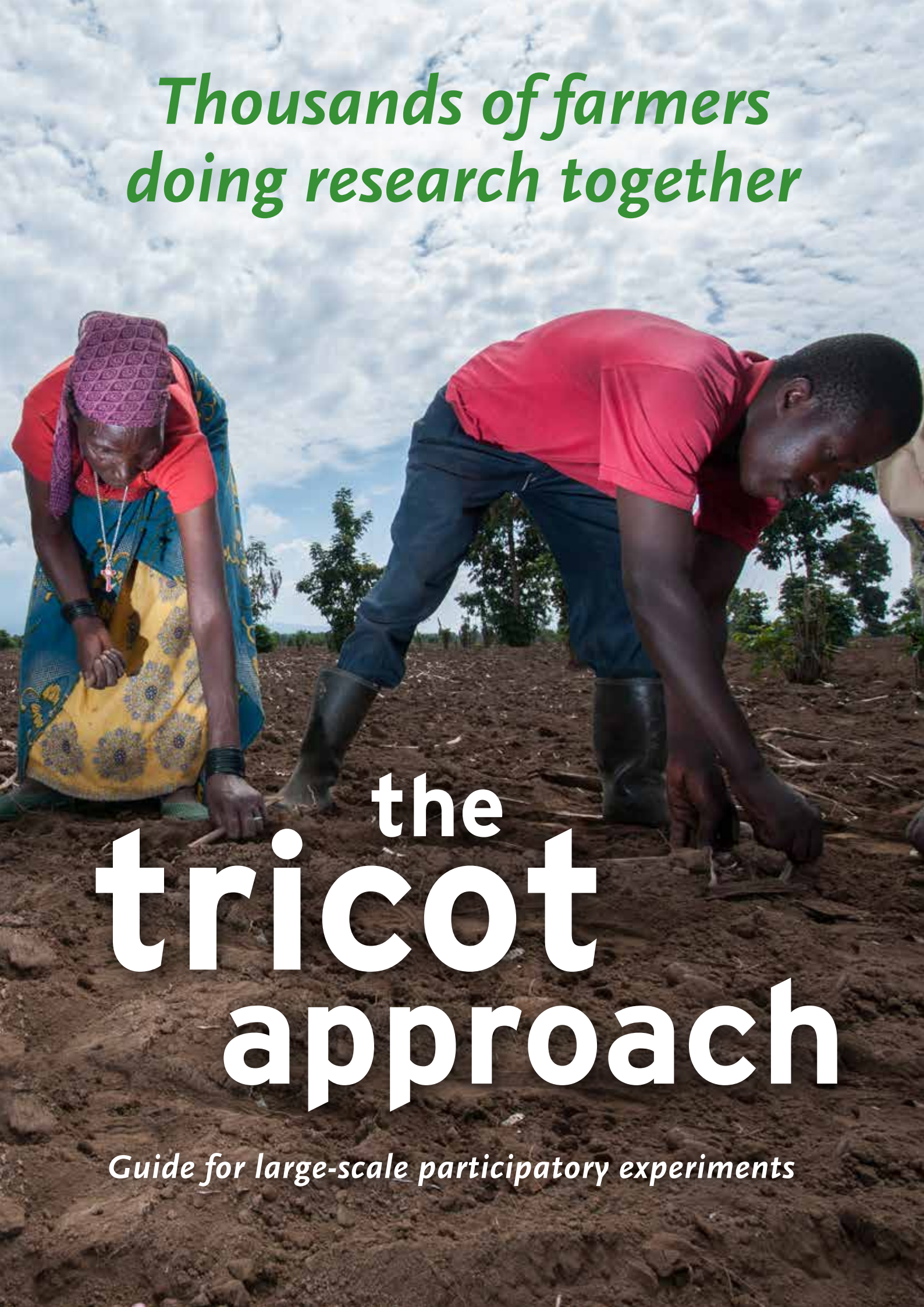
Thousands of farmers doing research together



the tricot approach

Guide for large-scale participatory experiments

The tricot approach for large-scale participatory experiments is fully supported by ClimMob. Free online software is available at climmob.net.

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Tricot

Speeding up agricultural innovation through large-scale participatory experiments

Under climate uncertainty, many farmers need to change their agricultural practices, adopt new crop varieties, switch to using different inputs, or apply new management strategies. But there is no one-size-fits-all solution. Triadic comparison of technology options (tricot) is a research methodology that helps farmers to identify the most suitable technologies for the local conditions of their farm. Tricot (read: 'try-cot') engages farmers as 'farmer researchers' in the testing or validation of new crop varieties and other promising technologies.

How tricot works

With the tricot method, large numbers of farmers carry out many small, simple trials on their own farms instead of a few big, complex trials conducted at research stations. A research center provides the participating farmers with material for the on-farm trials. The farmers provide observations from their trials to the agricultural research center, where the data from all mini-trials is aggregated and analyzed. The research center then feeds back the findings to the farmers.

With tricot, research centers can validate and disseminate new agricultural technologies in a participatory way, collaborating with a large number of farmers under diverse conditions. Large-scale tricot experiments, involving many farmers, generate excellent/reliable results about the performance of different technology options (such as different crop varieties or different fertilizer types) in different environments. Farmers evaluate the new technology options on their own farms and under real conditions.

The tricot trial format is very simple for participating farmers: each executes the mini-task of evaluating only three technology options, out of a range to be tested. This makes it possible to engage many farmers without expending excessive effort on training or supervising them. But this does not mean we can only evaluate three technology options at once! Even though each farmer only evaluates three options, they evaluate many different combinations of technology options, that partially overlaps with the combination of other farmers. By putting the results of their experiments together, a tricot trial can evaluate how well each the options performs relative to the others. Tricot is like a world sports ranking. These rankings cover all players (or teams) and reflect their relative strength. The scores depend on the matches the players have won from other players. But these calculations can be done even if certain teams never played against each other.

Tricot is a valid strategy to overcome the 'bottleneck' of technology dissemination to users,

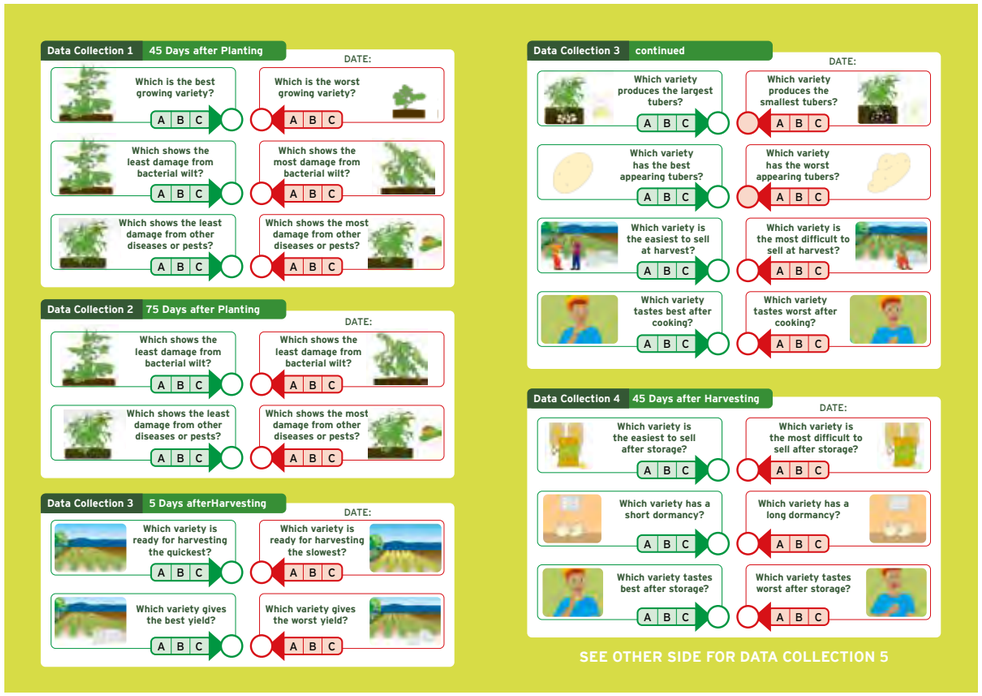
often faced by research institutes, because it presents the following advantages:

- **Farmer-led innovation**
  Being fully executed by farmers on their farm, tricot experiments account for important adoption criteria that could easily not occur in researcher-managed trials.

