits of using new technologies".
>
> Amadou Sow, Founder and Director, Daral Technologies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SHOWCASE 18: Animal Traceability Solutions

The evolution of animal traceability solutions

Interview partner: Dr. Ferdinand Schmitt, former Managing Director, ADT Project Consulting GmbH

What is the story behind animal traceability solutions?

The development of a national livestock sector requires interconnected information systems at the farm and the national level and across stakeholders in the value chain. However, it is difficult to transfer an information system from one country to another. As much as livestock systems and value chains differ, so do infrastructure, information needs of value chain actors and their capacities to manage information systems. The outbreak of the Bovine spongiform encephalopathy (BSE), also known as "mad cow disease", in Europe in the 90s, was an event that triggered the development of AIT systems in Europe. During this time, the German ADT Project Consulting GmbH and Dr. Karb Consulting decided to join forces and combine their expertise in promoting sustainable livestock sector development and IT to develop AIT systems (see Showcase 16). Over time, the demand from countries shifted from "simple" AIT systems to more complex agro-information systems that were able to integrate data on farms and on animals as well as their health status and production records. To not have to develop a new system from scratch every time, the partners decided in 2011 to design a generic database system from which customized solutions for different purposes could be created. The partners defined technical requirements for an AIT system with the aim to build a platform, the **ATS platform, that is based on open source-software and applicable worldwide for any type of animal identification.** "The objective was to provide users with building blocks that can be assembled individually and change over time", Dr. Ferdinand Schmitt explains. "This way, we can offer a database that is dynamic and can be adapted to changes in the livestock sector", he adds.

What are current developments in Africa?

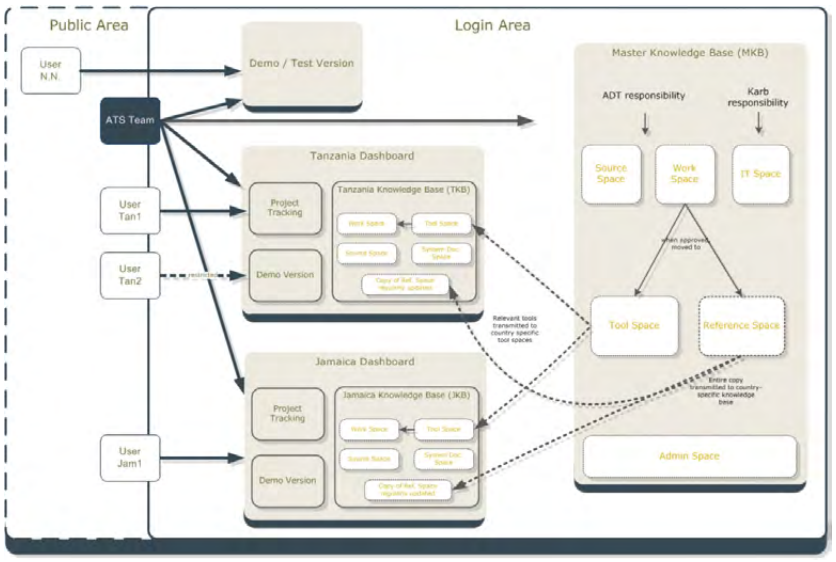
In Africa, the motivation of Governments to implement AIT systems differs. An important reason is the need to monitor animal health and the status of vaccinations to prevent the outbreak of infectious livestock diseases. They are also used to record yields and production volumes, to track animal theft and to provide information to the insurance sector. Dr. Schmitt believes that more and more African countries will build and implement online platform systems to strengthen the governance of in their livestock sectors. However, awareness raising and systematic investment by Governments and donors is needed to support this process. "Countries that produce for export markets, such Botswana and Namibia, have established AIT systems that have been verified by importing countries. Moreover, countries such as Tanzania, Uganda, Nigeria, Ethiopia, Egypt, Tunisia and Morocco are at an advanced stage in the development of national AIT systems".

