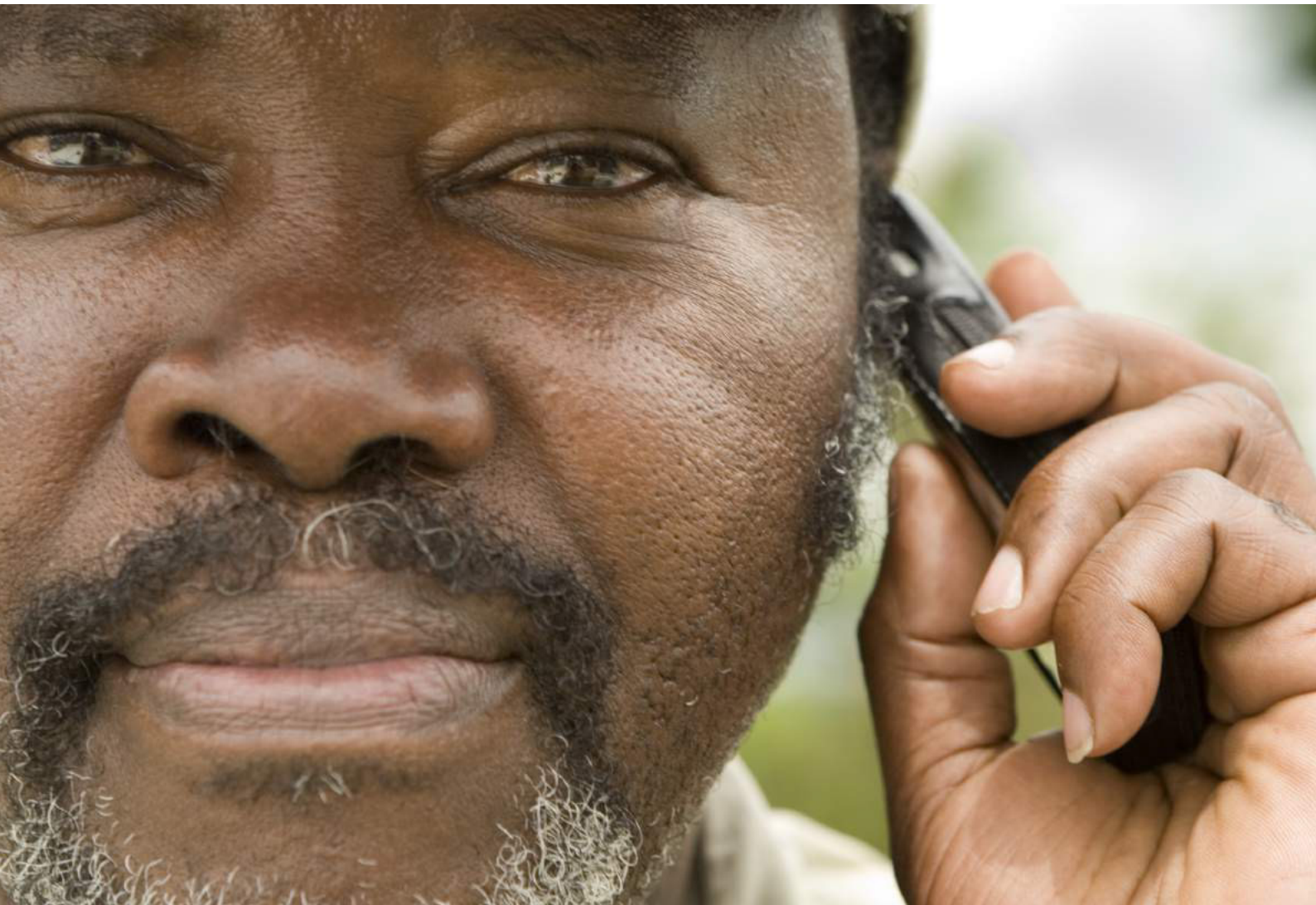


ICT Toolbox for Contract Farming Professionals

10 effective information and communication tools
to enhance the competitiveness of contract farming

Dr. Ralph Elsäßer – November 2017





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About the author

The author is an expert for the introduction and improvement of modern and locally adapted information and communication solutions in agriculture, supply chain management and integrated water management. He works for various projects of GIZ, KfW, World Bank, EuropeAid, FAO, BAD and other agencies worldwide and is regularly involved in private sector projects where ICT plays a major role in streamlining workflows and processes. He holds a doctorate degree from the Faculty for Environment and Natural Resources of the University of Freiburg and master's degrees in (hydro-)geology and computer sciences.

Acronyms

ADB/BAD	African Development Bank / Banque Africaine du Développement
CF	Contract Farming
ERM	Enterprise Resources Management
ERP	Enterprise Resource Planning
FAO	Food and Agricultural Organisation
GIS	Geographical Information System
GIZ	Gesellschaft für Internationale Zusammenarbeit
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
ICT	Information and Communication Technologies
IT	Information Technologies
IVR	Interactive Voice Response
KfW	Kreditanstalt für Wiederaufbau
MMS	Multimedia Messaging Service
MS	Microsoft
NPK	Nitrogen (N), Phosphorus (P), Potassium (K)
QA	Quality Assurance
RS	Remote Sensing
SMS	Short Message Service
USSD	Unstructured Supplementary Service Data



Introduction

The GIZ program “Improving the Framework Conditions in the Private and Financial Sector” (ProEcon) aims to promote sustainable economic development in Mozambique. One of its projects is the promotion of local economic cycles in rural areas. With contract farming as a powerful instrument ProEcon supports the inclusion of smallholder farmers into commercial supply chains, thus increasing their income opportunities.

In Mozambique the land owned by farmers involved in contract farming is often small (around or below 1 ha). These smallholders usually have limited farming skills and little awareness of modern farming techniques or knowledge about how value chains work. Therefore, in order to ensure sufficient quality and quantity of the expected produce, the agribusiness operating as lead firm is often forced to employ large numbers of extension workers to train and coach smallholder farmers throughout the year. This leads to high transaction costs within such contract farming models, reducing their competitiveness.

Modern information and communication technology (ICT) solutions are a way to reduce such transaction costs, making contract farming more competitive. This leads to higher profitability for both the smallholders and the lead firm and facilitates the inclusion of more farmers into such schemes. While the advantages are obvious and ICT in agriculture is booming, best practices for ICT in the field of contract farming have yet to be established.

Information and communication technologies (ICT) in Contract Farming

*'Across the developing world, the majority of the poor and most of the hungry live in rural areas, where family farming and smallholder agriculture is the main farming system. Family farming and smallholder agriculture's growth, through labor and land productivity increases, has significant positive effects on the livelihoods of the poor through increases in food availability and incomes.'*¹

Over the past 50 years, crop yields have grown at very different rates around the world. Most smallholder farming systems are much less productive and profitable than they could be. The reasons include their lack of access to inputs and credits, and their inability to bear risks. Another major challenge is the information and skills gap that constrains the adoption of available technologies and management practices, or reduces their technical efficiency when adopted. Public extension programs are often underfunded. They usually do not incorporate agricultural research, and contact to the farmers is often insufficient. A further problem is the lack of coordination along the agricultural value chain from farm inputs to food processing. This increases production costs and lowers the revenue for farmers.

Contract farming is an arrangement which can help to bridge the gap. The lead firm can invest in technology and capacity building and that way enable the contracted smallholder farmers to increase efficiency and competitiveness of their production. There is a wide variety of different contract farming arrangements. While differing in the way in which responsibilities and risks are shared, they all have one thing in common: Each of them involves a large number of stakeholders. The nature of contract farming entails operational challenges of planning, executing and monitoring activities across lands that are usually spread over many regions.

The coordination of harvest, delivery and transportation processes is a challenge which makes the traceability of the final product difficult. Therefore, extensive communication between the lead firm and all other participants is inevitable. Extension arrangements, however, usually have high overhead costs and very long response times while sometimes every minute counts.

In agriculture, information and communication technologies (ICT) can be of help in various ways: improve productivity through precision farming, mitigate risks through diagnostics and advice, enhance efficiency of the production

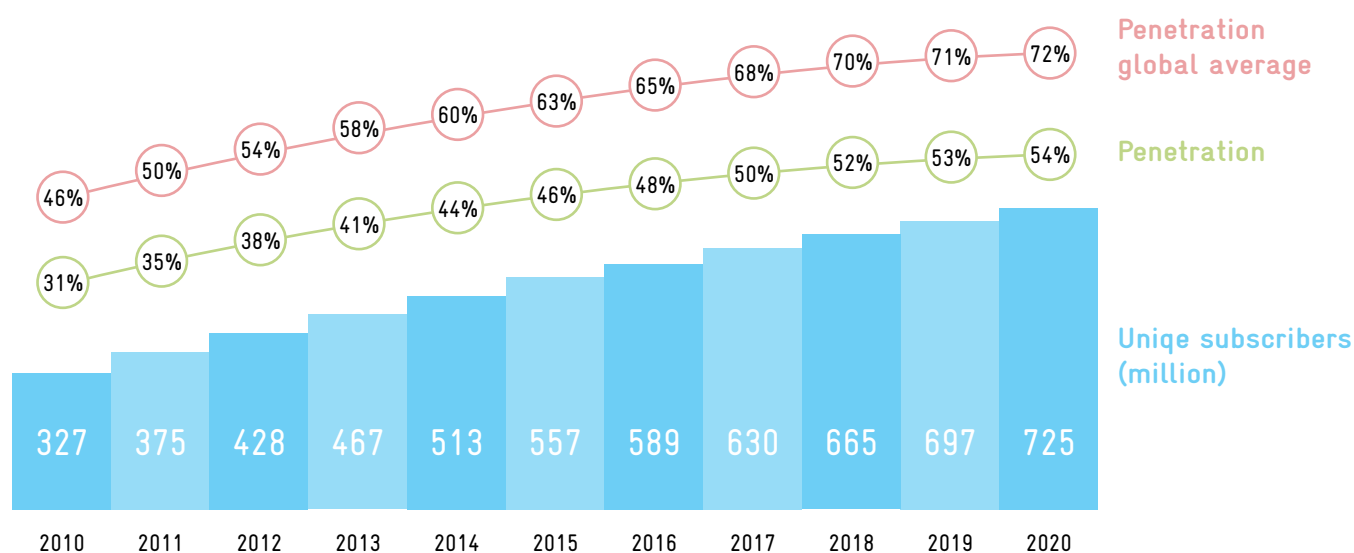
¹ FAO, IFAD and WFP. 2015., The State of Food Insecurity in the World in Brief. 2015. Meeting the 2015 international hunger targets: taking stock of uneven progress. Rome 2015.

chain through supply chain management software, building capacities through videos and webinars. ICT generally enables timely, precise and multi-modal communication. In contract farming ICT can be highly effective as the number of recipients can be enormously high. Some schemes have thousands of contracted farmers which makes it impossible to communicate with each of them individually.

