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Introduction to the tricot approach

Jacob van Etten, Jonathan Steinke, Kauê de Sousa

Tricot (triadic comparisons of technologies, pronounced “try-cot”) is a citizen science approach for testing technology options in their use environments, originally conceived in 2011 (van Etten, 2011). The Oxford English Dictionary defines citizen science as “the collection and analysis of data relating to the natural world by members of the general public, typically as part of a collaborative project with professional scientists”. Different definitions are given by others, but our use of it is not far from this one. As a citizen science approach, tricot actively involves non-scientists in experimental data generation and interpretation. This follows a broader movement of applying citizen science and crowdsourcing methods in research on food and agriculture, providing a fresh approach to participatory agricultural research (Minet et al., 2017; Ryan et al., 2018; van de Gevel et al., 2020).

Tricot addresses important challenges in on-farm testing, such as fully capturing socio-economic and environmental heterogeneity (de Sousa et al., 2024). In addition, the approach is increasingly used for areas closely related to on-farm testing of varieties, such as food product testing by consumers (Alamu et al., 2023; Moyo et al., 2021; Olaosebikan et al., 2023). Testing technologies in their use environments and product concept testing (Donovan et al., 2025; Rutsaert, 2022) is important for external validity of experiments,

the degree to which the findings have application outside of the experimental setting. To overcome common issues in user testing, the tricot approach streamlines the approach via digital support throughout the experimental cycle, simplifies the experimentation format to make user participation easy, and enhances data analysis by enriching it with data about the user context.

The tricot approach was first implemented and tested between 2013 and 2016 for on-farm testing of varieties, and an earlier article reported about methodological progress in this period (van Etten et al., 2019). Much of this work was part of the Seeds for Needs initiative, aiming at broadening the range of varietal diversity to farmers to adapt to climate change (Fadda et al., 2020). These projects were focused on cereals and grain legumes. Since then, the tricot approach has been used for other trials, by different organizations in the public and private sector for different applications (food products, product concepts, fertilizers, etc.), and for clonal crops (cassava, sweetpotato, potato), vegetables, and a perennial crop (cacao).

Description of the tricot approach

Tricot mobilizes many citizen scientists, each conducting a small experiment that collectively answers a larger question. Researchers and citizen science participants are supported throughout the experiment cycle by digital tools to design, execute, monitor and analyze the trials. As many citizen scientists contribute and do experiments in their typical use environments using their usual practices, it becomes possible to start to understand how variation in environments and practices affects the results. The trajectory from conceptualization of tricot in 2011 to its scaling phase in 2022 is described by de Sousa et al. (2024).

The particular way in which tricot works makes these steps possible. The following aspects are key to tricot:

1. The use of small incomplete blocks makes the threshold of participation low in terms of farm size, and reduces resource needs and training required;

2. The use of rankings and simple measurements to report observations facilitates digital data collection and makes it possible to evaluate an experiment with very little training and calibration;

3. The limited control of experimental conditions following common local technology use practices to maximize external validity;

4. The use of a streamlined digital process from trial design to analysis: makes it manageable, executable with many participants, reduces errors and costs, and quickly delivers feedback to achieve high motivation and impact on subsequent decisions;

5. Early feedback of the results to the participants: provides ownership and stimulates engagement of participating “citizen scientists”.

Tricot builds on existing participatory research formats that have been used in the past, as documented by van Etten et al. (2019). The novelty of the format is the combination of the different elements in a standardized, widely used approach supported by a corresponding digital platform, ClimMob (climmob.net). The platform is described in detail in Quirós et al. (2024) and throughout this book. ClimMob supports the user in designing a trial, randomizing the entries, creating electronic questionnaires, collecting the data, monitoring trial progress, and generating reports.

How is the tricot approach is used?