Take-away message

However, the replacement of remote databases through online solutions also has risks. "Solutions that are build by actors of livestock values chains themselves are disappearing. Nowadays, the target group of such systems is often not involved anymore in the development of these information systems, and their needs are not always the main focus of a digital solution. The flow of data should not be one-way, from farmers towards large telecommunication firms, for example. To promote the development of a sustainable livestock sector, all actors of a livestock value chain should benefit from a national AIT system".

"Solutions that are built by actors of livestock values chains themselves are disappearing. Nowadays, the target group of such systems is often not involved anymore in the development of these information systems, and their needs are not always the main focus of a digital solution".

Dr. Ferdinand Schmitt, former Managing Director, ADT Project Consulting GmbH



Organisation of the ATS platform. © ADT Project Consulting GmbH

4. Accelerating sustainable livestock value chain development with ICT

4.1 Potentials of ICT use

BRIDGING THE DIGITAL DIVIDE

African smallholder farmers increasingly benefit from digital solutions for the livestock sector, even in the most remote areas. **Technological barriers are slowly being removed**, though it will still take time until the majority of livestock value chain actors will have access to modern ICT. **During this transition phase, farmers should be able to obtain information through various channels at different technology level.** The same feeding advice, for instance, can be made available through a smartphone app, through SMS push messages and the community radio. Smartphone technology will provide this information on demand and in a more custom-tailored manner, which provides an incentive to eventually switch to this more advanced technology. Until then, the providers of digital applications should consider the available infrastructure and the skills and abilities of their target group. As many of the examples in this report show, even complex applications can be offered for settings with unstable networks, for users who cannot afford expensive data packages and may have difficulties to read and write. The opportunity to use content offline, to receive information in local languages and in form of symbols and pictograms, and to access solar powered chargers for electronic equipment, are steps towards overcoming the digital divide .Moreover, by modernizing livestock value chains through the implementation of digital solutions, it is possible to attract young people, who generally have a greater affinity with technology, to this sector. There is at least one mobile phone available in most rural households.[15] Children and young adults can help their parents to read and understand messages and to operate devices. In addition to that, cooperatives have shown to be a good testing ground for new digital technologies. Lead farmers

and cooperative leaders are usually the first to use them and can act as multipliers.

INTRODUCING TRANSPARENCY AND TRUST

Sharing collected or produced information from a digital application with all involved stakeholders helps to increase transparency and to build trust. Livestock keepers understand the need for data collection better if they can benefit directly from the resulting added value. If procedures for milk quality measurement, for example, are transparent and comprehensible, livestock keepers are more likely to accept payment conditions (particularly price deductions in case of quality issues) and keener to reach the quality standards of the aggregator. Quality-based payments for products such as milk can be an incentive for farmers to improve management practices of cows and the handling of milk. By providing data access and reports (digitally or on paper) to farmers, they receive instruments to improve decision making processes on their farms.

CAPACITY BUILDING, KNOWLEDGE TRANSFER AND BEHAVIOURAL CHANGE

Through e-advisory services and e-learning, knowledge can be easily transferred to a large number of recipients. There exist many examples of e-advisory and e-learning services in Africa, but few are specifically for the livestock sector. From simple push-message based systems which target the individual farmer, to more sophisticated systems, which support veterinarians or lead farmers through smartphones, ICT can help to reach out to large and diverse target groups. Through visual representations such as photos, graphics and videos, complex relationships and phenomena can be made more easily understandable and identifiable. Uploading a new video to a well-known website can disseminate information to thousands of Internet users of a target group within a few days at relatively low cost. Digital information transfer cannot always replace face-to-face visits and practical exercises. However, **e-advisory and e-learning services are cost-efficient and effective tools to deliver information and knowledge, and they have the potential to reach even people in areas where conventional extension services are scarce or unavailable.** Moreover, incidents such as the current SARS-CoV-2 pandemic show how remotely given advice can be essential when personal contact is impossible.