The introduction of new technologies in agriculture needs experience in dealing with the new opportunities, an insight into human nature, and intuition and sensitivity in how to involve the farmers. What makes a project successful is not always and not only IT-related. In most cases changes in the behaviour of the farmers are inevitable, and the introduction of ICT will fail if farmers are not willing to cooperate. This document provides an overview of existing information and communication technologies which can facilitate communication and increase the competitiveness of the contract farming business dramatically.

While the introduction of ICT-based tools will increase costs initially, it will also increase staff efficiency and the effectiveness of the production chain in the medium run. It can mitigate risks and enhance product quality. In each individual case, it is necessary to assess which tools are appropriate and particularly suitable for the given contract farming model, its size and the products planted.

Unique mobile subscribers in Africa



Source: GSMA Intelligence

Figure 1: <https://www.gsmainelligence.com/research/?file=3bc21ea879a5b217b64d62fa24c55bdf&download:>



Why a toolbox?

This toolbox has been developed for readers among donors, policy makers and the agribusiness who have already understood the importance of ICT for agriculture in general and for contract farming in particular. The document gives an overview of ICT related tools and their possible fields of application in contract farming. It shows their long-term financial benefits and gives advice for the selection and prioritization of suitable tools depending on the specific criteria of a given contract scheme, such as its size, business type, geographical setting and the type of production.

Ten different tools have been identified, each for a particular purpose. Some of the tools are simple and easy to implement while others can become very complex and might require a comprehensive preparation phase.

The toolbox lists the prerequisites, the possible benefits and related risks for the realization. It gives a basic overview of the implementation steps and times, and a rough estimate for the related costs. For some of the application fields, readily available solutions already exist. These are presented in an additional chapter (p. 39).

On pp. 44-45, a decision guidance matrix assists decision makers of a given scheme in identifying the tools with the highest importance, the lowest risks, and the highest expected benefits. A list of keys to success completes this toolbox (p. 46).

The document is the result of a comprehensive desk study, a field visit in Mozambique and experience collected in other countries.

The tools

The proliferation of mobile phone networks has transformed communication in sub-Saharan Africa. Even in remote areas there is usually a network available. Cell phone ownership has grown exponentially and the smart phone market is emerging. The cell phones most commonly are used for making calls and sending text messages. Taking pictures and videos are relatively common activities. Mobile banking is widely used in only a few countries in Africa.

The following ten tools discussed in this document have been identified to be relevant for contract farming. Depending on the type of contract farming arrangement, the crop types which are grown, the target markets and the

general technical framework conditions, one or more tools from this list might be suitable. Each of the tools can take on different levels of complexity to match different situations.

1. Farmer registry
2. Bulk SMS, voice mail & USSD
3. Data collection by SMS polls and surveys
4. Barcoding and traceability
5. Supply chain management software
6. ICT tools to support the training of smallholders in farming techniques
7. ICT tools for empowering smallholders in management capacities
8. ICT tools for diagnostics and advice
9. ICT supported financial services
10. Sensors, GIS and remote sensing



The tools are described in detail on the following 30 pages. The presentation of the individual tools follows a structure, which was elaborated to facilitate the selection of appropriate tools for a given contract farming scheme and a given problem. The below list presents the elements:

Problem:	Description of the problem
Solution:	Description of the proposed solution
Typical use:	Here the field of application is given. The applied classification of CF schemes follows the classification by Eaton and Shepherd 2001, adopted by FAO. ² A brief description is given in the 'decision guidance' table on page 44.
Priority:	Priority depends on type and size of CF scheme, crop types, etc.
Expected benefits:	The benefits for the lead firm, the farmers, third parties and the environment;
Prerequisites:	Technical, organizational or educational prerequisites
Cost-benefit assessment:	Comparison of benefits and costs
Challenges:	Possible challenges and associated risks for the implementation of the solution
Required implementation steps:	If possible, a general overview of the necessary implementation steps is given.
Required investments to implement solution:	A rough estimate of related costs
Readily available solutions:	Whether or not ready-made solutions are available and can be used
Implementation:	Who can implement the solution?

For decision guidance on the selection of appropriate tools for a given contract farming arrangement setting please refer to the two diagrams starting on page 44.

² Eaton, C. and Shepherd, A., Contract farming: Partnerships for growth. FAO Agricultural Services, Bulletin 145, Rome, 2001, p. 44 ff. Another FAO web resource: <http://www.fao.org/docrep/004/Y0937E/y0937e05.htm>.

Tool 1 : Farmer registry

PROBLEM:

By definition, contract farming involves a large number of stakeholders. The biggest group are the smallholder farmers, each single one with a specific profile in terms of name, location, parcels, crop, etc. In the contract farming business, no planning is possible without the knowledge of the number of farmers, the size and location of their parcels, what type of crop they grow. In most cases, advanced information like phone numbers, bank account details, water consumption, etc. is not available. This information would help significantly in streamlining various processes. Neither are maps of the farmers' lands available, which would help to identify best agricultural practices and fighting pest incidents. In some cases the bigger part of this information is actually available, but only on paper. Updating this information is difficult and making use of it by computer applications impossible. In most listings, the farmers are identified by their names only. This can lead to mistakes.

SOLUTION:

The implementation of a farmer registry targets the digitization of all relevant farmer data. It usually presupposes the introduction of a farmer ID number. For a comprehensive management it is essential to be able to identify each farmer distinctively. The name of a farmer isn't necessarily unique and street addresses usually are not available in rural areas. Therefore a convenient identification system has to be introduced in order to facilitate delivery of inputs and capacity, to enhance the buying process and to streamline

payment procedures. Typically, each farmer is identified by a unique number. This number remains valid in the system even if the farmer retires or deceases. It is not recommended to include the farmer's location, farmlands or name into the code as those properties can change over time.

The farmer registry can be seen as the primary database or the umbrella application for contract farming. Most other ICT services rely on its availability and on its contents. No ICT communication is possible without the farmers' phone numbers, no payment can be automated without bank accounts.

Data elements for the registry: Farmer ID, Name, Sex, Date of birth, [social security ID], [address], phone contact, association, hectares under cultivation, etc.

Simple variant

- 
- (a) Spreadsheet software listing farmers by name, including contact information and location;
 - (b) Database software with user interface and reporting tools; same information as above;
 - (c) Interfaces to other software (accounting, crop planning, asset management);
 - (d) Introduction of farmer ID cards (Interface to barcoding solution);
 - (e) ERP integration to handle material issuance to farmers and managing their accounts;
 - (f) Spatially enabled (GIS data of parcels and farm location);
 - (g) Web solution – farmers can get access to the data via web or app; software can become a platform for exchange and communication.

Complex variant

TYPICAL USE:

All sorts of contract farming arrangements. For the centralized and nucleus estate models it's a prerequisite

PRIORITY: | High |

Lead firm: No modern management practices are possible without a computerized farmer registry. Before introducing any other ICT solution, the farmer registry has to be operational.

EXPECTED BENEFITS:

| High benefits |

Lead firm: A complete and up-to-date list of all contracted farmers and their parcels will support all management activities: business development, communication and payment, delivery of supplies and streamlining of the collection process. The registry will support traceability, more accurate statistics, prognoses and planning. The use of a computerized registry is more accurate and efficient compared to a list on paper, updating is easier. **Farmer:** the contract farmer does not benefit directly but indirectly from all improved management practices.

PREREQUISITES:

| No prerequisites |

Existing data has to be reviewed; missing data has to be collected. Technically, the solution has to integrate into a (possibly) existing IT environment. If other software is already in use, interfaces have to be established where necessary (to accounting, communication or supply chain management software).

COST-BENEFIT ASSESSMENT:

| Very high benefit; low costs; safe |

Cost of a farmer registry can be very low. The simple variants (a) and (b) require nothing but a single computer and can be implemented using OpenOffice or LibreOffice BASE, free Excel and Access equivalents. The data can be collected on paper by extension officers and via questionnaires. The benefits can be seen as very high. Hence, this solution is highly recommended if not mandatory for every contract farming scheme.

CHALLENGES:

Lead firm: Every database requires permanent maintenance. Tracing changes in mobile numbers and bank account details or of the farmer's area under cultivation can be challenging. If software is already in use, interfaces have to be established to the existing programs to avoid doubling data maintenance. **Farmer:** the farmers need to understand the importance of the registry. Otherwise they will not keep their records (e.g. phone numbers) up to date.

REQUIRED IMPLEMENTATION STEPS: | Fast |

The following roadmap outlines the introduction of a farmer registry:

- (1) Defining data elements to be collected (see above);
- (2) defining the collection procedure;
- (3) collection, input and validation of data;
- (4) developing the IT solution (Excel sheet or database);
- (5) developing interfaces where necessary;
- (6) training users.

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION: |Low|

Collection of data and development of IT-solution (100 – 10.000 USD depending on complexity)

READILY AVAILABLE SOLUTIONS: |Yes|

Some commercial agribusiness software comes with solutions for contract farming management. It is not recommendable to purchase those complex and expensive solutions for a farmer registry only.

Free or low-cost solutions for farmer registries are available, built for the development context. In most cases they offer other additional, valuable services like bulk SMS sending or voice mailing.

IMPLEMENTATION:

|In-house, local and international|

The simple variant of an Excel sheet can be implemented by any computer literate while the more complex variants need technical assistance from a locally based IT firm. If interfaces have to be developed to software already in use, it can be necessary to search assistance from the software producer. For international software this can be very cost-intensive.

For a sustainable system, capacities have to be built in-house for maintenance and updating.



Tool 2 : Bulk SMS, voice mail & USSD

PROBLEM:

In contract farming large numbers of stakeholders have to interact and collaborate efficiently. Any delay in the processes of husbandry, harvest and transportation can lead to failure and/or product quality deterioration. The management of the supply chain, the communication of dates and times for delivery and collection, the planning of extension services and trainings; they all rely on vivid and efficient communication between the lead firm, its extension staff and the farmers.

As distances can be high in rural areas, travelling between the numerous farm lands is costly in terms of time and money. Likewise, phone calls can be time-consuming, notably if the number of farmers is large.

SOLUTION:

Modern information and communication technology offers a variety of ways for the streamlining of one-way and two-way communication between two or more participants. Even though the number of parties in contract farming is high, for transmitting certain types of information one-way sending can be sufficient. In all cases, the recipients need to have at least a simple mobile phone to be able to read or listen to the information received.

Simple phones are sufficient to receive bulk SMS messages sent from the buyer to the farmers as well as to collect information using advanced USSD technology.

Bulk SMS messaging:

Dissemination of large numbers of SMS messages to mobile phones. This can be done either using a SMS service provider (internet) or by installing desktop software, which will communicate with an SMS gateway. Both solutions allow uploads of as many phone numbers as required.

All recipients will receive the same message but placeholders can automatically be replaced, e.g. by the name of the recipient. Some desktop software offers the scheduling for sending at specific times and/or to a specific group of recipients (e.g. all baby corn producers).

This makes it possible to send the weather forecast to all farmers, a reminder for the application of fertilizer to the baby corn farmers only, and even individually configured SMS to every farmer listing the produce delivered and the amount of kilograms of the current week.