- **Specific solutions**
  Rural households benefit directly and firsthand from discovering new technology options that fit their environmental and socio-economic conditions, with a high probability of improving their farm production.

- **Capturing diversity**
  Tricot experiments address the challenge of diversity in regions where environmental conditions or socio-cultural preferences vary strongly across the landscape. The tricot approach helps research centers to collaborate with farmer organizations, development organizations or input providers in the organization of large trials with many farmers.

- **Meaningful data**
  Tricot uses a data-driven approach that can combine farmer-generated experimental and preference data with data about cropping systems and farming households, thus it enables a rich analysis. Without tricot, this could only be achieved by very complex methods (such as crop modelling). The tricot data can be analyzed with existing maps of temperature, rainfall, altitude, and other environmental variables. These analyses can provide recommendations for different environments or strategies to deal with climatic risk. Tricot makes it possible to combine several seasons of data to do in-depth analyses of this kind.



An observation sheet for crop variety evaluation. The tricot approach makes data collection simple for farmers.

THE STAKEHOLDERS IN TRICOT AND THEIR RESPONSIBILITIES

RESEARCHERS

Choose the varieties for the project
Produce high quality seed
Provide seed to implementers

SEEDS

Personal contact with farmers
Assist with trial cultivation
Assist with data collection
Pass on farmers' observations to the implementers

IMPLEMENTERS

Development Agency
Agricultural Service
NGO

TRAINING

DATA FROM FARMERS

LOCAL FACILITATORS

START: TRIAL PACKAGES

END: INFORMATION FEEDBACK

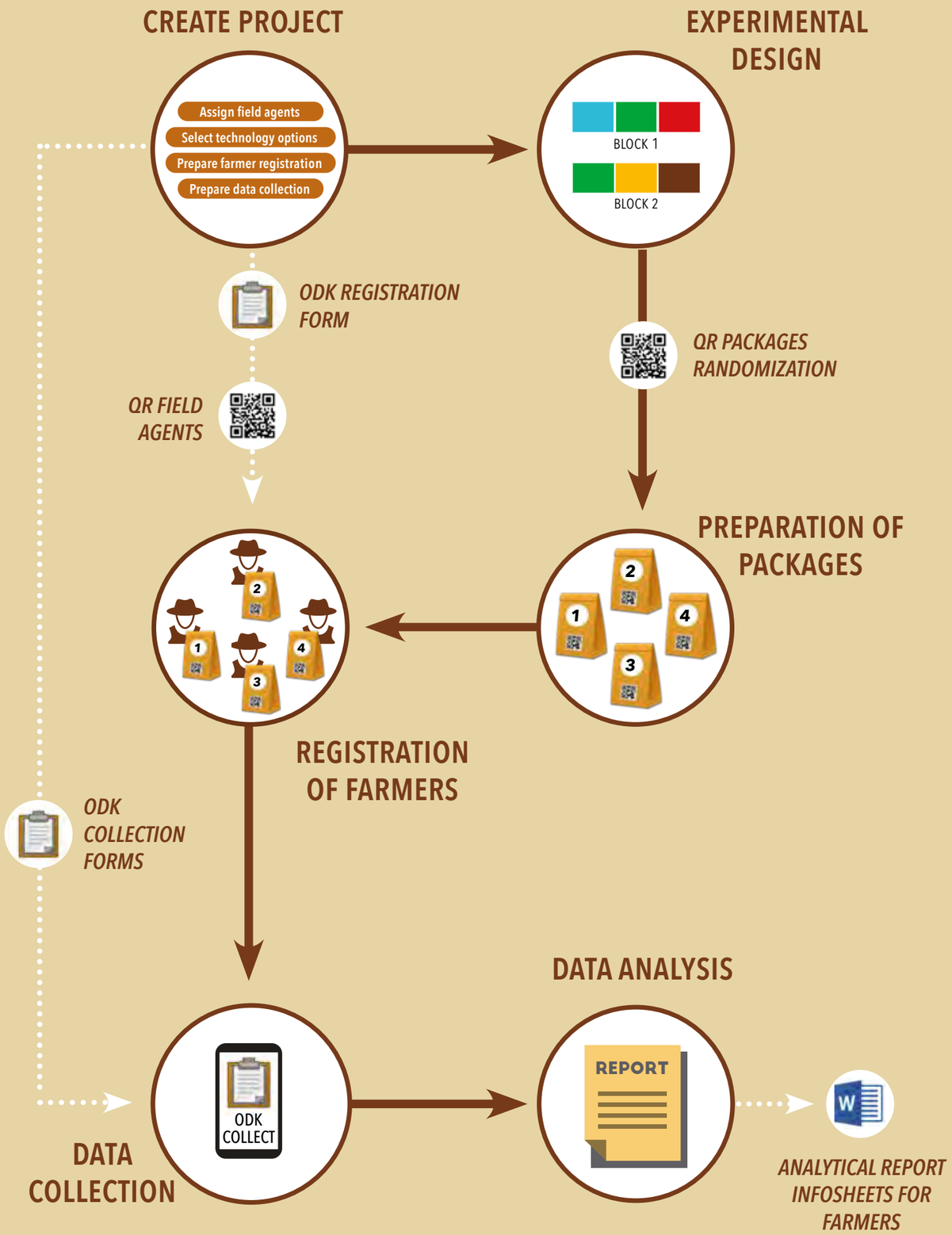
ASSISTANCE

OBSERVATIONS (DATA)

Define crop attributes
Train local facilitators
Organize initial workshop
Prepare and distribute trial packages
Keep track of farmers' data collection
Receive data from local facilitators
Compile and analyze data using ClimMob
Feedback results to farmers in final workshops

Receive initial training
Plant and cultivate one trial per person
Observe trial development
Evaluate the varieties
Report observations to local facilitators

FARMERS



The 10 steps of a Tricot project

This guide provides a short overview of each of the 10 steps needed to develop and implement a tricot project.

Step 1: Preparation

Researchers define a set of comparable technology options to test. For example, they decide to compare crop varieties with each other, or different fertilizer types, or irrigation technologies. They will provide the necessary materials (inputs or other) to project implementers (organizations that will reach farmers). Typically, about 8-12 technology options (comparable items) are included in the trial to be tested.