Through gamification, the understanding of complex interactions of livestock keeping and the environment can be improved. Simulation games can help livestock keepers to better understand future implications of current decision making which can help to trigger behavioural change. **Gamification is a relatively new field in the digital learning space, one that deserves more attention since it can have a high impact at relatively low cost.**

MITIGATION OF CLIMATE-RELATED RISK

ICT can help to mitigate climate-related risks – either directly through early warning systems and localized weather forecasts, or indirectly through index-based insurances. Satellite-based weather observation, completed by local terrestrial weather stations and combined with topographical data, allows computer algorithms to deliver hyper-localized weather forecasts. Alerts can be made available to farmers via radio, SMS or apps. The costs of such systems are high, but they help to save lives and to protect resources and infrastructure. **Governments and donors should therefore not only operationalize such systems but also consider permanently supporting their financing as well as making them available to the poorest, since their overall benefits far outweigh their costs in the case of natural disasters.**

FINANCIAL INCLUSION AND MARKET ACCESS

If well designed, **digital applications can facilitate farmers' market access and financial inclusion.** If farmers receive tools to digitally keep record of production and sales volumes, or to document good payment behaviour, they can proof their creditworthiness which in turn can facilitate access to loans or the purchase of goods.

TRACEABILITY

The improvement of AIT is often a joint effort of members of livestock value chains, veterinary and food safety authorities, livestock and support services, as well as national, regional and global organizations. AIT allow the registration of individual (ear-tagged) animals or group of animals, track their movements between locations, and may even record events, applied measures and performance data. It helps to improve food security, animal

health, herd management and sector governance, to mitigate environmental degradation and pollution risks as well as to avoid animal theft. **Traceability is a high technical hurdle, but it can open the door to new markets.** It helps to comply with international standards and certifications, and the entry into new markets can boost incomes of livestock keepers and aggregators. AIT needs information technologies such as barcodes, scanners, RFID chips, servers and computer programs to become operational.

Hi-end technologies such as RFID and NFC chips, GPS and remote sensing, as well as AI and ML, help to collect and analyse data and to derive alerts and information that can be made available for livestock keepers through simple technologies such as radio, voice mail or SMS. Livestock keepers can receive hyper-localized weather alerts, pest warnings and recommendations on where to move their herds to find enough water and the best grazing grounds. In this way, livestock keepers can benefit from technologies that were previously inaccessible to them.

SET-UP OF EFFICIENT MANAGEMENT STRUCTURES FOR CONTRACT FARMING

In contract farming, ICT based tools should create advantages for all stakeholders along the value chain. Contract farming is a very fruitful environment for the introduction of ICT solutions as a lot of data has to be collected, information has to be communicated between many stakeholders and traceability is complex. Novel tools can frequently be introduced via already implemented networks of technicians and advisors. **The need of contract farming for a comprehensive management of complex data sets can hardly be covered without appropriate ICT tools.** The data of a large number of smallholder farmers and of the aggregation, processing and sales of products, needs to be registered, processed and tracked. Most African livestock businesses still work with spreadsheets like Excel, which is a first solid step towards digitalization, but spreadsheet-based systems tend to become confusing and slow with increasing data volume and variety. Moreover, they do not prevent the users from entering inappropriate data, e.g. text entered instead of numbers, names misspelled, etc. For these reasons, the step towards a real database solution can become necessary, and the right system must be found. Various solutions are available that target livestock value chains. Most of these solutions provide digital communication tools, one- or bi-directional, by SMS, voice mail or apps, for various communication needs. Some offer mobile data collection functionalities and mapping tools or are connected to locally and regionally available e-payment services. Most of them work with cloud-based databases, which makes them difficult to use in areas where Internet is unstable or even impossible in those areas where Internet is unavailable.

BUSINESS MODELS

While the landscape of innovative and functioning ICT solutions for livestock in Africa is already surprisingly large and constantly growing, only a few of solutions have functioning business models. Turning promising ideas into profitable businesses is still a challenge. The problem of finding scalable and feasible business models is a general observation for ICT solutions for the African agricultural sector and is not limited to livestock alone. The investment behaviour, low literacy levels, difficult access to finance and a general scepticism towards new technologies are some of the hurdles which prove difficult to overcome. Traditional business models, where a user pays for a service, are still rare and more likely to be found in countries where ICT already influences peoples' lives in some way. In Kenya, for example, where the penetration of feature phones, smartphones and the use of e-payment services is above African average, the number of successful ICT solutions for the livestock sector is also high.