Voice mail:

In case of low literacy among the recipients, voice mailing can replace the bulk SMS messaging. It follows the same principle except that it does not allow to automatically configure custom-tailored messages to individual farmers. The administration of a voice-mail system, however, is more complex as the messages have to be recorded before they can be sent.

USSD:

The “Unstructured Supplementary Service Data” technology offers a way for bi-directional communication. USSD technology is commonly used by prepaid cellular phones to query the available balance. This technology allows the lead firm to provide on demand more specific information. The farmer can dial a number and is then led through a menu, e.g. “... for the weather forecast, press 3”. The technology is dramatically more complex and expensive than SMS services as it requires a USSD server which has to be developed and maintained – usually by the service provider.

What to send?

General information: Weather forecast, early warnings (flood, storm, thunderstorm, heavy rain, etc.), reminders to apply fertilizer or pesticides, time schedules, meeting points, market prices.

Custom-tailored information: Accounting and management information like deliveries of the last 24 hours/last week/last month; personal crop plans by plot; payment information; delivery dates for inputs. (see also tool 7).

Simple variant

- 
- (a) Using mobile phones for communication between farmers and extension staff;
 - (b) Bulk SMS for sending general messages from lead firm to farmers – using internet SMS services;
 - (c) Bulk SMS for sending general messages from lead firm to farmers – using integrated software;
 - (d) Sending bulk voice mail from lead firm to farmer, in case literacy rate is low;
 - (e) USSD technology to provide more sophisticated information;
 - (f) Interactive Voice Response (IVR): Callers can navigate to content using their phone keypad;
 - (g) Sending of personalized information about deliveries, received inputs and account balances.

Complex variant

TYPICAL USE:

All sorts of contract farming arrangements. The higher the number of contracted farmers and the more distant their farms, the higher the need and benefit.

PRIORITY: | High |

Lead firm: Modern means for rapid and efficient communication can help to make contract farming more efficient by preventing loss of crop, by ameliorating produce quality and by reducing costs through minimalizing travel expenses for the extension staff.

EXPECTED BENEFITS:

| Higher income on both sides

| Reduction of risks

Lead firm and farmers: The possibility of sending messages to all farmers at once can be very helpful and efficient. Timely alerts in case of natural hazards can prevent loss of crop. Advice about the right moment for fertilizing, weed control and harvesting can enhance the product quality. By sending messages regularly about market news, weather forecasts, etc. the lead firm can make the contract farming business more visible and attractive to the farmers. It can help build and strengthen a positive sense of belonging to the contract farming scheme.

PREREQUISITES:

| Mobile phone services; mobile phones |

A complete, operational and up-to-date farmer registry. Availability of cell phone services in the area where the farmers live and work. Availability of electricity for charging the phone – a mobile solar panel charger is sufficient. A major drawback is the low ICT literacy among the farmers and low literacy in general. The solution has to take the local circumstances into account and use workarounds like voice mails in case of low literacy of the target group.

COST-BENEFIT ASSESSMENT:

| High benefit; low costs; Safe |

Lead firm: The costs for sending bulk SMS vary depending on the country and the service chosen. But savings will outweigh the costs.

Farmer: The farmer has to invest in a cell phone, in telecommunication fees and eventually in a solar panel charger. The high costs might be justifiable by higher productivity (quantity and quality). Mobile phone technology is generally on the rise even without any financial justification.

CHALLENGES: | Medium |

Naturally this technology is only applicable where cell phone services are available, which in remote areas is not always the case. Likewise, the absence of national power supply can be a major drawback although mobile solar chargers are beginning to bridge that gap. **Lead firm:** This technology needs a fully operational and up-to-date farmer registry. Any missing, wrong or outdated phone number challenges the system. **Farmer:** Not all farmers have access to mobile phones and the necessary charging station. There is a significant risk for the poorest farmers to be marginalized.

REQUIRED IMPLEMENTATION STEPS: | Fast |

The technology can be tested without any major preparation once the list of farmers and their phone numbers is complete. As a first step, it is recommended to use readily available bulk SMS services on the internet to test the farmers'

acceptance for this channel. If this technology seems to be promising, client software can then be purchased or freeware installed allowing the setting of filters and sending rules. The best solution would be to integrate the technology into the farmer registry.

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION: | Low |

The costs for sending bulk SMS vary from country to country. Some free services are available on the internet but they are prone to sending spam to the phone numbers and therefore should be avoided. Software for configuring voice mails is inexpensive but preparing the messages requires expertise and time.

READILY AVAILABLE SOLUTIONS: | Yes |

A variety of SMS gateways are available on the internet. But only few provide the specification of a national sender phone number to which the farmers can respond. Also, the cheapest providers often use the uploaded numbers to send ads and spam to the recipients. Usually the national service providers offer a similar service at a much higher price but which are mostly reliable and professional. Many of these bulk SMS providers also offer free desktop software solutions. Of course they only work with the provider's SMS gateway.

Some solutions have been especially designed for business in developing countries. They usually comprise free language customization which in many regions is of great advantage.

EXAMPLES: ESOKO Push – see page 42 (www.esoko.com)

IMPLEMENTATION:

| In-house and local |

Every computer literate can prepare an Excel table with messages and phone numbers and upload it to a bulk SMS provider for sending. Neither is the installation and configuration of desktop software very complicated. However, a strategy has to be conceptualized, what messages to send to which recipients. It would make sense to have this software use the existing farmer registry for the farmers' names and phone numbers. Yet the integration of the SMS messaging into the farmer registry is not a simple task and requires the development of an interface or the integration of the messaging into the farmer registry via an application programming interface (API). Locally operating IT firms can assist here.



Tool 3 : Data collection by SMS polls and surveys

PROBLEM:

Many management decisions of the lead firm rely on up-to-date and complete information about the contract farming scheme and its members. In most cases, this information is related to the contracted farms. Regarding the data collection, several problems typically arise:

- Collection by extension staff is time-consuming and causes a large extension overhead.
- Most of the information collected becomes outdated after a short while. This is why the information needs to be collected repeatedly after short time intervals.
- In many cases the information collected may be complete but no record exists about which location it refers to. Sometimes the location is known to somebody but there is no written record.
- Manually collected and hand-written information is unreliable and prone to errors. This requires good verification procedures. Transfer of the data sheets to the company's head office or data center is time-consuming.

SOLUTION:

Modern communication technology offers ways to collect information efficiently. It helps to prevent typing-errors, structuring and saving the data and ensures rapid data transfer and safe storage. It can automatize data verification and automatically store relevant meta data, such as date, time and location where the information was collected, name of the collector or collecting device.

Available technologies:

SMS polls:

SMS polling, based on two-way communication by SMS, allows sending out simple but structured questions via SMS and collecting/mapping the corresponding answers. Questions like "How many pigs have died due to the African swine flu in your section" can rapidly be answered. Expenses for the poll are paid by the lead firm in order to guarantee a high percentage of responses.

What to collect? – Management data:

- Pest information: Number of animals/size of plots affected. Observation of specific pests on the farmer's fields.
- Inputs survey: "How many kilograms of fertilizer XY do you need?"

Smartphone & app:

Smartphones allow the installation of different apps (applications), e.g. specially developed or customized apps for the collection of a specific set of information. The survey conductor can enter the data directly into the smartphone. Checkboxes and drop-down lists help to avoid input errors and accelerate the data collection. Smartphones are equipped with GPS technology and cameras and allow capturing coordinates and photos along with all other data. Smartphone-based GPS signals are less accurate than the signals from pure GPS devices. Smartphones also are more sensitive to dust, water and direct sunlight. Depending on the type of application a pure GPS device might be more convenient.

What to collect? – Management data (see above) and general data:

- Farm data, farmer contact information, household size;
- Hectares/acres under cultivation, crop type.

GPS: As most information in agriculture has a spatial component, the technology of capturing precise locations is of very high value. GPS devices store the exact position in a format which later can be read out for further processing (it is not recommended to write down the measured co-ordinates on paper for later data entering as the number formats are confusing). Some modern devices allow the capturing of geo-tagged photos which can easily be imported into Google Earth and visualized on satellite images. This is a very effective method to build up a common photo database. Traditional GPS mapping technology is used for geo-mapping the boundaries of the farmers' parcels (see tool 10). Running periodic inspection schedules with geo-coded proof of visits and pictures to assist in further analysis is another field of application.

What to collect? – Spatial data:

- Shape, size and location of parcels: Hectares/acres under cultivation;
- Locations of farms;
- Locations of pest incidences.

Simple variant



- (a) GPS-mapping of parcels and visualization on Google Maps; connection with farmer registry;
- (b) SMS polls to collect management data;
- (c) Smartphone apps to collect general data and management data.

Complex variant

TYPICAL USE:

All sorts of contract farming arrangements. The higher the number of contracted farmers and the more distant their farms, the higher the need and benefit.

PRIORITY: | High |

Lead firm: High. **Farmer:** Low.

EXPECTED BENEFITS:

| Higher income on both sides

| Reduction of risks; Better water management

Lead firm and farmers: A fast and low-cost solution for the collection of up-to-date data will result in better decision-making. Both sides will benefit from reduced risks and higher incomes. The availability of accurate data about the parcels and their size will allow better pest mitigation, a more effective early warning system, and better catchment planning by sustainable water management.

PREREQUISITES:

| Mobile-phone services, mobile phones

| smart phones; GPS

None for the GPS. The technology is simple – however, staff has to be trained. SMS polling only works with a functioning mobile network and literate farmers with phones at hand. For the collection of data via app, a mobile connection is not necessary. It is sufficient to transfer the data once a connection is available.

COST-BENEFIT ASSESSMENT:

Lead firm: The costs for SMS polling are low compared to on-site surveys in rural, sparsely populated regions. The benefit achieved by better planning will outweigh the investment. The development of an app, by contrast, is cost-intensive and worth the investment only if the number of farmers is high and if the app can be re-used. Data is usually collected by extension workers.

Lead firm and contract farmers: The availability of maps of the parcels, of slopes, of soil conditions, etc. will allow a sophisticated research and can result in much higher yields through correlation and optimization of the

combination of soil type, varieties, climate condition and application plan.

CHALLENGES: |Low|

SMS polling only shows good results if the participants are literate. There is, however, a technology to conduct polls by phone using voice mail.

REQUIRED IMPLEMENTATION STEPS: |Fast|

GPS technology can be introduced without any major preparation phase. The operators (extension officers) have to have the necessary background or need to be trained. For **SMS polling** free and commercial software exists. One good solution for the contract farming context comes from ESOKO (see Integrated Solutions, p. 39). Simple **app development** can be automated with software, such as OpenDataKit: Following specific rules, a structured Excel sheet is sufficient to generate a corresponding Android app for data collection. Complex app development has to follow common IT project rules.

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION:

|Low for the simple variants

|High for app development

Good quality **GPS** devices can be purchased for 200 USD and upwards. Free Software for the representation of the data can be found. But to build the necessary capacities for data analysis and for the creation of maps can be high. The price for **SMS polling** depends on the arrangements made with the providers. Usually, prices for Bulk SMS are much lower than the normal network SMS price. Collecting data with Open-

DataKit is a low-cost solution which can be technically realized by an IT department. However, smartphones or tablets for the extension staff are required.