Step 2: Design

The implementing organization uses the ClimMob (climmob.net) free online software to design the project. This digital platform has been specifically created to manage tricot projects, from designing the experiment to data collection and analysis. The use of the digital platform streamlines the process. ClimMob offers the following benefits:

1. ClimMob helps to avoid mistakes by introducing QR codes and electronic forms;
2. ClimMob provides a dashboard to monitor progress;
3. ClimMob reduces or eliminates the effort spent on digitalizing data collected on paper;
4. ClimMob creates automatic reports with analytical results, avoiding the usual lengthy process of data cleaning and analysis;
5. ClimMob provides clean, formatted data that can be easily downloaded for further analysis with existing tools, for example, combining with weather data.

The tricot project will only work well if ClimMob is used from the very start and implementers are trained in its use. After designing the project, the implementers prepare trial packages, which include experimental quantities of three randomly selected technology options generated by the ClimMob platform.

Step 3: Recruitment

The implementers recruit dedicated farmers interested in improving their farming through the use of new technologies.

Step 4: Distribution

Farmers are trained in the tricot approach and on how to collect data. Each farmer receives a trial package of three technologies to be tested.

Step 5: Execution

Farmers use their trial packages to apply the new technology options separately, on small plots next to each other, in a mini-trial on their own farm. To avoid any bias, they are not aware of the names of the crop varieties or other technology options they are testing. These are revealed to them only after the data has been collected.

Step 6: Observation

Every farmer is responsible for their own trial and makes various easy observations about their three options over the course of the season. For example: Which variety had the highest or the lowest yield?

The farmers record these observations on an observation card.

Step 7: Compilation

The local designated field agents collect and compile the observation data from the tricot farmers, either in person or by phone. They record the information digitally and send them on to the implementing organization. For this, they can use the free 'ODK Collect' smartphone app, which is connected to the ClimMob software.

Step 8: Analysis

The implementers compile and analyze the data from the trials, using the ClimMob online software, to identify which technology options showed the best performance and under which conditions.

Step 9: Feedback

The implementers provide feedback to every participating farmer: the names of their three technology options, which options were most suited to their farm (out of the three options tried by them and out of all the options tried by farmers throughout the project), and where to obtain them.

Step 10: Evaluation

Tricot is an iterative process: after every project cycle, researchers, implementers and farmers collaboratively evaluate how the process may be improved in the next cycle.

Step 1

Preparation

Before you start the project and the participating farmers can receive their trial packages, make sure you have answered the questions below.

Whether or not the tricot method is suitable for your project should be based on knowledge of local farming. Tricot is a methodology for introducing agronomic innovation. It is most useful in situations where farmers are experiencing agronomic challenges or where they are dissatisfied with product quality of their harvests. Tricot should only be used when it is believed that agronomic innovation can be part of the solution.

A thorough problem analysis must first be done. By discussing with experienced field agents and members of your target group about their needs and aspirations, you should ask: *Is there a pressing problem that can be solved through agronomic innovation?* If yes, *Which technology should be considered (for example: crop varieties, irrigation technologies, fertilizer dosage, tillage systems)?*

Which technologies will be tested?

Researchers should be considering and proposing technologies that have the potential to solve local problems and can be easily adopted by farmers. The more you know about the agronomic problems experienced by the target group, the more precisely you can select the technology options. As a start, a total number of 8-12 technology options is recommended. A good way to select these from an even larger pool is by conducting focus group discussions with a core group of local farmers from diverse locations.

In which area will the project be conducted?

For practical reasons, it is best to work in a defined region. If the project is spread across an entire country it can be hard to stay in touch with the local field agents and to assemble farmers for the initial training.

How many farmers will participate?

It advisable to involve as many farmers as possible. The larger the number of trials evaluated, the more useful the information about the technology options becomes. Bear in mind that involving more farmers will also take more work to assist farmers in completing the process. Avoid including more farmers than the local field agents can assist. Each field agent may be responsible for up to 25 farmers. When starting a project and gaining experience with the methodology, it is advisable to include around 100 to 200 farmers, which is enough to obtain good results in most situations. In future iterations, the tricot experiment can be scaled up to involve more farmers.

Who should participate?

It is important to think about the selection of farmers, who should be representative of the broader group of potential users of the

technological options. Think about age and gender aspects, but also about different uses that can be given to the technology in different contexts. For example, technology needs can be very different between a household that produces for its own consumption and another that produces for the market. Also, different users may perform different tasks in relation to the technology and may therefore have different knowledge about it. For example, in the case of crop varieties, it can be relevant to include processors and consumers. Decisions on the groups to include in the trial will influence you planning the recruitment (see Step 3).

Which criteria will be evaluated?

Maybe one technology option provides higher yields, but another one is less labor-intensive. Both criteria can be important, and there may be many more aspects that matter. You will need to define the criteria to be evaluated by the farmer-researchers. These can be defined by consultation with experienced field agents and local future users of the new technologies, both women and men of all ages. Many criteria can be evaluated, but it is recommended to pick no more than ten criteria. With more criteria, farmers may be discouraged by the complexity of observation. The key question must be: What really matters to the farmers? Most importantly, farmers should be asked to give their opinion about the overall performance of their technology options. Also, they should be asked why they prefer the best option. This is an open question and it is therefore possible that farmers mention criteria that had not been considered beforehand.

How will data be collected?

Tricot uses the Open Data Kit (ODK) Collect app as the main way to collect data. The ODK Collect app is available free of charge on Google Play Store and can be installed on any Android smartphone or tablet. It allows implementers to register participating farmers, and field agents can collect farmers' observation data for each of the criteria. When field agents gather the data collected by farmers in the field, the data will be stored on the device until an internet connection is available. All data is then sent to the ClimMob server for storage and analysis. During different steps of the project, ODK forms will be automatically generated by the ClimMob software or will be available on the ClimMob website for download. Other data collection methods can be made available (interactive voice response, Whatsapp). Contact the ClimMob team (climmob.net) for more information.

What do you need to know about the participating farmers?

Tricot research can be used to evaluate how farmers' adoption preferences for different technology options differ by region, gender, wealth status, or other farmer-specific variables. Understanding these differences can help to generalize by category the results from the experiment and to tailor technology recommendations for further households. Project implementers should define variables they consider important, so these can be collected from the farmer-researchers. Project implementers can formulate their own questions or they can use questions from the 'Rural Household Multi-Indicator Survey' (RHoMIS) to gather key household information. RHoMIS is free for download on the ClimMob platform.

Should participation be rewarded?

This question requires careful thought. Providing a reward to motivate farmers could increase participation. But some types of rewards can undermine enthusiasm, curiosity, and the desire to learn, which are often the most important reasons for participation. In several tricot projects, farmers received extra seed of the variety they preferred. This kind of reward is closely tied to the goal of the project and motivates farmers not only to contribute, but also to pay attention to the process, and

to be sure to pick a good technology option for their farm.

Which visual materials are needed?

At www.climmob.net you will find examples and illustrations to help you generate your own visual materials. In order to explain the process to your tricot farmers and to facilitate the data collection, the following materials can support you:

- Informative leaflet or poster, as an aid to explain the tricot process to the farmers.
- Observation card, for the farmers to collect their observations on the field. It is designed to enable participation with a minimal level of literacy.

Step 2

Design

Once you have chosen which technology options will be evaluated and you have identified which criteria are most important to the farmers, your project can start.

As explained earlier, tricot uses ClimMob (climmob.net), a free online software specifically created for tricot projects. ClimMob is the fundamental tool for any tricot project, and is used for the following activities:

- Designing the experiment
- Generating a randomized list of combinations of three technology options for the individual trial packages
- Project management and data overview
- Input of farmers' observation data
- Data analysis and automatic generation of the post-trial information sheets for farmers

The basic steps for setting up an account and developing and adjusting your project are listed below. More detailed information on how to use and make the most of the ClimMob software can be found on the ClimMob website.