Depending on the value chain, different business models may be needed. Business models suitable for ICT services that target livestock value chains range from classical models, where the user pays for a subscription, to transaction-based payments, as well as Freemium models, where a product or service is offered for free but where money (a premium) is charged for additional features or services. Pay-as-you-go models describe a payment method for online services where customers pay only for services or products they used. Such models can be designed as rent-models or pay-to-own models, where a smallholder farmer or a cooperative owns the system after a certain period. There are other ICT solutions where a governmental institution is offering services for free, such as e-advisory services or weather forecasts. If such systems can help to reduce risks and prevent the loss of lives, infrastructure and livestock, then investments into these systems will be cheaper than the costs of dealing with loss and damage.

Insurance products usually have a clear yet complex business model. The model's profitability depends on a sufficiently large customer base, which may not be easy to build. This is due to the fact that these products and their impact are difficult to understand and that from a farmer's point of view, initially only costs incur. **Insurance products can be sold more easily by bundling them with other services.** Thus, many insurance companies do not directly communicate with individual farmers but rather approach cooperatives and contract farming arrangements to sell their products.

Some companies provide software for free to livestock keepers but collect information which is sold to other commercial entities, such as agrodealers, who want to address the farmers with tailored offers. This can be a win-win situation: users receive free or highly subsidized content, while vendors can identify customers through improved data-driven targeting. This model is particularly applicable for marketing platforms. Some mobile network operators invest in ICT4Ag solutions in order to find and bind clients to their brand.

DEVELOPMENT OF THE LOCAL ICT SECTOR

In rural Africa, many young people want to work in a sector that is perceived as modern and innovative compared to traditional jobs in agriculture. **The integration of ICT solutions into agriculture can help countries to modernize the sector and to accelerate economic progress.** A well-developed IT sector nowadays is a pillar of the economy. In Ghana, for instance, ICT has been incorporated as a subject in schools' curricula for years already. The expertise is needed to introduce ICT into the agricultural sector, and the use of modern technologies can help to attract young innovative people to work in agriculture. Through conferences and workshops, awareness can be raised for the potential of ICT for agriculture. Matchmaking of the agricultural demands with the technology-offering IT sector can be facilitated by hackathons and accelerators. Synergies can be found with development programmes developing basic services such as energy, health, financial services and Internet facilities, as well as with economic programmes promoting inclusive business models.

4.2 Risks and challenges

SOCIAL RISKS

Availability and access to digital technology is generally lowest for the poorest part of the African population. Basic services such as electricity, network access and Internet are better developed in urban areas, while in remote areas, where small-scale farming is ubiquitous, they are barely developed or have not yet arrived at all. If ICTs are available, the technological leap is still enormously daunting, and a large part of the population will still be unable to utilize the technology to its full potential. Not every livestock keeper has a cell phone nor can read and understand messages in text-form. Here, **the introduction of ICTs can lead to further marginalization if it is not done with care.** The paradigm 'leave no-one behind', contained in the 2030 Agenda for Sustainable Development, risks being missed.

Technologies like the community radio, also part of ICT, still play a very important role in the outreach to the poorest. ICT cannot fully replace field visits or training sessions on livestock management practices. These continue to be an important instrument of getting information across, especially when it comes to explaining complex relationships. E-learning might be a good means to allow people access to knowledge, but it is only equitable if everyone can access it.

Technological and logistical capacities are needed among the target group for the operation of the ICT solutions and for the interpretation of data in order to derive the correct decisions. Farmers have to be appropriately trained, which may prove difficult if they are illiterate. Traditional methods such as lead farmers and / or advisory services can help in training farmers on how to make use of a software.