READILY AVAILABLE SOLUTIONS: |Yes|

For the visualisation of **GPS** data on maps, the simple, free and most widely used standard solution is Google Earth. Any graphical information (GIS) program is also capable to visualize the data but requires specific expertise. There are powerful free solutions available for download. For **SMS polling**, many software solutions are available – almost every SMS gateway provider also offers appropriate software. A good, free and development-oriented solution is offered by ESOKO specifically for the agricultural market. For **apps**, no standard solutions are available as the requirement of every agricultural business is very specific. OpenDataKit allows the creation of simple native apps from structured Excel sheets.

EXAMPLES: ESOKO Push

IMPLEMENTATION:

|In-house and local|

The operation of a **GPS** does not require much training but some preparation. Likewise, the transfer of the collected data to Google Earth or a GIS needs some basic expertise. The calculation of areas and distances, however, requires basic GIS capacities which the company's IT might not have.

Before sending out a team to collect data, the conductors of the survey have to understand the objective of the measure. Whether the data collection is done on paper, by smartphone app or any other means, the different data elements have to be clearly defined. The same holds true for what can be accepted as an answer and for which aims the measure is taken.

Tool 4 : Barcoding and traceability

PROBLEM:

Transparency and traceability are key factors within the agricultural supply chain. In order to be compliant with national or international standards and certifications, information concerning the farm has to be collected and made available to the end-user. Along the supply chain, all participants from suppliers to major markets have to be able to identify the producer if problems related to food safety arise. The production chain has to be identifiable from the end product back to its producer and plot. The shift from quantity-agriculture to a new emphasis on quality, safety and sustainability-oriented production demands for the development of traceable supply chains.

In contract farming, a large number of individual producers are involved in planting and harvesting a variety of crop types on different sized parcels at different times. A lot of information has to be collected to be able to deliver inputs and extension services to the farmer and to master the buying process and the calculation of the payments to each individual farmer. The smallholder farmers themselves often lack the expertise for comprehensive bookkeeping and they frequently rely on the documents that the lead firm provide as receipt for the deliveries. During the process from the delivery of inputs to contracted participants, the collection of produce from the farmers at the fields, the transportation and quality control, a lot of information is collected and captured only in hand-writing. This procedure needs extensive human resources and, even with trained personnel, is time-consuming and prone to errors.

SOLUTION:

The introduction of barcoding in the agricultural value chain helps organizing the high amount of information collected. The fact that computers and scanners are much more reliable and faster than manual data collection has led to the worldwide spread of barcoding in the food chain, which starts at the farmer and field level. Barcoding produce directly in the field during the buying process enables traceability on the parcel level. Barcoding can also be helpful for the accounting of inputs and deliveries. Packed produce can be equipped with barcode stickers for the foreign market.

Regarding technology, barcoding is only feasible with an IT department and a professional procurement department. Barcoding needs databases, servers, and reliable backup procedures. Once barcoding has been introduced, daily operation strongly depends on its functioning accurately. Power breakdowns, computer and software failures, lack of material/consumables, they all would affect the production chain and in the worst case can provoke interruptions and standstill.

The producer can benefit from barcoding as the technology introduces higher transparency by the use of digital scales, printers, and reports. The contractor can deliver monthly reports for each farmer listing all available information, such as purchase dates, weights, produce quality, delivered inputs and the accounting balance.

Medium complex variant



- (a) Solution for the collection of the produce (digital scales, barcode scanner, printer and handheld device)
- (b) All-in-one solution including farmer registry, supply management, quality control, communication channels.

Complex variant

TYPICAL USE:

Not suitable for the informal model. Applicable particularly for the centralized and nucleus estate models.

PRIORITY:

| High for export; medium for local production |

Lead firm: For the production of fresh produce for more developed markets such as South Africa or Europe, traceability is a prerequisite. Traceability itself is virtually impossible without barcoding. Furthermore, barcoding is the means to effectively collect, manage and analyse large amounts of information. Thus, the higher the number of contracted farmers, the more necessary and helpful is barcoding technology for the company.

EXPECTED BENEFITS:

| Higher income on both sides
| Reduction of risks; New markets

Lead firm and farmers: Traceability is a high technical hurdle but it can open the door to new markets. It helps to comply with international standards and certifications. The new markets can help generating a higher income on both sides. The introduction of barcoding leads to a higher efficiency of the collection and production process. Furthermore, the increased trans-

parency strengthens the stakeholders' trust into the contract farming business.

PREREQUISITES:

| High; IT-department
| Competent implementation partner

Lead firm: Barcoding is most convenient for high-value, fresh produce for export. For cash crops it is less applicable and beneficial but still can be helpful to accelerate certain processes in the production chain. The technology needs a strong in-house For the implementation of the project, the lead firm needs a competent and experienced solution provider, preferably from the region. The project requires a preparatory assessment phase which has to result in an appropriate and complete blueprint for the system. The risk of failure is high if the system design is incomplete or does not fit the requirements. Later changes are complicated and expensive.

COST-BENEFIT ASSESSMENT:

| High benefit; high costs |

Lead firm: The investment in barcoding is a major hurdle for the lead firm. In most cases it only makes sense if the farming scheme produces for foreign markets. Barcoding needs databases, servers, networks, etc. Hence, the lead firm has to develop IT expertise and has to invest in IT infrastructure. **Farmer:** No investment is necessary for the farmer. The benefit, however, is high. The farmer can receive reports for better book-keeping and planning. The opening of new markets could be a great advantage as the revenues are higher for high-quality products. On the other hand, the farmers' produce quality has to comply with new standards which might need training and time to achieve. In the long term, the technology will pay off through

- Lower human resources at the lead firm (no

hand-writing, no quality control of hand-written information);

- Higher efficiency during the collection process;
- New markets with higher revenues.

CHALLENGES: |High risk|

Lead firm: Barcoding is a sophisticated technology which needs expertise, hardware and software which at farm-level in rural Africa is rare. If, however, the technology is introduced in contract farming, the lead firm has to develop the necessary resources to set up and maintain such a technologically advanced system. IT department capable of administering databases, backups, scanners, etc. A complete, operational and up-to-date farmer registry has to be available (the setup of such a registry can also be an integral part of the solution). The company's infrastructure has to be modernized and has to comply with international standards. In most cases high investments are required (permanent power supply, internet, IT infrastructure, quality control, etc.).

REQUIRED IMPLEMENTATION STEPS: |Complex|

- (1) Assessment phase.
- (2) Blueprint phase.
- (3) Implementation phase.
- (4) Test and maintenance phase.

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION: |High|

The cost for introducing barcode technology is moderate, if agribusiness software is already in use and the necessary hardware is already available. In this case, a digital scale, barcode scanners, and printers can be sufficient, if the existing software supports the technology. However, in most cases the digitalization of the

whole production chain becomes necessary, including the setup of a company-internal IT department. As a consequence, this makes high investments inevitable, a longer project implementation phase and a time where old and new technologies will have to be run in parallel.

READILY AVAILABLE SOLUTIONS: |Yes|

Numerous software providers specialized in agribusiness solutions offer barcoding and traceability. It can be advantageous to select an all-in-one solution which covers the farmer registry, the quality control and the production chain including all processing activities (cleaning, packing, shipping, etc.). It is recommended to select a software provider who offers the necessary consulting services for the introduction and adaption of the software.

IMPLEMENTATION:

|Local or regional software firm.

|In-house IT has to be operational.

In most cases, the barcoding technology has to be integrated into existing procedures on an existing production chain. Hence, there is no common standard solution available on the market. The system architecture differs from case to case and has to be developed and adopted for every single setting. The lead firm usually does not have the required expertise and needs professional support.

In most cases it is advisable to contract a local or regional consulting firm with experience in the sector. Internationally acting agribusiness software producers usually operate regional offices which can provide the necessary consulting services. The consultant should have experience with the local setting and with the crop type(s) planted. The selected hardware for weighing produce, scanning barcodes and recording data has to be robust and resilient to allow operation in rain and dust.

Tool 5 : Supply chain management software

PROBLEM:

The agribusiness production chain includes a variety of processes, such as supply management, production management, and demand management to customers. In contract farming, additional issues, such as the difficulty in communicating with a high number of producers, in guaranteeing a homogeneous quality from these different producers and in managing the harvest-and-delivery process are standing in the way of competitiveness and success. Each step on the way has its difficulties, such as the diversity of production and demand, traceability, quality dissimilarities, complicated transport (perishability), and seasonality. Bookkeeping for hundreds or thousands of smallholder farmers and their payment in remote regions where banking services are rare or absent can make contract farming difficult. If the various risks and uncertainties cannot be mitigated, contract farming can be unattractive both to the lead firm and the smallholder farmers.

SOLUTION:

Supply chain actors are typically interdependent and need to manage several different types of risk. In one way or another, the majority of the ten tools presented in this brochure addresses the mitigation of risks. Supply chain management software is especially designed to comprise most of these tools or interconnects them. This software can thus play a major role in reducing the addressed risks and in improving the efficiency of the agribusiness. It helps reducing overhead and time loss, the latter of which poses a high risk to the quality of the produce. Agricultural supply chain management software is not restricted to contract farming; it is

common for all types of large-scale farming all over the world.

Supply chain management software covers the following objectives: producing crop plans on a parcel basis, calculating the necessary inputs with respective delivery and application dates, forecasting harvest dates and yields, organizing the delivery, buying and transportation process. The software helps to manage the quality control, the pack house input procedures and the traceability from the farm to the end user. It presents an opportunity to both farmers and lead firm to have more control over what their holding produces throughout the year. Such data can then serve as a basis for the farmer's business plan. Also, the software helps farmers to comply with the required certification regulations. Such a system can allow land users to integrate their crop plan, the type of manure they plan to use and the NPK-values of their soil, and return a balanced fertilizer plan.

The introduction of supply chain management software is always a complex task. It has to be based on a conceptual framework of the concerning agribusiness. The software solution will depend on the type of crops produced, the size of the farms in their entirety, the number of contract farmers with their average field size, the transport distances and road conditions, the target markets and the respective rules and legislations, etc. It also depends on the type of contract farming arrangement. Hence, a comprehensive analysis of the contract farming arrangement, the existing agricultural practices, the current and future markets, etc. needs to be done prior to selecting appropriate software. Due to the high level of complexity, which can include communication tools, crop planning, accounting functionalities, farmer registry, etc. it is recommended to make use of existing software. The development of a custom-tailored

solution might be too complex and thus expensive and time-consuming.

Performant supply chain management software integrates many of the functionalities, presented in this report under the headlines of the individual tools. The tools presented in this brochure also function separately and autonomously without any supply chain management software. Coupling all other nine tools will, however, also result in a kind of supply chain management software.

Normal complex variant

- 
- (a) Creation of application plans for every farmer and calculation of necessary supplies;
 - (b) Integration of GIS for the calculation of areas and yield;
 - (c) Integration of quality control, production of barcode stickers for end users;
 - (d) Integration of accounting with payments to farmers' accounts;
 - (e) Crop estimations.