A. Setting up an account

To create a new user account, access the ClimMob software from the main menu on the ClimMob homepage and click on 'Log in or register an account'. If you already have an account, you can enter your username and password, and click 'Log in'. If you have not registered, start the process by clicking on 'Register an account'.

B. Creating a project

When you first log in after having registered, you will see a *'Create a new project'* button. After clicking here, you will be asked to fill out general information, size and location of your tricot experiment. In cases where you have already created a project, you can navigate to 'Projects' (upper right corner of your screen) to get an overview of your existing projects, navigate between them and create new projects.

After selecting an existing project or designing a new one, ClimMob will take you to the Main menu, which is the central hub to design your tricot experiment. You need to specify the information on each of the field agents who will work on this project, the technology options that you want to compare, and the registration questions the farmers will be asked when they register to participate. ClimMob will only move on to the next step after you have provided this information.

C. Define the evaluation criteria

Depending on the technology options included in your tricot experiment and the needs of your target group, you will define which observations the farmers should make. Each observation corresponds to a question on their observation cards. For example, common criteria for varieties are 'yield' or 'plant height'. The corresponding questions would be 'Which variety produced highest yield / lowest yield?' and 'With which variety did plants grow tallest / least tall?' See also Step 6 about how farmers will observe crop performance on their trial plots.

D. Define the time point for evaluation

The intervals at which farmers are expected to make an observation during the trials will vary depending on the technologies being tested. For each evaluation criterion you will need to decide at which point in the tricot project farmers make their observations. For example, if you intend to test different crop varieties, you might want to ask farmers to make observations at the start of the project (day of sowing), again after 30 days, and lastly at the end of the trial (day of harvest).

E. Assign field agents

All field agents who will work on your project must be added individually to the ClimMob project design. Field agents are the people who will be working on site, communicating with the farmers and later collecting observation data. You need to assign a username and password to each field agent, which they will use when logging collected data into the ODK Collect app.

F. Select technology options

Here you specify the technology options you will compare in your tricot experiment. We recommend a pool of 8 to 12 options. For example, if you want to test which bean variety is best adapted to the region, you would add the names of all the bean varieties to be tested. If you want to test which fertilizer type makes crops grow best, you would add the names of all the fertilizer types to be tested.

G. Prepare farmer registration

Once farmers have registered to participate in the trials they will be asked a number of questions by their field agent. Here, you will define which questions should be asked. This information is important for administrative reasons (farmer name, telephone, village, and other relevant details) and for data analysis (e.g. registering the gender and age can help to understand if social indicators influence farmers' preferences for a certain technology option). You can define the questions yourself here, or you can use the standardized Rural Household Multi-Indicator Survey (RHoMIS) provided on the ClimMob website. This is a widely validated format used to characterize farming households. Once you define the list of questions, they will become available as an ODK form, which can be downloaded to your ODK Collect app. Field agents can input the information directly into the app on their smartphone or tablet when registering the participating farmers.

H. Prepare data collection

Throughout their tricot trial, the farmers make comparative observations about their three technology options. Here, you will define which types of observations farmers should make. For example, a common criterion to observe is the total crop yield achieved with each technology option. You must decide which criteria are important for your experiment. Eventually, all these questions will be printed on the observation cards and handed out to farmers at the distribution stage.

I. Prepare the packages

ClimMob will take you through the steps to execute the randomization. Once the randomization is set up, ClimMob will make a list of the packages and the content of each package (each has three technology options drawn from a larger set). This list is available as a downloadable spreadsheet (available in the Downloads section). Also, ClimMob generates a document with QR codes for each of the packages. The project implementer prints the codes and pastes it on to each package. These QR codes are used to identify each package during distribution and avoid mistakes. Print these documents and use them to prepare the packages. This process should be done very carefully. Try to follow a procedure that avoids mistakes and allows for checks.

At the end, each package has a unique number (1, 2, 3, etc.) and contains three different technology options (package 1 has 1A, 1B, and 1C). To get there, organize the work in the following steps:

- Before starting, keep all small bags of one technology option together, each having their own place on a table or a corner of the room.
- As a next step, mark all the small bags with their respective code (1A, 1B, 1C, 2A, 2B, etc.).
- Only when all the small bags are coded, they are picked up and combined in packages of three.
- When a package is ready, it is handed to a different person who checks its contents before closing it.

Step 3

Recruitment

Any farmer who wishes to participate can get involved in a tricot experiment. Recruiting as many motivated farmers as possible is key to the success of the project. The local field agents should help to identify and recruit farmers in their communities.

Hanging posters in agricultural shops, village halls or corner shops may also help to attract attention. You do not need to know the farmers before they participate.

However, farmers should be:

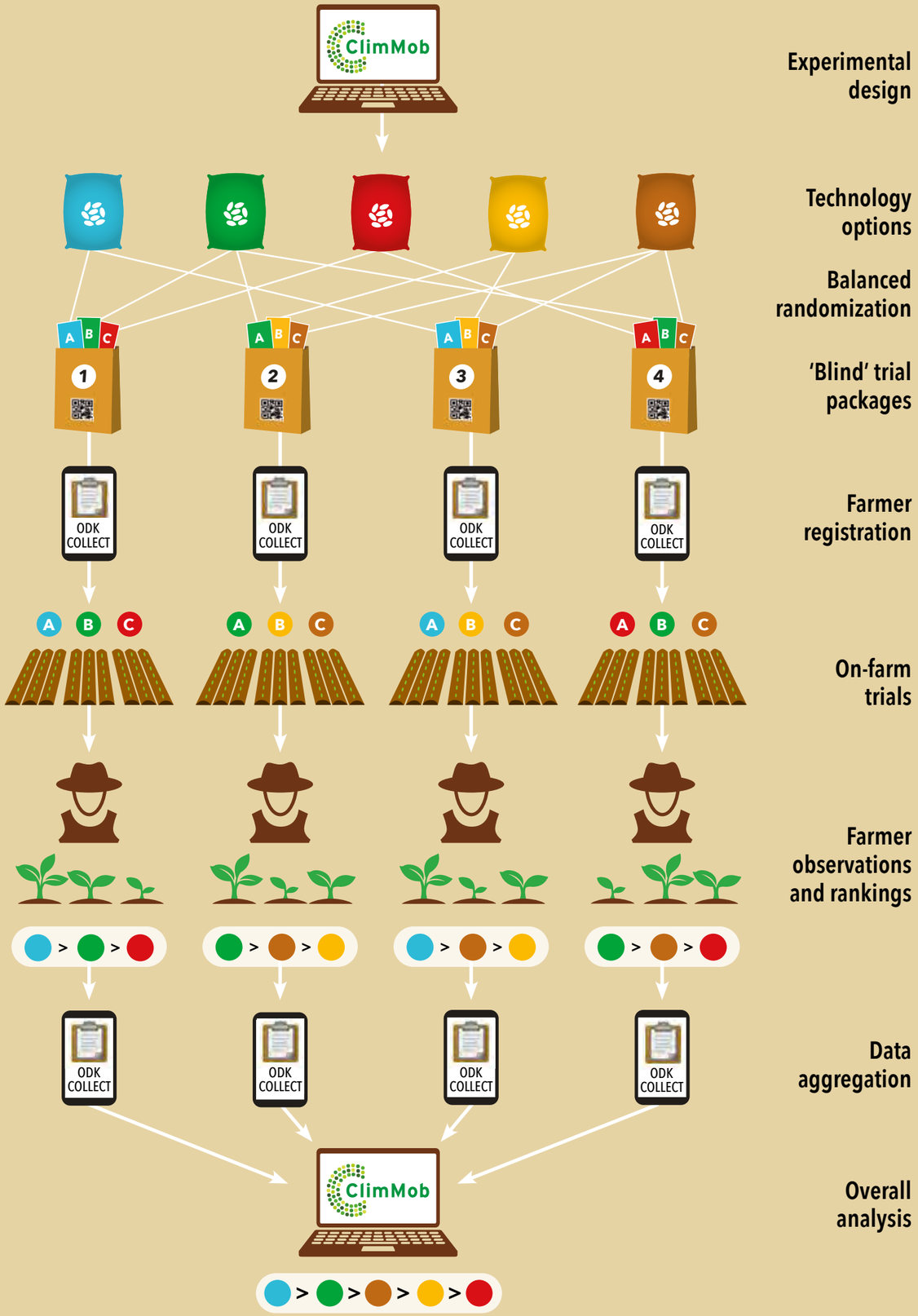
- volunteers who are ready to commit time and effort to participation;
- farmers who enjoy experimenting and trying out new methods;
- both women and men, preferably at an even ratio.