The tricot approach leverages citizen science to generate robust, scalable insights across diverse environments and user contexts. Here's how it

integrates into different aspects of product use testing:

1. On-farm testing

Farmers receive three randomly assigned technology options (e.g., seed varieties, fertilizers) and independently evaluate their performance under local conditions. No direct supervision is required, making it cost-effective and scalable, especially in remote areas. Data collection focuses on farmer-reported outcomes such as yield, resilience, and preference, linked to environmental metadata (e.g., soil, climate), socio-economic metadata (e.g., market preferences, household dynamics, management practices) and DNA metadata (de Sousa et al., 2021; Kang et al., 2025; van Etten et al., 2019; Voss et al., 2025).

2. Consumer testing

Tricot is used to assess consumer preferences for end-use products (e.g., taste, cooking quality, shelf life). The approach helps bridge the gap between agricultural production and consumer needs by combining field performance with end-user satisfaction (Alamu et al., 2023; Olaosebikan et al., 2023).

3. Concept testing

Tricot can be used to evaluate broader concepts, such as new varieties, innovative farming practices and agroforestry designs. Participants compare alternatives in terms of usability, practicality, or benefits, ensuring the development of context-specific solutions (Donovan et al., 2025). This iterative testing phase supports refining ideas before large-scale implementation. Breeders find that tricot is capable of providing real time market intelligence and differentiating preferences by different users if effort is put in characterizing the participants in the trial and choosing them with social impact in mind.