Very complex variant

TYPICAL USE:

Not suitable for the informal model. Applicable particularly for the centralized and nucleus estate model.

PRIORITY: |High|

Lead firm: High, if the business reaches a certain size and a certain number of contracted farmers. Very high, if foreign export markets are targeted.

EXPECTED BENEFITS:

|High benefits; Effectivity;
|Traceability; Reduction of overhead

Lead firm and farmer: The introduction of supply chain management software aims for higher efficiency and thus higher incomes and the reduction of overheads. A precise planning of the crop cycles with estimation of inputs and outputs helps to reduce risks. Traceability is a prerequisite for the export of high-value crops to foreign markets.

PREREQUISITES: |High|

A competent and functioning company-owned IT department. A perfect understanding of all supply-chain-related processes.

COST-BENEFIT ASSESSMENT:

|High benefit at high costs; High risk|

Lead firm: Benefit for both sides by higher yield and quality resulting in higher incomes will outweigh the investment in the long term. In particular, the reduction of overheads and the acquisition of new markets can be high incentives for the introduction of this technology. Applicable only for large farms.

CHALLENGES: |High|

Lead firm: The software has to be carefully selected and introduced. **Contract farmers:** The farmers have to understand the processes; restructuring might cause confusion in the beginning and result in time loss. Ownership among the farmers has to be created in order to convince them of the solution.

REQUIRED IMPLEMENTATION STEPS: |Complex|

- (1) Case analysis;
- (2) conceptual framework;
- (3) market scan;
- (4) contracting a service provider;
- (5) purchase of a software;
- (6) adjustment of the software;
- (7) implementation of the software;
- (8) introduction and test phase.

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION: |High|

Prices vary according to the complexity of the solution but are generally high. Hard- and software has to be purchased; license costs have to be paid. Highly skilled staff has to be employed (but other staff will become obsolete).

READILY AVAILABLE SOLUTIONS: |Yes|

Many software solutions are offered for the management of agricultural supply chains. They usually do not particularly provide functionalities targeting contract farming. Therefore, the few of them that do provide contract farming management functionalities should be prioritized if possible. Some of the available software might be too sophisticated for the target scheme as they have been conceived for large-scale precision farming.

IMPLEMENTATION:

|Local, regional or international software firm

|Strong control by internal IT department

The complex technology of supply chain management software usually cannot be introduced without external expertise. Most software providers offer consultancy services for the adaption and introduction of the software. The first three steps of the implementation, however, should not be contracted to a software provider, as he will search for a solution based on his own software. Therefore, it is recommended to split the implementation in two contracts: (a) preparation (steps 1–3) and (b) implementation (steps 4–8). The company's IT department should be involved in all above-listed implementation steps.

Tool 6 : ICT tools for training smallholders: Farming techniques

PROBLEM:

In most cases, contract farming schemes produce for the export market and thus target the production of crops which formerly were unknown to the local communities. As a positive side-effect, this reduces the risk for side-sales and strengthens the mutual interest in a long-term partnership. Successful cultivation of unfamiliar crop, however, depends on the transfer of the necessary knowledge and techniques to the farmer. The lead firm has to make sure that the contracted farmers have the ability to grow the crop in the demanded quality and within the given timespan. Farmers who fail to produce the amounts of crop in the demanded quality cannot sell their produce to the lead firm and consequently will leave the contract farming business and search for more profitable alternatives.

Consequently, the lead firm's interest in building the necessary capacities at the farmers' level is high. Traditionally, the lead firm provides these training measures through extension services which may have local installations but highly depend on the centralized expertise available at the lead firm. There is a high need for frequent local field visits which entails travelling in rural areas. This procedure is resource-intensive in terms of time and money and also results in a large overhead of the extension services.

Wrong or missing farming techniques may result in low quality of the produce and/or low yields, both putting livelihoods into danger. Examples are: wrong farming techniques for the respective crop, insufficient pest and weed control, soil deterioration due to missing or wrong application of manure and fertilizers, unsuitable or missing crop rotation, etc. Besides, high water consumption and high water loss lead to water shortages downstream and may trigger conflicts.

SOLUTION:

The transfer of knowledge for better agricultural practices highly relies on practical or visual presentations. ICT cannot replace agricultural trainings but it can support them in various ways. Although not strictly ICT, the production of video modules, flyers and posters can intensify training by audio-visual support. This material should be specifically produced for the existing target group. Particular attention has to be paid to locally existing idioms and to the local agro-climatic setting. It makes little sense to present an Indian video about baby corn cultivation to farmers in Africa as they might not be able to understand the language and also might have a totally different approach for irrigation, soil preparation, etc. The best solution is to produce videos and posters on the farms of the contract farming scheme using local languages and local practices, in short: to tailor the training material to the local situation. Unlike training sessions, the videos and posters can be re-viewed and re-used repeatedly so that the knowledge acquired sticks better with the farmers.

Videos:

By far the best medium to transfer agricultural knowledge. Use the locally spoken idioms and produce the video in a well-known surrounding. The video can also present the whole production chain "from farm to fork" and that way create a better understanding for the complexity of the contract farming business.

Posters and photo guides:

The cheapest way of training. But opportunities are limited. Use photos and pictograms frequently as the literacy rate might be low. Use colour printing if photos show plant varieties, pest incidents and other colour-sensitive features.

Possible topics are:

- Ground preparation, minimal soil disturbance, permanent soil cover;
- Planting and crop-rotation;
- Application of spray, fertilizer, manure;
- Best weed and pest control practices;
- Best harvesting practices;
- The contract farming business – “from farm to fork”.

Simple variant



- (a) Production of posters and photo guides/flyers promoting best agricultural practices;
- (b) Production of thematic videos.

Medium complex variant

TYPICAL USE:

Best suited for the centralized and nucleus estate model. For multipartite, intermediary and informal CF models, tools can be handed over to the third party who is giving the technical advice.

PRIORITY: | High |

Lead firm: High. **Farmers:** High.

EXPECTED BENEFITS:

| High benefits at low/medium costs |

Lead firm and farmer: Better agricultural practices will result in higher quality of the produce and a higher yield; this will bring benefits to both lead firm and farmers. A better

understanding for the contract farming business will result in a better team play of farmers and firm. **Lead firm:** The introduction of the technology can help to reduce the extension overhead and will result in lower costs. A lower travelling frequency of the extension staff releases time for other activities such as the development of new farms and the extension of the business.

PREREQUISITES:

| Power supply

| OR alternatively autonomous hardware

For the presentation of videos or PowerPoint presentations the necessary infrastructure has to be available. Power supply is mandatory for a regular video projector. Portable video projectors do exist, which can be operated on batteries. Some projectors allow to project videos directly from USB, which makes the computer redundant. If the literacy rate among the farmers is high, handbooks and flyers can be used. This situation, however, is rare and the lead firm has to be careful not to exclude the poorest farmers of the communities.

COST-BENEFIT ASSESSMENT:

| High benefit at medium costs; No risk |

Lead firm and farmer: Benefit for both sides by higher yields and higher quality resulting in higher incomes. **Lead firm:** The production cost of a high-quality video might be considerable. But this type of video can be re-used for all contracted farmers in all communities and might attract and convince other farmers to engage in contract farming. **Farmers:** The training videos can be presented in the evenings so that farmers do not lose time they would usually spend doing husbandry on their fields.

CHALLENGES: |Medium|

Lead firm: The production of high-quality videos can be time-consuming. Also, for the presentation of the videos in the farmer communities, travelling might become necessary.

Farmers: none.

REQUIRED IMPLEMENTATION STEPS: |Medium|

- (1) Selection of topics;
- (2) Writing scripts;
- (3) definition of length and content;
- (4) contracting a producer;
- (5) realization of the video(s);
- (6) acquisition of hardware for projection;
- (7) dissemination programme (travels).

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION: |Medium|

Prices for the production vary locally and also depending on the length, contents and quality of the videos. The local market has to be scanned for pricing. As usual, the cheapest offer will not always result in the best quality.

READILY AVAILABLE SOLUTIONS: |No|

Not available. There are, however, a lot of examples on YouTube which might be useful for inspiration.

IMPLEMENTATION:

|In-house (flyers)

|Local and regional (videos, flyers)

While flyers and handouts can be produced in-house, the production of videos demands expertise and material. Local media firms offer the production of videos. The contents of the videos, however, must come from the lead firm. Hence it is necessary to write a script before engaging a production company.

from USB, which makes the computer redundant. If the literacy rate among the farmers is high, handbooks and flyers can be used. This situation, however, is rare and the lead firm has to be careful not to exclude the poorest farmers of the communities.



Tool 7 : ICT tools for empowering smallholders: Basic management capacities

PROBLEM:

The very nature of contract farming makes it reasonable that all stakeholders should dispose of a certain degree of management capacities. Depending on the type of contract farming arrangement, the buyer or lead firm partially takes over responsibilities. Frequently, the lead firm does the entire financial book-keeping, all planning of supplies and application plans. In any case, the farmer himself should have some basic management skills. These capacities concern financial literacy, stock management, and decision-making in terms of planning, implementation and control of decisions at the farm. The farmer should also have awareness of environmental issues, such as solid waste disposal and catchment management.

In many cases the farmers' lack of confidence in the contract farming procedures, especially in the accounting process, is attributable to a lack of understanding. Basic financial capacities can help to build trust and confidence and thus can help to make the contract farming arrangement more sustainable and resilient against other influences. Better decision making capacities can prevent the farmer from taking the wrong decisions, in particular regarding investments and the environment.

Smallholder farmers in and also outside Africa are generally poor and higher education is scarce. This and their limited financial resources stand in the way of their using auxiliary means like tablets or computers. Many farmers do not even own a writing pad to record the basic data for the bookkeeping, such as expenses for the inputs and the detailed information about the sales. Without this information, planning is impossible.

From the viewpoint of a farmer, it is most attractive to plant the type of crop which grants

the highest revenues while demanding a minimal input of labour and money. But a decision can only be taken if the farmer can refer to detailed data about the past crop cycles, the applied practices and the past earnings. The yield itself not only depends on the agricultural practices but also on the natural conditions of a site, such as soil type, slope or drainage, and on climatological parameters, in particular the availability of water. The more farmers understand about the big picture and about the scope of their individual actions, the more resilient and effective their contribution and the agribusiness will become.

SOLUTION:

The building of management capacities and financial literacy amongst farmers can be supported by ICT. The lead firm can provide the farmers with reports about deliveries and purchases, about balances and market prices. These reports can either be handed over on paper or sent via SMS (see Tool 2). More sophisticated solutions allow the farmer to view his own data via a downloadable, custom-tailored app. This app can be developed in such a way that the mobile data network is needed only for the download of new data. Thus, the farmer can use all data in the offline mode.

Simple variant

- 
- (a) Lead firm provides trainings for farm management and bookkeeping (video or audio trainings via ICT);
 - (b) Lead firm provides farmers with monthly reports on paper and trainings on how to make use of them;
 - (c) Lead firm provides farmers with daily/weekly/monthly reports as SMS and training how to make use of them;
 - (d) Lead firm provides web site where common and/or individual data can be accessed by the farmer;
 - (e) Lead firm provides relevant/selected data on a server and an app for the farmer to make use of.