A. Tricot is an iterative process

This means that farmers ideally participate more than once in different experiments and across different seasons. When a tricot project starts and farmers participate for the first time, upfront project investments are required. The local field agents must be trained. Also, setting up and implementing the training workshops for participating farmers takes time. During their first cycle, farmers may have many questions and need assistance from local field agents. As the farmers will learn many things during each iteration of the process, and as they get to know only three randomly chosen technology options per cycle, we would encourage farmers to participate repeatedly. This way, first-time farmers can ask their more experienced farmer-colleagues when they have doubts, and the farmers get the chance to experiment with new sets of technology options with every cycle.

B. Local groups can carry out a joint trial

Carrying out a group or joint trial makes the learning process easier and participation more fun. Any existing group, like farmers' committees, credit cooperatives, or a religious group can receive a trial package and participate together. In this case, a 'host' farm is needed, where the technology options can be tested. The host farmer will be the contact person for the local field agent, while all activities – such as planting and making the trial observations – can be performed jointly by the group. In the following season, individual group members may want to plant a trial for themselves, building on the experiences they gained in the group trial. To enhance the participation of women farmers, it can be useful to establish 'women's research groups', who would be in charge of a number of tricot plots.



Step 4

Distribution

The tricot process starts with a training and distribution workshop. Here, the farmers receive their trial packages and learn about the tricot methodology and data collection process.

A. Organization and logistics

The training and distribution workshop should take place about four weeks before the start of the trial, so that farmers can adapt their own farm planning. It is most effective to invite a maximum of 20 farmers at a time to the workshop. Women and men should be invited in equal numbers, if possible.

Required workshop material and logistics:

- A meeting place for about 20 persons
- Snacks
- Trial packages.

Every trial package should contain the following four elements:

1. A QR code generated for each package that will be used as a unique ID to track all the information collected during the trial. It is important to tell farmers to keep this code throughout the duration of the trial.
2. Three bags with equal quantities of the technology options (e.g. seeds, fertilizers) or instructions on how to apply the alternative technology options (e.g. tillage systems), according to the randomization that was generated by ClimMob.
3. An observation card where testers will note their on-farm observations
4. A brochure that explains the entire process to the farmer.

The randomization is done in such a way that it ensures that, in all places, the technology options will be made available with the same frequency. In technical jargon, the randomization is 'balanced'. This avoids, for example, that one of the technology options did not occur in one of the villages in the trial. 'Balancing' the trial means that all technology options are spread across all the villages. For this to happen, however, it is crucial that each of the villages receive packages with consecutive numbers (1, 2, 3, 4, 5, etc.) and not random numbers (3, 11, 9, 23, 1, etc.). For example, the first village receives packages 1 to 9, the next village receives packages 10 to 23, etc. If this principle is followed, each of these villages will receive a balanced set. If it is not followed, there is a risk that one or more technology options will be completely absent in some of the villages, so that you will never know if it is suitable there or not.

B. Teaching tricot

The project implementers, together with the local field agents, invite interested farmers to a central location. This can be a village meeting hall or an NGO office. They explain the tricot trial, its purpose, its benefits, and the responsibilities the farmers have. It is important to visualize what a tricot trial looks like, so farmers can see what is expected of them. If

possible, you can develop a demonstration trial nearby beforehand. Otherwise, the trials can be visualized with a video (video 1: available at climmob.net). A small pictorial guide for farmers on tricot should also be handed out at the training workshop. A format for a foldable, guide (the size of a credit card) is available from climmob.net.

At the workshop, farmers are also trained on how to fill out the observation cards. Every farmer receives one observation card for the immediate exercise. It is important to fully explain the design of the card and go through filling out the card to allow the farmers to practice and gain familiarity with the process. Farmers will then be advised on how data will be collected, and whether a project implementer will be calling them or visiting them in person.

C. Registration of farmers

The ODK Collect app is used to register participating farmers. When the farmers receive their personal trial packages, they are registered by Field Agents using the project-specific registration form. This form was set up in Step 2H 'Prepare farmer registration' and will be available when the ODK Collect app is connected to the project on the ClimMob digital platform. The form should be downloaded to all field agents' devices.

At a minimum, these basic data are required:

- Trial package QR code
- Name of the tester (participating farmer)

The trial package code uses an QR code generated by ClimMob as a unique package ID throughout the trial. The QR Code is generated once the technologies are defined and the randomization is set up. The project implementer prints the codes (available in the Downloads section) and pastes it into each package. Note: farmers should keep their package (QR) code for the duration of the project.

More in-depth information regarding household and farm characteristics can be collected during registration using the pre-developed RHoMIS survey (available on the ClimMob website).

Step 5

Execution

The farmers plant and manage the trials independently. Every farmer is responsible for his/her own plot.

Two messages are key here:

- Carrying out an on-farm trial is simple. No special skills are required. Any farmer can participate.
- Farmers are farming experts. The participating farmers deserve full respect as generators of new knowledge.

Through the training and distribution workshop (Step 4), farmers were trained in tricot methodology, received their individual trial packages, saw a trial plot (on-site or through video), and received a brochure about tricot. Now they need to choose a part of their land on which to conduct their own trial. It is important to understand that the trials must represent regular farming practice for the results to be useful.

Two principles should be kept in mind.

1. **The trial should resemble production conditions that reflect reality, not optimal production conditions.**
   - To ensure this, the trial plot should be located right next to, or even within, the farmer's regular production plot. Farmers should neither select the best nor the worst spot, but an average, representative location.
   - Also, each trial should be managed by the participating farmer in exactly the same way as they normally manage their crop (unless the technology under analysis is about crop management). For example: If the farmers usually intercrop with another crop, they may also do intercropping with the trial varieties. The regular plot and trial plots should be treated and maintained equally. Special attention to the trial plots, but also negligence, will distort the results. For example, if the farmers do not irrigate their production plot, they should not irrigate the trial plot either.
2. **The trial should enable a fair comparison between the three options on each plot.**
   - The three technology options are applied next to each other, in separate sub-plots of the same size, and in the exact same way. In the case of varieties, each variety is planted in the same defined number and length of rows. For example: Six rows of five meters' length each, or four rows of eight meters in length.
   - In the case of fertilizers or other input trials, amounts or combinations are applied as specified by the implementers.
   - Technology option A is used to the left, B in the middle, C to the right. The borders between the technology options may be marked with sticks or a rope. The three technology options should never be mixed with each other.