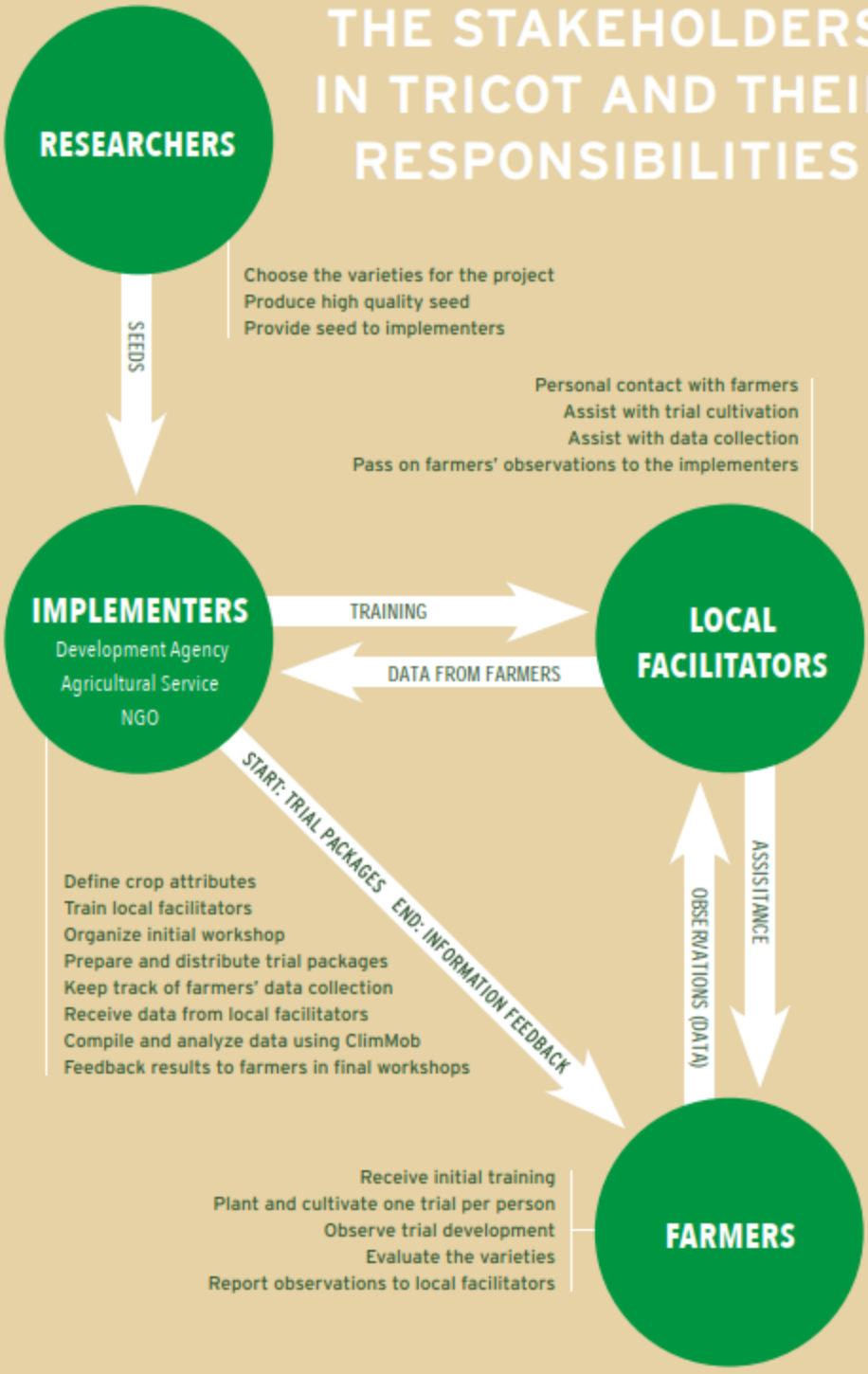
4. Scaling and adaptation

Tricot's simplicity allows broad implementation across geographies, crops, and technologies (de Sousa et al., 2024). The model is adaptable to low-resource settings, supporting smallholders while enabling private sector product testing.

5. Outcomes and impact

Tricot contributes to an impact by enabling the evaluation of many options in local contexts. It enhances crop diversity and resilience by tailoring recommendations to local needs (Gotor et al., 2021). It speeds adoption rates by aligning product characteristics with farmer and consumer preferences (Occelli et al., 2024). It supports sustainable and climate-adaptive agriculture by integrating real-world testing with robust scientific analysis. It also fosters inclusitivity, involving women, youth, and marginalized groups in the innovation process. In summary, the tricot approach is a dynamic, end-to-end solution for product use testing in agriculture, integrating farmer trials, consumer insights, and conceptual testing. It drives innovation by prioritizing user needs, ensuring product relevance, and enabling resilient and inclusive agricultural systems.

THE STAKEHOLDERS IN TRICOT AND THEIR RESPONSIBILITIES



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The 10 steps of a tricot experiment

This book is divided into chapters describing the 10 steps required to develop and implement a tricot project as laid out in the Tricot Short Guide (van Etten et al., 2020).

This section provides a short overview of each of the 10 steps.

Step 1: Preparation

Researchers first set the trial objectives and 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

Starting with a target product profile information, a list of technology options and focus traits, the implementing organization uses the ClimMob (climmob.net) online software to design the project. This digital platform has been specifically created to streamline the tricot process, from designing the experiment to data collection and analysis. 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

In the case of on-farm testing, the implementers then recruit dedicated farmers interested in improving their farming through the use of new technologies. The number of farmers needed for a trial is determined by the number of options to test. Local field agents are assigned to groups of farmers to facilitate the trial setup and data collection.

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 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 (which are identified by QR codes). 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. Here is

where they rank the set of three options. For example: Which variety had the highest or the lowest vigor? The farmers record these observations on an observation card. Yield can be measured quantitatively.

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 ‘ODK Collect’ smartphone app, which is connected to the ClimMob software. Also, other options are available.