Complex variant

TYPICAL USE:

Best suited for the centralized and nucleus estate model. For the multipartite, intermediary and informal CF models, tools can be handed over to a third party, responsible for giving the technical advice.

PRIORITY:

| Medium to high

| Depending on type of CF model

Farmer: High; **Lead firm:** Medium to high.

EXPECTED BENEFITS:

| High benefits |

Lead firm and farmer: A better understanding of the contract farming business can lead to trust and confidence and makes the business more

sustainable and resilient against crises. Better management capacities will result in higher incomes for both farmers and lead firm as produce will be available on time and in the necessary volumes and quality. Water loss will be mitigated. In the long run, responsibilities will be shifted from the lead firm to the farmer.

Farmer: Better management practices will prevent the farmer from taking the wrong decisions. A higher financial literacy will make the farmer's business more profitable and resilient. Downstream farmers will benefit from better water management by upstream farmers.

PREREQUISITES/RISKS:

| Power supply

| OR alternatively autonomous hardware

The building of management capacity and financial literacy is difficult if not impossible among illiterates. The development of reports for the farmer needs to be based on a functioning Enterprise Resource Planning (ERP) system (tool 5) at the lead firm. The accounting software for contract farming usually stores all necessary data; however, it depends on the solution, whether it is capable of (automatically) providing the reports needed. For the SMS solution, tool 2 has to be coupled to the financial software in use. For the web and app solutions, a web server could have to be rented, allowing the dissemination of tailored information to the individual farmer.

COST-BENEFIT ASSESSMENT:

| High benefit at medium costs; No risk |

Lead firm and farmer: Trainings for better management capacities are not typically very expensive but their impact can be considerable; cost-benefit for variants (a) and (b) is therefore considered to be very high.

Complex variants: the complex variants (c) to (e) are expensive and entail continuous costs. This type of service cannot be financed by the lead firm only. It may be realized only once the farmers' financial potentials and management capacities are sufficient to actually make use of the trainings and data.

CHALLENGES: |Medium|

Lead firm: Higher management capacities at farmer's level might lead to a lower acceptance of the lead firm's planned targets.

Contract Farmers: Among the farmers the illiterates might be left behind. For the more complex variants, bigger farmers will adopt the new procedures while smaller and poorer farmers might not have the financial means to join.

REQUIRED IMPLEMENTATION STEPS: |Medium|

- (1) It is recommended to build the capacities on the farmers' side first, using training modules. For this purpose, guidelines, flyers, handouts or videos (tool 6) can be produced.
- (2) As a second step, tools can be developed for the farmers allowing access to their data via SMS, web portal or app.

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION:

|Medium to high|

The simple variant of trainings is at low to medium costs while the complex variants are cost-intensive.

READILY AVAILABLE SOLUTIONS: |No|

Not available.

IMPLEMENTATION:

|In-house (trainings)|

|Local and regional (SMS, web, app solutions)|

The simple variants (a) and (b) can either be realized in-house or by contracted trainers. The more complex variants (c)–(e) require an IT firm to be involved.



Tool 8 : ICT tools for diagnostics and advice

PROBLEM:

The lead firm (buyer) highly depends on timely deliveries of good quality products. As the quantities and dates for the export of a specific crop are usually negotiated with an overseas buyer in advance, shortages or delays in the delivery of the products from the contract farmers to the lead firm for further processing can disrupt the process severely. It is in the interest of the lead firm as well as of the farmers that no loss of crop occurs, no matter if it is due to pest, drought, heavy rains or other problems. Thus, action has to be taken as soon as a problem occurs or even better: before the problem gets severe. In case advice is needed, the communication chain is often complicated and time-consuming while it should be as short and responsive as possible. The resulting delay often entails a partial loss of the crop or quality degradation. The risk the lead firm has with its clients can have a critical impact for the future of the lead firm, and as a final consequence for all contracted farmers as well.

SOLUTION:

Locally available knowledge is the best remedial measure (tool 6). If advice cannot be found at the local level, ICT is a strong means to accelerate and specify answers to the questions. The simplest way is the use of mobile phones for a precise description of the problem and for asking advice on how to mitigate it. The extension services have to provide a hotline number during day hours. Usually the lead firm has comprehensive knowledge of all possible pest incidents and of the possible results of wrong agricultural

practices. Mitigation actions can be communicated via phone but in most cases might need a site-visit of an extension worker for a better understanding of the problem, its size and for the implementation of the remedial action. The description of the distinct problem can be enhanced by taking photographs with a smartphone and by sending them to the lead firm's diagnostics centre via WhatsApp or any other data channel.

Simple variant

- 
- (a) Lead firm provides a hotline number to call for diagnostics and advice;
 - (b) Farmer sends photos of the problem (leaves, root, fruit..) to an extension worker to call for advice;
 - (c) Farmer uploads a photo of the problem (leaves, root, fruit...) to a diagnostics server which identifies the problem and automatically sends an advice message.

Complex variant

TYPICAL USE:

Best suited for the centralized and nucleus estate model. For the multipartite, intermediary and informal CF models, tools can be handed over to a third party, responsible for giving the technical advice.

PRIORITY:

| Depending on type of CF model |

Farmer: Depends on the capacities of the farmers to remediate the problems with local advice. **Lead firm:** Depends on the existing extension procedures. If they are functioning, priority might be low.

EXPECTED BENEFITS:

| Higher incomes; Higher security |

Lead firm and farmer: A smarter, clearer and faster communication chain between the farmers and the knowledge base will reduce risks of loss and quality degradation of the crop. This improves security on both sides and leads to higher incomes. An exact description of the problem supported by photos can help extension workers to give the right answers from far away. This reduces extension overhead and travel costs.

PREREQUISITES/RISKS:

| Power supply

| OR alternatively autonomous hardware

The introduction of mobile phone based tools requires the availability of the mobile network in the rural target areas. Photos can be sent as MMS via GPRS but the use of smartphones and apps needs a higher quality data transferring network technology. Variant (c) cannot guarantee that problems can be automatically identified. A site visit by the extension worker might still be necessary.

COST-BENEFIT ASSESSMENT:

| High benefit; No risk |

Simple variant: Every existing extension service usually offers phone calls to the extension officers. The provision of one or more specific hotline number(s) for reporting pest incidences and the like is not related to any additional costs. It can have a high impact as response times are lower.

Complex variants: the more complex variant (b) is inexpensive but would probably make it necessary to provide smartphones or tablets to the extension officers. Variant (c) is very sophisticated. This approach is still in the testing phase and is not yet considered to be fully operational. Farmers would have to acquire smartphones.

CHALLENGES: | Medium |

Lead firm: No challenges for variant (a). For variant (b) the extension officers would have to be trained to interpret photos of the plants and their potential diseases. Depending on the crop types cultivated, variant (c) can be feasible.

Contract Farmers: Taking clear pictures for the interpretation of the problem is not a simple task. Also, low general literacy, low IT literacy, low financial resources and weak networks might interfere with the distribution of the smartphone technology (variant (c)).

REQUIRED IMPLEMENTATION STEPS: |Medium|

- (1) The extension service has to be restructured and focal points have to be denominated for specific problem areas.
- (2) If the farmers own smartphones or are willing to invest into this technology, the extension workers (maybe only foremen) have to receive the appropriate technology (smartphone or tablet) as well.
- (3) Variant (c) is very sophisticated. It takes time to train the server to be able to identify the most common diseases and problems. This might be an option for very advanced CF schemes or for cooperation with an international research institute.

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION:|Medium|

Variant (a) is free. Variant (b) is a low-cost solution. Variant (c) is not very expensive, either, but the benefit will not be visible immediately.

READILY AVAILABLE SOLUTIONS: |No|

If mobile network is available in the target regions, variants (a) and (b) can be realized immediately. For variant (c) an app is available (see ‘Integrated Solutions – PEAT’ on p. 34) but cooperation with the developers is recommended.

IMPLEMENTATION:

|In-house (trainings)

|Local and regional (SMS, web, app solutions)

The simple variants (a) and (b) can be realized in-house. For the realization of the diagnostics app solution it is recommended to get in touch with the developing research institute.



Tool 9 : ICT supported financial services

PROBLEM:

Delays in payments from the lead firm are a major cause for dissatisfaction among the farmers. Long distances between the lead firm and the farms frequent payments cumbersome. In most cases, the lead firm makes payments once per month. As most farmers do not dispose of a bank account, the payments have to be made in cash which is risky in most remote regions and also resource-consuming as a car has to travel and often security personnel has to accompany the vehicle.

It is possible that harvesting a parcel takes as long as two months or even longer. As a first payment, the farmer receives the money for the delivered crop less the money for the delivered inputs and services. The resulting balance can be very little or even zero. Thus, the farmer has to wait one additional full month before he receives the money for the rest of the delivered crop. The use of bank accounts usually leads to a more careful handling of the earnings and to better planning of the monthly obligations.

SOLUTION:

For the described reasons, cash money transfer should be replaced by other payment channels (see benefits). Banking services, however, can be sparse in rural Africa, as branches usually only exist in larger towns. Another option is the use of mobile payment services. In some African countries these services are well known and are highly appreciated by a large part of the population while in others they are virtually non-existing.

Depending on the situation regarding service availability, pricing and the presence of locally installed agents, either bank account payments or mobile payments should be favoured.

It is also technically possible and organisationally feasible to offer both ways of payment to the farmer to choose from.

Once the new payment method is available for the money transfer to the farmers, payment modalities can be reviewed and optimized, depending on the software which is in use at the company's finance department. The objective ought to be timely payment, right after delivery of the last part of the crop from one particular parcel.

Simple variant

- 
- (a) Payment to farmers via bank transfer;
 - (b) Payment to farmers' mobile accounts;
 - (c) Automatization of the payment process.

Complex variant

TYPICAL USE:

Best suited for the centralized and nucleus estate model. Less suitable for the multipartite, intermediary and informal model.

PRIORITY:

| Depending on type of CF model |

Farmer: High. The farmer expects the payments directly after delivery or at least after the harvest of a particular parcel is complete.

Lead firm: High if the solution mitigates the risk of attacks and theft.

EXPECTED BENEFITS:

| High benefits |

Lead firm: Lower risk of theft and attacks; lower costs in the long term as no transportation to rural areas is necessary; possibility of automatizing payments from the company's financial software.

Farmer: The farmer expects frequent and timely payments. A delivery-based payment would be the best choice; parcel-based payment directly after the final delivery from one parcel can also be acceptable. The use of bank accounts forces the farmers into better financial planning of their livelihoods which can be of benefit for the entire living conditions of the farmer's family.

PREREQUISITES/RISKS:

| Power supply

| OR alternatively autonomous hardware

Mobile payment services: The potential for the introduction of mobile phone-based payment services depends on the mobile network coverage in the rural target areas. Furthermore, if the

farmer receives the money on his mobile account but there is no local agent where he can withdraw cash, the system is not likely to be accepted by the farmer and will not work. **Bank**

accounts: The same applies to bank accounts: Without a local branch or a locally installed agent, the banking services are likely to fail.