TECHNOLOGICAL RISKS

ICT offers numerous technologies that are growing exponentially in number and performance. For a given problem, there are usually several technical solutions possible. Blockchain, RFID and LiDAR technologies sound like a panacea; the use of technologies such as AI and ML make a solution appear infallible, but in reality, they are often unsuitable for solving the problems of livestock farming. **The high technologies are particularly difficult for smallholder farmers to understand and risk further widening the digital divide.** Smallholder farmers rarely have the resources to invest in new technologies, and agriculture is traditionally a sector that is not particularly innovative. For these reasons, the introduction of ICT4Ag solutions bears the risk of low acceptance among the target groups.

Many digital solutions require adequate Internet availability and seem to work perfectly in a pilot environment, but the subsequent outscaling then reveals the weakness of the design. Video streaming, for instance, needs high Internet bandwidths, and even opening a Facebook site in a browser can be a time- and data-consuming task.

App development frequently targets the latest version of operating systems, but farmers often have old phones which cannot be updated. To be usable by a large target group, apps should be able to run on old Android versions and on smartphones with low resources.

Agricultural work generally has a lot to do with dust, dirt and water – not the best environment for state-of-the-art technology. Although robust end devices are available for outdoor use, they are usually too expensive for smallholder farmers.

The maintenance of software is expensive. Once developed for a certain version of an operating system or a certain Web service, it needs to be updated for future releases in order to remain compatible. A software company needs to have the financial capacities (a feasible and scalable business-model) and a competent team to guarantee the sustainability of its products.

FINANCIAL RISKS

The acquisition of digital technologies is often associated with high costs for the participants of livestock value chains. The operation of sensor and transmission networks, satellite data acquisition or the purchase of RFID chips is expensive. There are only a few positive examples where the costs for digital services provided are fully covered by livestock farmers themselves. Classical business models mainly exist for software which targets larger, commercial livestock businesses. Many technically successful solutions are not financially sustainable and only work for the duration of the implementing project. Costs to access technology such as smartphones, airtime and Internet, but also costs to finance the services which allow service providers to setup sustainable business models, are difficult to cover for livestock keepers. The landscape of currently available digital applications for the livestock sector shows that services have to be very cheap, or offered for free, in order for smallholder farmers to benefit from them.

LOW LEVEL OF ICT EXPERTISE

In contrast to standard software like word processing or spreadsheet programmes, the livestock sector usually requires highly adapted digital solutions. The diversity of value chains, regional differences in culture, climate, soils, threats from diseases and natural disasters require adapted solutions. The variety of languages in Africa and the different livestock systems further complicate the provision of standardized technical solutions. Developing new technical solutions or adapting existing solutions to a specific context requires IT expertise, which frequently is not sufficiently available yet in the target region. Available local IT experts work for telecommunications companies and the banking sector since the agricultural and livestock sectors are considered a less attractive field of activity. Moreover, the difficulty of obtaining IT hardware and related consumables or obtaining the necessary maintenance in rural areas of Africa should not be underestimated. The development of software by international companies, on the other hand, entails the risk of dependency and high costs and frequently results in a low level of local adoption.

Without the necessary expertise, it is difficult to develop ICT applications that integrate seamlessly into livestock value chains. This study shows that the most innovative ideas for the use of ICT to promote sustainable livestock value chain development come from African ICT graduates who grew up in farming communities. They know farmers' needs, how farmers think and can best predict their behaviour. **The implementation of ICT solutions requires cultural sensitivity and deep understanding of the perspective of the application users,** who may be both illiterate smallholder farmers as well as degree-holding agronomists.

RISK OF DATA MISUSE

ICT technologies collect, store, analyse and share data. **This data can contain sensitive privacy-related information of a certain value and should therefore be protected and not shared with third parties unless by appropriate agreements.** Misuse of data by governments, the private sector or even by NGOs must be avoided through appropriate regulatory frameworks. For countries lacking laws and guidelines for data principles, GIZ developed so-called RD Principles RD Guidelines and a corresponding toolbox to fill these gaps. Chapter 2 deals with this topic and shows feasible solutions to mitigate the risk of data-misuse.