Step 8: Analysis

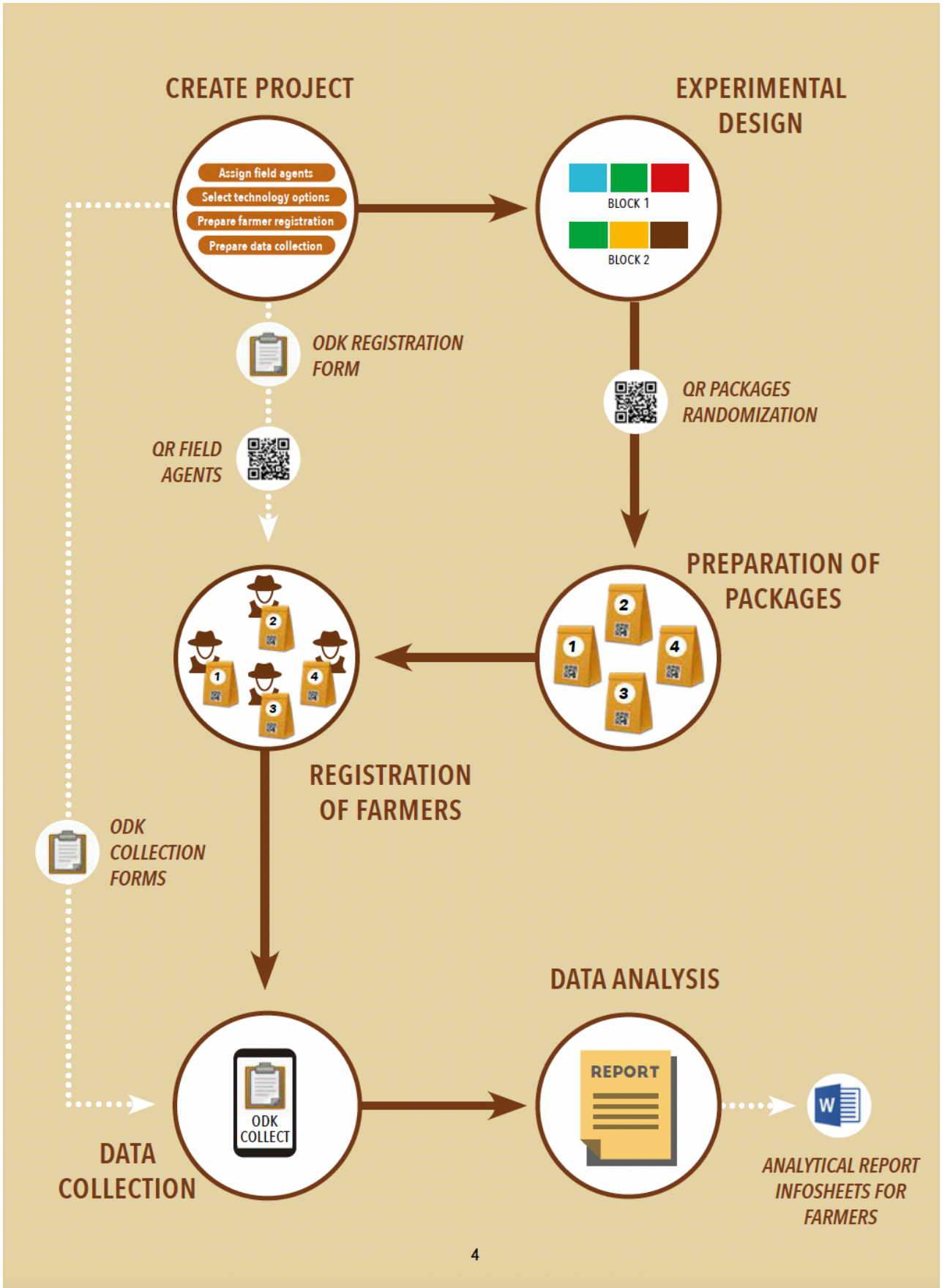
The implementers compile and analyze the data from the trials to identify which technology options showed the best performance and under which conditions. ClimMob provides an automatic report for quick analysis. Also, analysis can be done with easy-to-use statistical software (R-Instat or using R).

Step 9: Feedback

The implementers provide feedback to every participating farmer, including the names of the three technology options, which options were most suited to their farm and where to obtain them. Farmers are duly recognized for their participation with certificates.

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.


CREATE PROJECT
Assign field agents
Select technology options
Prepare farmer registration
Prepare data collection
EXPERIMENTAL DESIGN
BLOCK 1
BLOCK 2
ODK REGISTRATION FORM
QR PACKAGES RANDOMIZATION
QR FIELD AGENTS
PREPARATION OF PACKAGES
REGISTRATION OF FARMERS
ODK COLLECTION FORMS
DATA ANALYSIS
ODK COLLECT
REPORT
DATA COLLECTION
ANALYTICAL REPORT INFOSHEETS FOR FARMERS

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Objective setting

Jacob van Etten, Rachel Chase, Kauê de Sousa

What is the main question?