Apart from the small plot size, there is really nothing new or special about planting the trials. The farmers should be confident in using their own farming skills and implement the new technologies in the same way as they would normally conduct their work.

Step 6

Observation

As the crop grows, the farmers observe the technologies and record their observations on the observation card. For many farmers, the questions asked in tricot pose a new way of looking at things.

Most farmers can tell which of the three technology options they generally like best. But it is not always easy to decide which one is the best for a specific evaluation criterion.

The farmers observe and evaluate the technology options in their trials and focus on only one criterion at a time. The observations they make always follow the same structure: the 'best' and the 'worst' among the three trial technologies need to be identified. Farmers mark their choices on the appropriate page of the observation card. On the card, the question is asked in as few words as possible to make it easier for farmers. For example, instead of asking 'Which of the three varieties has developed the best foliage?' the observation card just asks: 'Best foliage?'.

A. Focus on one criterion at a time

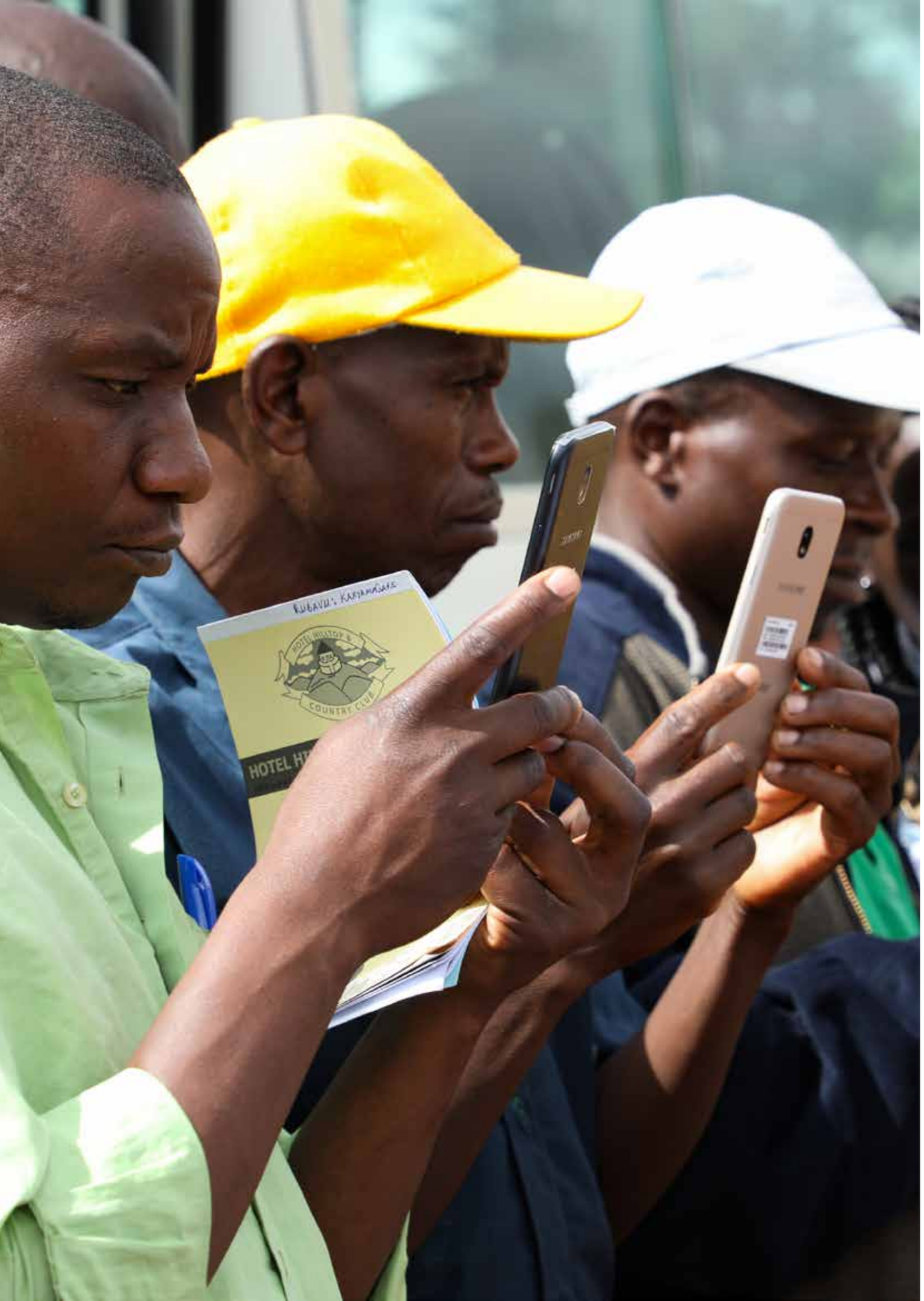
Sometimes it is hard to acknowledge that a technology option was not successful for one criterion, but still performed best for another. For example, imagine a maize variety that was heavily affected by drought and disease and hardly produced yield, but has an excellent growth habit, with many tillers. It could look poor overall but would still be 'best' for 'growth habit'. For best results, it is crucial to really focus on only one criterion at a time and ignore all others.

B. Choose the right dates for the evaluation

Appropriate timing is important, and farmers should be told at which point in the process each criterion needs to be evaluated. For fertilizers or varieties, it is common to evaluate the trial in three stages: earlier-developing criteria (for example, foliage development), later-developing criteria (for example, disease resistance) and post-harvest criteria (for example, yield or market value). The project implementers should suggest the evaluation steps and dates to the farmers.

C. Provide follow-up assistance

Many farmers have a busy life and their tricot trial will be one activity among many others. Through telephone calls, the project implementers or the local field agents may help the farmers to keep track of their evaluations and remind them of upcoming observation steps. The telephone calls will also help to clarify open questions and to let farmers know that their contribution is important and valuable. Within their own capacities, the local field agents may also support farmers directly in the evaluation at the plot. These follow-up calls can also be used to support the data compilation if farmers mention that they have already collected their data.



Step 7

Compilation

Step 6 has been completed when every participating farmer has put into practice the three technology options, has observed the trial and marked their findings on the observation card. Each farmer now has the data ready, but it needs to be compiled to be analyzed.

The local field agents will compile the farmer-generated observation data. To do so, they have different options, including using ODK-based forms generated by ClimMob. Data compilation in the field can be done offline with ODK Collect. If the local field agents cannot upload the data directly from the field, they upload the data from ODK Collect as soon as they have an internet connection. It is important to upload the data regularly to avoid any inadvertent data loss. To upload the new data to your database, choose 'Send data' with the ODK Collect app on an Android device. If data is collected through physical visits, each field agent can usually cover up to 25 farmers.

Some alternative options for data collection can make the process more efficient. Some of the different options include:

- Visit farmers, inspect observation cards and transcribe farmers' observations directly to the ODK Collect App.
- Take photos of the observation cards to copy the data later directly into your database or input the data using ODK Collect App. Remember to write down the farmers' name and package ID with the number of each photo.
- Call the farmers on their own or their neighbor's telephone and fill out the form in ODK based on the information transmitted by the farmer during the call.
- New data collection formats (WhatsApp, interactive voice response) can be made available. Check with the ClimMob team.