4.3 Key to success

ICT offers a wide range of technologies and there is always an appropriate technical solution for a given problem. **To find the most suitable technology, however, many factors must be evaluated: the end user's access to basic services such as grid and Internet, her or his literacy-level, access to technology and related know-how as well as availability of financial resources and access to financial services.** Business models here are mostly direct-to-farmer based. Financial sustainability can be achieved because of the large potential customer base and PAYG models.

A few general keys to success are given on the following pages. They not only apply to the introduction of ICT-based solutions for the livestock but are also relevant for other fields of agriculture. Taking these keys to success into account will increase the probability of implementing successful ICT solutions. They are derived from a large number of individual projects, from documents and reports from other organizations, and from personal experience of the interviewed experts and the authors themselves.

→ **Keep it simple for the end user.** ICT solutions should be as simple and user-friendly as possible. The most successful ICT solutions are those that anybody can understand. Not many users will read a multi-page tutorial before using an app. User Experience (UX) is a new field of science which discusses intuitive user design of applications.

→ **Select the appropriate technology.** ICT is a means of providing better services and streamlining existing processes. ICT offers a wide range of technologies and there are usually several approaches that deliver the same result. Selecting state-of-the-art technology is not always the most effective option. Livestock keeping frequently takes place in remote areas where the service coverage for mobile phones is not complete or the literacy of farmers is not high enough.

→ **Create sustainable and affordable solutions.** Expensive digital services are not likely to be adopted by livestock keepers. Free services, however, frequently do not receive full appreciation. Wherever possible, basic services should be offered for free, while advanced service levels should not be free of charge. ICT is a perfect means to reach a high number of beneficiaries – this can lower the cost for the individual user.

→ **Consider the local setting.** When designing a digital application for a specific target group, their access to basic services, their literacy-level and local languages should be considered. If farmers have to interact with the ICT solution (SMS, SMS polls, USSD, apps, training videos, etc.), it is essential that it is provided in the local language. If literacy is low among the end users, voice mail technology, pictograms, and photos can be the solution.

→ **Attract the youth to modern farming.** Modern technologies can be an incentive for young people to stay in rural areas and to engage in activities that promote sustainable livestock value chain development. Literacy rates and technical affinity are generally higher among younger generations. Access to information can trigger the transformation of the livestock sector.

→ **Mobilize local ICT capacities.** ICT capacity can be found, developed and mobilized in all capitals and larger cities worldwide. Globalization gives access to state-of-the-art ICT know-how which stimulates the emergence of local IT ecosystems. This process can be initiated and accelerated through local or regional hackathons, IT and programming competitions.

→ **Make use of existing solutions where possible.** There are many examples of successful ICT projects in the livestock sector. Learning from successful projects is purposeful, as are the lessons learnt from failures. Sometimes readily available software can be the more appropriate solution. It is cheaper than the development of a custom-tailored product and prevents the implementer from repeating errors and from creating solutions which are too complex. Case-specific software development should be avoided where possible. If IT development is unavoidable (e.g. for barcoding, database development, etc.), cooperation with local IT firms can enhance its sustainability. Where the customer and the IT service provider work closely together, a successful outcome is more likely. An IT firm with knowledge and experience in the livestock sector is more likely to come up with a suitable solution.

→ **Use local products with local support.** For sustainability reasons, local or regional hardware products should be used where possible. The international 'big tech' players might have local offices, but the smaller ones do not. There are highly specialized international providers of agricultural software, and the risk that local dealers exist and dominate the market is high. Development projects, however, should support local IT development where possible.

→ **Develop a feasible business model.** For the development of a viable business model, a comprehensive analysis of various factors is necessary. If the ICT solution targets the poorest and most marginalized part of the population, common business models will only work if a large number of users can be expected or third parties pay for the service. In any case, both sides must be considered in the search for a suitable business model: the end user as well as the service / solution provider.

→ **Find and create synergies.** The promotion of financial services and the related improvement of financial literacy in rural areas can benefit from the introduction of ICTs and vice versa. Likewise, local IT firms will benefit from investments into ICT. More sustainable livelihoods in rural areas will allow public and private investments into the infrastructure of these regions as the communities will be able to pay for the services.

Endnotes

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