Lead firm: The introduction of cashless payment methods has to target the full cancellation of cash payment, otherwise the costs for the transport would persist. **Farmers:** In rural areas people are used to cash money, means of cashless payment are unknown. Farmers might mistrust the new modalities and thus show low acceptance. Without financial incentives and without accompanying awareness-raising measures, the farmers are likely to oppose cashless payment.

COST-BENEFIT ASSESSMENT:

| High benefit at medium costs

| Savings in the long term; risk

Lead firm: Money transfer to mobile accounts or bank accounts results in costs; whether these costs are lower than the costs related to the existing cash money transfer method depends on the distances, the number of farmers to pay, road quality, salaries and the security situation. Taken together, the benefits will most probably outweigh the problems; but if it proves impossible to change to cashless payments for ALL farmers, the remaining cash payments will continue to cause the same high costs for transportation. **Farmers:** For the farmers, a timely processing of payments is of high benefit. In the long term, cashless payment is likely to induce a higher financial literacy among the farmers.

CHALLENGES:

| Low, if local agents are available
| Otherwise high.

Lead firm: In case no local agents are available in the target region, negotiations have to be conducted with banks and/or mobile payment service operators; the number of potential new clients can be an incentive to expand their services into the target region.

Contract farmers: Opening a bank or mobile payment account cannot be forced on the farmers. Through incentives and awareness-raising measures the farmers have to be convinced to change their financial behaviour voluntarily.

REQUIRED IMPLEMENTATION STEPS: | Can be complex |

- (1) Baseline study:
 - Collect information about availability and prices for banking and mobile payment services in the country.
 - Check availability of local agents in the target region(s).
 - Farm-level survey collecting information about existing financial literacy and availability of bank/mobile payment accounts.
- (2) Optional: If no local agents are available, negotiations with potential service providers to expand their services into the target region.
- (3) Development of a business model.
- (4) Assisting farmers in opening accounts and collecting the information.
- (5) Operationalizing the new (alternative) payment.

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION:

| Low to medium |

Costs for the lead firm are necessary mainly for the implementation steps listed above, thus for human resources necessary for the implementation of the process. In the long term, the solution will produce savings.

READILY AVAILABLE SOLUTIONS: | No |

Solutions for banking and/or mobile payment services have to be available. For variant (c) software exists that allows the configuration of payment plans. Any professional accounting software will be able to configure payment plans.

IMPLEMENTATION: | In-house |

If banking services are available with local agents in the target areas, the main topic of the project would be to attract and convince farmers to make use of the technology. If those agents are not yet available, it might be helpful to ask partners of the development world for assistance in negotiating with banks and mobile payment providers.

Tool 10 : Sensors, GIS and remote sensing

PROBLEM:

In agriculture, most data has a spatial reference: Water consumption depends on the size and the situation of the parcel. Productivity depends on the soil type, slope, applied techniques and solar insolation, which all vary over time and space. Transportation costs depend on distances, the availability of roads and waterways and their conditions. The absence of this information often slows down better planning or the identification and introduction of appropriate agricultural practices. Finding new lands and small-holders best suited for the crop to plant is difficult.

In many places, water resources are limited. Uncontrolled water consumption severely affects farmers downstream. But water extraction rates are unknown in most cases (e.g. flood irrigation). If figures exist, there are no procedures in place to make use of the information and to mitigate the problem.

SOLUTION:

Introducing high technology such as sensors and geographical information systems (GIS) opens the field of precision farming where high-precision positioning systems (like GPS) play a major role. Modern tractors can collect all kinds of information. Integrated electronic communication between tractor and farm transmit this information to a control and analytics centre for analysis. Sensors measure the soil moisture and control the sprinklers for the best conditions for the plants.

For contract farming schemes in less developed countries, most of these solutions are too expensive and too sophisticated. Still, some of these technologies might be useful and worth the investment. Using GPS for geo-mapping the

farmers' plots, for instance, can be very useful for a better understanding of the local conditions. This knowledge can help to identify the best crop varieties for the specific parcels and can help to optimize irrigation schemes and plans. This information will also be useful for fighting and mitigating pest incidences and for optimizing transportation routes. It results in higher yields and a more sustainable management of available resources. Drones with infrared sensors can be very effective for early warnings and for harvest control, but this technology is applicable only for cash crop CF schemes. Satellite images are becoming less and less expensive. They are a good source for the identification and development of new agricultural lands. Technologies and application fields vary very much. The classification below is neither complete nor always applicable.

Simple variant

- 
- (a) GPS-mapping of parcels and visualization on Google Maps; connection with farmer registry;
 - (b) Operation of sensors for continuous monitoring (climate, water consumption, soil moisture);
 - (c) Using satellite and airborne imagery for the identification of additional agricultural lands;
 - (d) Using GIS for the correlation of natural parameters, agricultural practices, and the resulting yields.
 - (e) Use of drones for the creation of digital elevation models in case of drainage issues, for the design of irrigation schemes, for harvest control, etc.

Complex variant

TYPICAL USE:

Best suited for the nucleus estate model where the buyer owns the land. Also suitable for large and medium centralized models. Less suitable for the multipartite and intermediary model. Not suitable for the informal CF model.

PRIORITY:

| Varying |

Farmer: Low. Advice on the identification of best practices to obtain the highest yield will be a great advantage. **Lead firm:** Depending on the agribusiness, the priority can be very high.

EXPECTED BENEFITS:

| High benefits |

Lead firm: The mapping of plots and their sizes is a prerequisite for all agri-cultural activities, such as crop estimation or area-based water payment. Overlay of the plots and correlation with other data, such as soil types, nutrient maps, slope, etc. allows the development of site-specific application plans and tackling drainage issues. Lower water consumption will improve the yields on farms that are situated downstream. A sophisticated procedure for the identification of new agricultural lands will give better results. A better harvest and delivery system will improve the quality of the products and reduce costs and loss of time.

Farmer: Early warning in case of pest incidents or severe weather conditions will bring higher security for the farmers and increase incomes. Farmers benefit from more precise advice for the selection of varieties for a specific plot, for the appropriate application plan and for timely warnings in case of pest incidents. Downstream farmers will benefit from a more sustainable upstream management of water resources.

PREREQUISITES/RISKS:

| Power supply

| OR alternatively autonomous hardware

Lead firm: The lead firm needs to build appropriate capacities; otherwise it will not be worth the investment. Sensor technology is highly sensitive and needs careful handling and protection against damage by theft and vandalism. Solar panels, for instance, are frequently target of theft. **Farmers:** None.

COST-BENEFIT ASSESSMENT:

| High benefit at medium costs

| Savings in the long term; risk

Lead firm: Precision farming has a high potential for streamlining, automatization and thus for economization. But the high investments are justifiable for large contract farming schemes only. GPS mapping of the farmers' plots and visualisation via Google maps is a low-cost solution with high technical impact.

Farmers: A better site-specific advice on what to plant, when to plant, and what kind of fertilizer to apply at a certain date would be highly appreciated by the farmers and would result in higher yields, better incomes and lower risks.

CHALLENGES:

| Low, if local agents are available

| Otherwise high.

Lead firm: Before investing in precision farming, a comprehensive feasibility study has to be conducted and the financial attractiveness has to be evaluated. Parcels might be reshaped, split or merged from time to time. Hence the mapping needs frequent updates. A solution is the definition of blocks within the parcels. These blocks

then remain static and will be used by the farmers to grow the produce for the lead firm.

Contract farmers: None.

REQUIRED IMPLEMENTATION

STEPS: | **Can be complex** |

Variants (b) to (e) all rely on solution (a) but can be implemented independently from each other.

Variant (a): GPS–mapping of the parcels and blocks is a prerequisite for precision farming and should be the first step. This database should be coupled with the farmer registry. On this basis, areas can be calculated and neighbouring parcels can be identified. Variant (b): For the installation of sensors, the area has to be studied and the best locations for the sensors have to be identified. An appropriate mode of data transfer has to be realized. Purchase and installation of the sensors and the related database. Variant (c): This solution needs a high level of expertise, expensive software and powerful hardware. It is recommended to contract a specialized firm.

Variants (d) and (e): Likewise, the application of GIS and remote sensing (RS) needs a high level of expertise, expensive software and powerful hardware. It is recommended to contract a specialized firm.

REQUIRED INVESTMENTS TO IMPLEMENT SOLUTION:

| **Low to very high depending on variant** |

Variant (a) requires the purchase of a few GPS devices (~ 200–300 USD each) but no additional hardware or software. The necessary human resources for the geo-mapping of all parcels can be significantly high. Variants (b) to (e) all are expensive investments and only a case-specific

analysis can provide further information on costs and expected benefits. These solutions usually have to be realized by specialized firms or consultants – hardware investments are only related to variant (b).

READILY AVAILABLE SOLUTIONS:

| **No** |

There are free and powerful tools for the work with satellite and airborne images as well as GIS data. The production chain from GPS mapping to the visualization of the plots in Google Earth is short and not too complex. The full potentials of precision farming however cannot be exploited without appropriate expertise to integrate the different sensors and sensor networks into one functioning system.

IMPLEMENTATION:

| **Partly in-house**

| **Contract with specialized firm or consultant**

Variant (a) can be implemented with in-house capacities as GPS devices today are user-friendly and intuitive. The calculation of areas, the visualization in Google Earth and interfacing this data with the farmer registry, however, needs IT expertise and most probably has to be contracted. Variants (b) to (e) cannot be handled in-house.

Integrated solutions

The presented tools 1 to 10 cannot always be considered separately. The farmer registry, for instance, is a prerequisite for a seamlessly functioning SMS service. One tool might need interfaces to other tools. That way integrated solutions evolve, which cannot strictly be assigned to one of the ten presented fields of application.

For exactly this reason, many of the solutions developed for existing agribusinesses and contract farming schemes, have emerged as a mixture of the presented tools. Some of these “hybrid solutions” are available for money, others are free.

Most ICT solutions in agriculture were particularly conceptualized for a very specific agro-industrial subsector and a very specific situation. The different agribusinesses vary in their crops or products, their size, country, language, environmental conditions, remoteness of the location, etc. It is not the object of this document to give a comprehensive list of all possible solutions.

The six solutions presented below offer functionalities helpful for the contract farming business. Some solutions can be used for free, others have to be purchased or are licensed.