Step 8

Analysis

When all the data is uploaded to your ClimMob database, analysis can start.

The analysis will give you an automated report with useful results, such as:

- Description of the methodological approach applied
- A rating of how well each technology performed for each pre-defined criterion (see Step 2)
- Information on differing performances (if any) depending on explanatory variables (e.g. the highest yielding crop variety with or without irrigation; or the variety preferred by women, variety preferred by men)
- A rating of how all pre-defined characteristics were correlated with the overall performance. This is useful to assess which characteristic influenced the overall appreciation of the technologies tested.

The analysis is conducted in six simple steps:

1. Select the project you will analyze.
2. Press the button 'Select variables to analyze' in the main menu of ClimMob.
3. Select the explanatory variables you want to include. Explanatory variables can lead to a better understanding of different observations about the tested technologies, and to more useful results. For example, one crop variety may perform best under irrigation, but in drought conditions, a different variety may give best results.
4. Select the documents you want to generate. Two types of outputs are possible:
   - *Analysis report*
     This is for the implementing organization and the researchers. It is a report presenting all results: it tells you which technologies performed best for every tested criterion, and whether there are any differences due to explanatory variables, for example gender, age, irrigation.
   - *Infosheets*
     This is a document that contains a personal information sheet for each participating farmer. These infosheets contain:
     - The names of their three specific tested technology options
     - The farmer´s own answers
     - The most recommended technology options for the farmer's own farm.
5. Press OK.

Depending on the number of farmers, the analysis can take a long time. In some cases, it may take up to half an hour to generate all of the infoheets. You can obtain the infosheets and reports from the Downloads section.

Step 9

Feedback

You have run the analysis using the ClimMob online software. Now the farmer-researchers are eager to know the results of their trials. All farmers are invited to a final workshop to receive and discuss the results.

Soon after all the data are collected and the analysis is completed, participating farmers are invited to a feedback workshop. Here, they receive information sheets about their trials and will have a chance to discuss the results. The farmers have had different experiences with their trials, so reciprocal sharing of these experiences with other farmers is an important part of the learning process. Plan at least half a day for each feedback workshop.

The workshop consists of three parts:

1. The project implementers or the local field agents present the overall results of the technology evaluation. Farmers learn which technology options performed best under which conditions.
2. The farmers receive their personal infosheets about which technology they have preferred and are given time to discuss the results with other farmers and implementers. It is recommended to form small groups for this activity (of about 5-7 persons), including a facilitator (a field agent or experienced farmer). Groups can present their conclusions in a plenary session.
3. Farmers then receive a practical agronomic lesson as another incentive for participation. For example, field agents may use this opportunity to disseminate knowledge about seed storage or seed selection.

These points should be considered by the field agents:

- Discussion among the farmers is important: everyone can learn from each other.
- It is crucial to make it clear that there is no single best technology option. In fact, optimal technology options can differ across farms and farmers.
- Field agents should also annotate feedback provided by the farmers on their experience with the trials and the project in general.

Preparations for the final workshops:

- As with the training and distribution workshop, in most cases farmers should be limited to around 20-25 per event, in a central location accessible to all.
- Have the infosheets for all farmers ready for distribution during the workshop.

Step 10

Evaluation

The first tricot cycle has finished. What can be improved?

Countries, crops, farming systems, and people are diverse, so every tricot project is different. This booklet can only be a guide to assist you in designing your own local experiment. Tricot is an iterative process and the last step in a project cycle is the evaluation of the project for further improvement.

Listening to the farmers' experiences is most important. It is crucial that the farmers perceive tricot as both simple and beneficial. You should try to identify possible improvements in managing and executing the trials. At the feedback workshop, farmers can express their experiences, recommendations and complaints about the process. Moreover, the local field agents can provide project implementers with many valuable comments and recommendations, since they have constantly been in touch with the farmers and in some cases have followed the trials in person on site.

After every project cycle, the project implementers, researchers, and local field agents should discuss how to improve the process. Including more farmers with every project cycle should be a constant objective in tricot, so that more households can benefit from the investigation.

Also, with the results of every cycle, you may identify one or two technology options that were not well accepted by the farmers, or that did not work well in your region. For the next cycle, you can discard those technology options ranked lowest by farmers and replace them with new ones. This way, there is 'refreshed' input to the research system, and the farmers' chances of discovering a suitable technology option for the conditions of their farm remain high.

Indicators of success

The success of your tricot project can be measured. You can evaluate five indicators, which will give you an idea about the individual trials' impact, and the project's overall success.

1. **The rate of completed trials**
   Count the trials that were fully completed, as well as the trials where data was missing. You can evaluate whether the loss of information is due to natural causes (e.g. drought that made it impossible to evaluate certain criteria on farm) or to the farmer's management of the trial (e.g. a mistake with the package code (QR code), lack of interest in finishing the observations). This way, important knowledge about the specific difficulties can be generated, which will help you find strategies to avoid them being repeated.

2. **Farmers' gender ratio**
   Women tend to have less access to the profits of agricultural production and other resources generated by such work. Participation in a tricot experiment can open doors for the empowerment of women. It is recommended that every tricot project strives to achieve a balanced gender ratio among

farmers by specially encouraging the participation of women.

3. **The percentage of farmers who participate again, after the first cycle**
   Returning farmers are a clear indicator of the farmers' motivation. If many of the farmers do not want to participate a second time, something about the tricot process design may need to be changed.

4. **Changes in the technology choice**
   On the observation card, the farmers write whether they will continue using any of the new technology options from their tricot trial. If they choose to use at least one of the three technology options, this shows the impact of the trials. If no or very few farmers want to continue using the newly introduced technology options, then the initial pool of technology options may need to be reconsidered.

5. **Dissemination of technology into the communities and information exchange**
   Because of their joint experience in the tricot trial, farmers may become more active in experimenting with technologies and exchanging information within their communities. This can be checked by estimating the scale of diffusion of technologies into communities a year after the tricot experiment, by talking to the farmers, as well as to other farmers in the communities.

Glossary

ClimMob
Online software for the design and management of any tricot experiment (www.climmob.net). The database of all tricot projects is stored here. Project implementers also use ClimMob for the analysis of results and the generation of information outputs at the end of the project.

Balancing a trial
'Balancing' the trial means that all technology options are spread across all the participating villages. Each village will receive packages with consecutive numbers (1, 2, 3, 4, 5, etc.) and not random numbers (3, 11, 9, 23, 1, etc.). If this principle is followed, each of these villages will receive a balanced set and all of the technology options will be tested and evaluated.

Evaluation criteria
The 5 to 10 criteria that will be evaluated within the tricot experiment. These criteria should be chosen in consultation with all stakeholders. For example: Plant height, disease resistance, yield, and others.

Explanatory variables
Information about meteorology and agronomic management of the trials, serves to improve the analysis. The explanatory variables refine the results and help to identify the most suitable variety for the local conditions of every farmer. Examples: Use of irrigation, use of fertilization, season was rainier or drier than usual, etc.

Field agents
Lead farmers of rural communities, field workers, or extension agents. They are trained and remunerated by the implementing organization to assist the farmers in the execution and evaluation of their trials. They collect the data from the farmers and pass them on to the project implementers.

Implementing organization/ project implementers
The organization that is in charge of carrying out and monitoring the project. It can be an NGO, a government service, or a research program, among other options. Implementers have the major responsibilities in the project, for example:
- Training the field agents and farmers
- Distributing the trial packages
- Carrying out the data analysis once all data is collected and compiled
- Feeding back the information to the farmers via the field agents.

Infosheet
Personalized information output for every farmer. It is generated automatically using ClimMob and includes:
- Names of the three technology options that the farmer received and tested
- Names of the most recommended option for their farm
- Information about where to obtain more material of the preferred technology option (if applicable).

Observation card
A pictorial form printed on thick paper, on which farmers mark their observations of the technology options being tested on their plots. A generic design can be found for downloading at climmob.net and can be adapted to the local requirements.

ODK Collect
A free app available for download from Google Play Store to all Android-based mobile devices. ODK Collect is used for farmer registration and data collection in tricot projects.

Farmers / participating farmers

Women and men who participate in a tricot experiment by managing their own tricot trial and carrying out the observations, marking the observations on the observation card at the appropriate dates, and eventually reporting the observations to the local field agents. Their recruitment should involve considerations of gender, age and other demographic factors, as well as their task related to the technology under evaluation. In some tricot trials, non-farmers participate, based on their role in food processing, trading, retailing or consumption.

Randomization

The balanced creation of sets of three varieties from the full pool of varieties. The randomization is generated by the ClimMob software and is required to prepare the trial packages.

Researchers

Experts studying or using the agricultural technology under evaluation. They select the technology options to be included in the project and supply experimental material for each technology option to the implementing organization.

Technology

With tricot, many different kinds of farm innovations can be tested. Crop varieties can be one kind of agricultural technology, but irrigation systems, fertilizers, fertilizer dosage, or cropping styles and tillage systems are also 'technologies' that can be tested using the tricot approach. Within each technology, there are different variants or options (see next entry 'Technology options').

Technology options

Each tricot experiment focuses on one agricultural technology (for example, 'fertilizer composition'), but tests several technology options (fertilizer composition X, fertilizer composition Y, etc.). These technology options should in principle be suitable to local conditions and have the potential to be adopted by some of the farmers. The researchers select the technology options, and they are recommended to begin a first experiment made up of between 8 to 12 options.

Trial package

A bag given to every farmer at the initial workshop. The large bag is marked with a number and a QR code. It contains: (i) three small bags containing material of the different technology options (marked with 'A', 'B', and 'C'); (ii) an observation card; and (iii) an explanatory brochure about the tricot process

Tricot

The word 'tricot' is derived from three words: **Tri**adic **co**mparison of **t**echnology options. 'Triadic' refers to the sets of three technology options that are compared in each trial. In technical jargon, three things define tricot: (1) the use of incomplete blocks of three items (to make the threshold of participation low in terms of farm size and to make it cognitively manageable), (2) the use of ranking as the main way to report observations (to facilitate digital data collection and to make it possible to cultivate a tricot plot with very little training), and (3) the limited control of experimental conditions (following usual technology use practice to maximize external validity).

Trial plot

A small area within or at the margin of the farmer's production plot, with representative soil conditions. It is divided into three equal parts, for the testing of the three technology options assigned to the farmer.

Tricot trial

Field test of different technological options, in sets of three, each grown and observed by a farmer in a small designated area of her/his own farm.

Frequently Asked Questions

Which agricultural technologies can I include in a tricot trial?

So far, tricot has mostly been used to evaluate varieties of annual crops (e.g. beans, rice, wheat). But you can use tricot to evaluate different options of any agronomic technology, such as fertilizer management regimes, different irrigation systems, intercropping systems or early establishment of perennial crops. Many of these types of trials are now underway. Also, recent trials have focused on consumption of crop varieties.

Every farmer compares only three technology options per trial. Does that mean I can only include three options in the whole tricot experiment?

No, you can include more than three technology options in your tricot experiment. We recommend you pre-select a pool of between 8 to 12 different options that you would like to test. No matter how many options you are testing, every farmer will receive a personal trial package containing only three technology options out of the larger pool you are testing. As an example, every farmer might receive a sample of seeds of three different crop varieties out of a larger pool. It is important to know that each farmer receives their three specific varieties based on a strict randomization scheme. The ClimMob software takes care of organizing which three varieties go to which farmer. It will also apply statistics to put all the separate answers together into a coherent picture.

Is there a cost for any of the software that I need in order to run a tricot experiment (e.g. for ClimMob, ODK Collect)?

No, both ClimMob and ODK Collect are free. On climmob.net, you will find everything you need for planning, designing and analyzing your tricot experiment. The Android smartphone app 'ODK Collect' is used by the field agents to collect data from farmers in the field, without the need for internet connectivity. In the future, there may be modest charges for commercial applications, or very large trials, to cover costs.

I am familiar with Participatory Variety Selection (PVS). Why should I use tricot?

The tricot approach is based on the idea of Participatory Variety Selection: new crop varieties are evaluated by farmers, on their own fields, and for traits that are of direct interest to them. The unique idea behind tricot consists in 'crowdsourcing' the data generation process. This makes tricot experiments more flexible, less resource-consuming and easier to scale up to have large numbers of tests, representing more diverse use environments.

What is the incentive for farmers to participate?

Through participation in a tricot experiment, farmers are exposed to new technologies. For example, they may try out new crop varieties directly under the conditions of their own farm. This way, participating farmers can learn about new options to improve their farming and might discover useful innovation under realistic conditions. Research has shown that many farmers are also motivated by being part of a research project, interacting with researchers and contributing to knowledge generation. Even when a farmer does not immediately

identify a suitable option among the three tested technology options, participation can be useful to them: farmers often discuss results with their neighbors, exchange experimental material, and subsequently try out options that were successful on other farms. Research also shows that money as an incentive is not needed. The tricot trial should be designed in such a way that farmers are motivated to contribute based on intrinsic motivation, which is likely to lead to better data.

Farmers work in different environmental conditions. How can their observations be merged?

Farmers provide rankings based on what they observe in their trials. Under different environmental conditions, such as different climate, these observations may vary. The ClimMob process allows for geospatial disaggregation of results by registering farmers' GPS locations. Using existing maps of temperature, rainfall, altitude, and other environmental variables, ClimMob can provide different results for different environments. For example, the results may show that one technology option had highest yield in lowlands, while another option had highest yield in higher altitudes. When the observations differ significantly between environments, ClimMob can provide location-specific results. A special software package, 'ClimMobTools' can be used to load the data into programming environment R for in-depth environmental analysis. Contact the ClimMob team for more information.

Should farmers control their field conditions?

Tricot experiments are designed to generate results that apply to realistic management and farm conditions. In order to generate results that are meaningful for general farming practice, the small trials should be cultivated in strictly the same way as the general farming plot. If farmers control conditions in ways they are not used to, they might end up selecting a variety that will not fare well under their usual cropping system.

How do the farmers record their field observations?

At the beginning of the tricot experiment, farmers will receive observation cards. These paper cards contain all the questions you decided they should answer during the experiment. The observation cards are very easy to use; farmers just need a pen. At the end of the tricot experiment, the data that was recorded on the observation cards will be collected by the field agents and uploaded onto the ClimMob platform.

Do the farmers need a smartphone to participate?

No, they note all of their field observations on observation cards. Only the field agents need a smartphone or tablet to enter the growers' data into the ODK Collect app. ODK Collect will then upload and merge all data into ClimMob. There are alternative ways to gather data from farmers. See Step 7.