SAP Rural Sourcing Management

What:	Value chain management, traceability, farmer registry, prepayment, purchase; for cashew, shea, coffee, cocoa, rice, sesame.
Technology:	SAP, smartphones.
Features:	• Support of data analysis; • Facilitates operational field support; • Ensures traceability.
Modalities:	Commercial solution.
Benefits:	Introduction of traceability for export; Higher incomes for both sides, higher transparency; reduction of overhead.
Contact	http://www.africancashewinitiative.org



AGRIMANAGR

What:	Combination of supply chain software, farmers registry and data collection with GPS.
Technology:	Smart phones, tablets, digital scales, GPS, email and database.
Features:	• Introduction of digital scales; • GPS coordinates of transaction location; • Receipts to farmers; • Tracking of transportation; • Comparison of drop-off weights at the warehouse with pick-up weight.
Modalities:	Commercial solution. Paid for by the lead firm – free for the farmer.
Benefits:	Reduction of overheads for company.
Contact	http://www.virtualcity.co.ke/

ConnectedFarmer (Vodafone/Mezzanine)

What:	Communication, data collection & mobile payment.
Technology:	Basic phones for farmers, android devices for company.
Features:	• Introduction of digital scales; • GPS coordinates of transaction location; • Receipts to farmers; • Tracking of transportation; • Comparison of drop-off weights at the warehouse with pick-up weight.
Modalities:	Commercial solution. Set up costs, licensing fees, communication fees, M-PESA transactions (mobile payment).
Benefits:	Increased income for farmers, reduction in overhead for company, increased volume of supply, increased attendance at annual general meetings.
Contact	http://www.mezzanineware.com/agriculture/

ESOKO Push

What:	Bulk messaging to drive sales, source products, launch campaigns, or communicate best practices
Technology:	SMS or recorded voice messages
Features:	• scheduling series of messages; • personalized alerts for each farmer; • customization by language, currency and measure; • scheduled messages by day and hour; • reusable templates.
Modalities:	Commercial solution. Paid for by the lead firm.
Benefits:	Better reaching of farmers; reduction of overheads for company.
Contact	http://www.esoko.com

ESOKO SMS Polls

What:	Two-way polls to send out simple questions via SMS and map the answers automatically.
Technology:	SMS polling
Features:	• reaching thousands of farmers at once • responses are shown in lists or on maps • data download for further analysis
Modalities:	Commercial solution. Paid for by the lead firm.
Benefits:	Easier collection of data; reduction of overheads for company.
Contact	http://www.esoko.com

Farmforce

What:	Planting and harvest planning, barcoding, GPS mapping, farmer registry and SMS communication; integrated mobile platform to manage smallholder farming.
Technology:	Basic mobile phones, smart phones.
Features:	• Planting details of each field; harvest planning; • Tracking costs for farming inputs, operators and equipment; • Communication with field staff and farmers via SMS.
Modalities:	Commercial solution. Syngenta Switzerland.
Benefits:	Full supply chain software; Efficient planning results in higher incomes for both sides; Certification compliance through traceability -> new markets.
Contact	http://www.farmforce.com

PEAT PLANTIX

What:	Diagnostics & advice
Technology:	Smartphone app for farmers.
Features:	• Plant damage diagnostic app. Recognizes plant diseases, pest and nutrient deficiencies by a picture sent to it; • Automated image recognition and sending of options for action to farmer; • Adaptive database; • Geo-statistical analysis; • Digital library of plant diseases, pests and their treatments; • Text-to-speech technology is easy to integrate (in case of low literacy); • Multi-lingual.
Modalities:	Use of the app is free; databases are available for Brazil, India, and Germany. Setup of a case-specific database needs expertise.
Benefits:	Uplift of income and reduction of risks for both sides.
Contact	http://www.peat.ai

Decision guidance – by CF model

	Contract farming model ³				
	Informal model	Intermediary model	Multipartite model	Centralized model	Nucleus estate model
Summary⁴	Speculative, seasonal sourcing on an ad-hoc or semi-formal basis and spot-market transactions; few if any inputs/services provided to farmers; minimal firm/farmer coordination; little to no product specification by buyer	Semi-formal to formal subcontracting by buyers to partner intermediaries (e.g. lead farmers, farmer groups, buying agents) who manage contracted farmers & provide services; limited direct firm–farmer interaction; enhanced but limited product specification	Buyer sources from farmers & farmer groups; technical assistance/ input/ credit provision & grower management via 3rd parties; limited firm– farmer coordination; higher level of product specification necessitates close monitoring/ supervision of production	Buyer provides technical assistance/ inputs directly, purchases crop, handles many postharvest activities; farmers provide land & labour; high degree of firm– farmer coordination; strict product specifications monitored by in-house technical staff; often linked to processing	Buyer operates centralized production and processing (estate), supplementing throughput via direct contracting with farmers; buyers often own/control land used by farmers who supply labour; buyer provides technical assistance/inputs/ credit; close monitoring/ supervision
① Farmer registry	Variants (a) or (b) optional in form of an address book.	Variants (a) or (b) optional in form of an address book of lead farmers/ buying agents.	Variants (a) or (b) optional in form of an address book of lead farmers/ buying agents.	Variants (a) or (b) mandatory even for small CF schemes. Variants (c) – (g) for higher number of farmers	Variants (a) or (b) mandatory even for small CF schemes. Variants (c) – (g) for higher number of farmers.
② Bulk SMS, voice mail & USSD	Good tool for dissemination of prices and dates.	Messaging to lead farmers, farmer groups, buying agents only.	Interesting for 3rd parties	High priority High benefits Low investment Network available?	High priority High benefits Low investment Network available?
③ Data collection by SMS polls and surveys	Good tool to scan the market	Depending on the number of lead farmers, farmer groups, buying agents.	Interesting for the 3rd parties	High priority High benefits Low investment Network available?	High priority High benefits Low investment Network available?
④ Barcoding and traceability	Not applicable	Not applicable	Not suitable	Mandatory for organic produce and the European market. IT department available?	Mandatory for organic produce and the European market. IT department available?
⑤ Supply chain management software	Not applicable	Not applicable	Not suitable	High benefit High investment. High risk.	High benefit High investment. High risk.
⑥ ICT training: Farming techniques	Not suitable	Interesting for lead farmers, farmer groups	Interesting for the 3rd parties	High benefit Medium investments	High benefit Medium investments
⑦ ICT training: Management techniques	Manuals only	Manuals only	Manuals only	All five variants	All five variants
⑧ Diagnostics and advice	Interesting for any farmer	Interesting for any farmer	Interesting for any farmer	Sophisticated tool for quality control.	Sophisticated tool for quality control.
⑨ Financial services	Depending on country situation	Depending on country situation	Depending on country situation	Very suitable, if existent	Very suitable, if existent
⑩ Sensors, GIS and remote sensing	Not applicable	Not suited	Not suited	Very suited	Very suited

³ Eaton, C. and Shepherd, A., Contract farming: Partnerships for growth. FAO Agricultural Services, Bulletin 145, Rome, 2001, p. 44 ff.
Another FAO web resource: <http://www.fao.org/docrep/004/Y0937E/y0937e05.htm>.

⁴ Will, M., Contract farming handbook, Volume 1, GIZ 2013, p. 19.

Decision guidance – by crop/product type

	Crop/product type				
	Fresh fruit/vegetables for local market	Products of uniform quality for processing	High value fresh produce for export	Livestock, poultry, aquaculture	Dairy products
Summary	Horticulture, tree crops	e.g. sugar cane, tobacco, tea, coffee, cotton, nuts	Legumes, horticulture, tree crops	Beef, sheep, pigs, chicken, fish, prawns	Milk
① Farmer registry	Variants (a) and (b) helpful	Variants (a)–(g) very helpful	Variants (a)–(g) very helpful	Variants (a)–(g) very helpful	Variants (a)–(g) very helpful
② Bulk SMS, voice mail & USSD	Variants (a)–(d) very helpful for communication of prices, dates, etc.	Very helpful for communication of prices, dates, etc.	Variants (a)–(g) very helpful for enhanced communication	Variants (a)–(g) very helpful for enhanced communication	Variant (g) very helpful as products get collected daily
③ Data collection by SMS polls and surveys	Can be helpful	Very helpful to mitigate risks	Very helpful to mitigate risks	Very helpful to mitigate risks	Can be helpful
④ Barcoding and traceability	Not necessary	Can be helpful	Prerequisite for export	Partly suited	Not suited
⑤ Supply chain management software	Can be helpful	Very suited	Very suited	Very suited	Very valuable as products get collected daily
⑥ ICT training: Farming techniques	helpful	Very helpful to ascertain product quality	Very helpful to ascertain product quality	Very helpful to mitigate risks	Very helpful
⑦ ICT training: Management techniques	Very helpful	Very helpful	Very helpful	Very helpful	Very helpful
⑧ Diagnostics and advice	Helpful	Very valuable to mitigate risks	Very valuable to mitigate risks	Very valuable to mitigate risks	Very valuable to mitigate risks
⑨ Financial services	Very valuable, if existent	Very valuable, if existent	Very valuable, if existent	Very valuable, if existent	Very valuable for automatic payment of daily deliveries
⑩ Sensors, GIS and remote sensing	Not suited	Very helpful	Can be helpful	Not suited	Not suited



Keys to success

Keep it simple!

ICT is not the target and ICT is no miracle cure; ICT is a means of providing better services and streamlining existing processes. In many contract schemes the service coverage for mobile phones is not complete or the literacy of the farmers is not high enough, so lower-technology solutions, such as radio emissions may be the better choice for years. ICT solutions have to be as simple and user-friendly as possible.

Create trust and confidence!

It is of high benefit for the contracted farmers to fully understand the arrangement. Videos or flyers presenting the full process “from farm to fork” along the value chain can help to build understanding and trust. Better payment modalities and the mitigation of risks will create visible advantages of the contract farming arrangements.

Create solutions with benefits for both sides!

Communicate the potentials of the solutions to the farmers in an understandable way. Most of the ICT solutions will fail without the support/collaboration of the farmers. Both sides should benefit from higher production and improved product quality. Both sides should profit from lower risks and early warnings. The remaining risks should be shared fairly between lead firm and farmers.

Create sustainable and affordable solutions!

Services that take a significant share of the farmers' incomes are likely not to be adopted by the farmers. Free information services, however, frequently do not receive the full appreciation. Wherever possible, create free basic services with additional paid advanced service levels.

Consider the local setting!

If farmers have to interact with the ICT solution (SMS, SMS polls, USSD, apps, training videos, etc.), it is essential that local idioms are considered. If literacy is low among the farmers, try to make use of voice mail, pictograms, and photos.

Attract the youth to modern farming!

Modern technologies can be an incentive for young people to stay in rural areas and to engage in farming. Access to information can trigger the transformation of the local communities into a modern society.

Make use of existing solutions wherever possible!

There are many examples of successful ICT projects in agriculture. Try to learn from the successful projects as well as from the lessons learnt of the failures. Make use of readily available software. It is not only cheaper than the development of a custom-tailored solution, it also prevents from repeating errors and from creating too complex solutions. Case-specific software development should be avoided where possible. If IT development is unavoidable (e.g. for barcoding, database development, etc.), try to cooperate with a local IT firm. The IT firm should have knowledge and experience in the agricultural sector.

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 ICT in CF arrangements. 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.



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The ProEcon Programme: Sustainable Economic
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Rua António Simbine (ex-Antonio Bocarro) nº 211
Sommerschield
Maputo
Moçambique/Mozambique

Tel.: +258 21301372

Fax.: +258 21493258

Mail: pro-econ@giz.de

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Author

Dr. Ralph Elsaesser
www.geo-solutions.de

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