Trial objectives could span a wide range of agronomic and social questions. Studies have used tricot to evaluate farmer preferences for yield, drought tolerance, and disease resistance in crops such as common bean in Ethiopia and Nicaragua, groundnut in West Africa, and bread wheat in South Asia. Beyond pure agronomy, tricot trials have been designed to explore gender-differentiated trait preferences, as in work examining how men and women farmers in sub-Saharan Africa prioritise post-harvest attributes like cooking quality and storability. Other trials have used the tricot approach to study climate adaptation, pairing trial data with gridded weather observations to model genotype-by-environment interactions at scale.

Which technologies will be tested?

Researchers should consider and propose 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. A local (check) variety is often planted near the tricot trial or is included as one of the three options (although it should not be a fourth option or option 'D').

For example, topics to discuss (depending on the goal of the trial) could include:

- selection of the number of options
- selection of the check variety (local variety)
- selection of options for multi-seasonal trials

Which aspects will be evaluated?

Maybe one technology option provides higher yields, but another one is less labor-intensive. Both aspects can be important, and there may be many more aspects that matter. You will need to define the aspects 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 aspects can be evaluated, but it is recommended to pick no more than ten aspects. With more aspects, 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 aspects 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. Enketo is a web-based tool used to upload data when the ODK application is not available (or when using an iPhone). Other data collection methods can be made available (interactive voice response, Whatsapp). For example, in the near future, an AI-enabled application to record and translate languages (Sikia) will become available. Contact the ClimMob team for more information.

In which area will the project be conducted?

Project implementers define the area where the trial will take place, which should be related to **Target Product Profiles (TPPs)** in the case of variety evaluations. The area should represent the conditions of the target environment - the area were the tested options will be used if they perform well. For an explanation on how to select areas, see the section on **location selection**.

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Stakeholder engagement

> Taken from van Etten et al. (2020), page 7-8

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.

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.

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 farmer 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.

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Budgeting

Costing a tricot trial

Stephen Angudubo, Grecia Benavente

Preparing the budget for a tricot trial requires consideration of many technical aspects, from seed multiplication to farmer training. To facilitate this, a standardized costing tool has been developed that will help users plan the budget of implementing a tricot trial for a specific crop. It ensures cost transparency and consistency across projects, allowing for cross-country comparisons. It also helps in distributing resources, identifying high-cost centers, and noting unnecessary additional expenses. For example, a major cost driver is due to too many farm visits, which can be reduced with better planning and management. Breeding programs can employ the tool for calculating the cost of implementing tricot trials for specific crops, thereby providing estimates that enhance the planning and efficiency of future tricot trials.

Two costing tool templates are available - one for grain crops and one for root, tuber and banana (RTB) crops. These separate templates consider the differences in estimating seed multiplication costs.

The costing tools (the template guidelines and 2 x costing templates) are found in the Resources section of this document.

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Introducing ClimMob

Sofía Acuña, Marilyn Manrow, Brandon Madriz, Kauê de Sousa

ClimMob: A software platform for experimental citizen science in agriculture

ClimMob supports tricot trial implementers in evaluating technology options across diverse contexts with a one-platform solution to design, manage, and share experiments. It helps implementers plan and monitor processes while ensuring that relevant outputs reach researchers, field agents, and trial participants at the right time. This enables effective trial operations and agile, data-based decisions, underpinned by an excellent user experience.

ClimMob is a **free, open-source, online platform** for participatory testing projects. It guides users through all stages of their tricot projects: from project design and generation of randomized test packages, to efficient data collection, automated analysis, and reporting.

- Current version: ClimMob 3
- Data collection: can be conducted using the Android app ODK Collect, through online forms (Enketo), or by uploading data via Excel templates
- Analysis: uses many R packages

Requirements: A computer with an internet connection to design the trial and an Android smartphone or tablet for field data collection

Why ClimMob?

Participatory testing in agriculture can be complex, involving multiple actors—such as project implementers, field agents, and farmers—often across different regions or countries. These projects generate large volumes of data that must be organized, validated, and analyzed. Before ClimMob, previous disintegrated pipelines made it unlikely that project outputs were delivered on time.

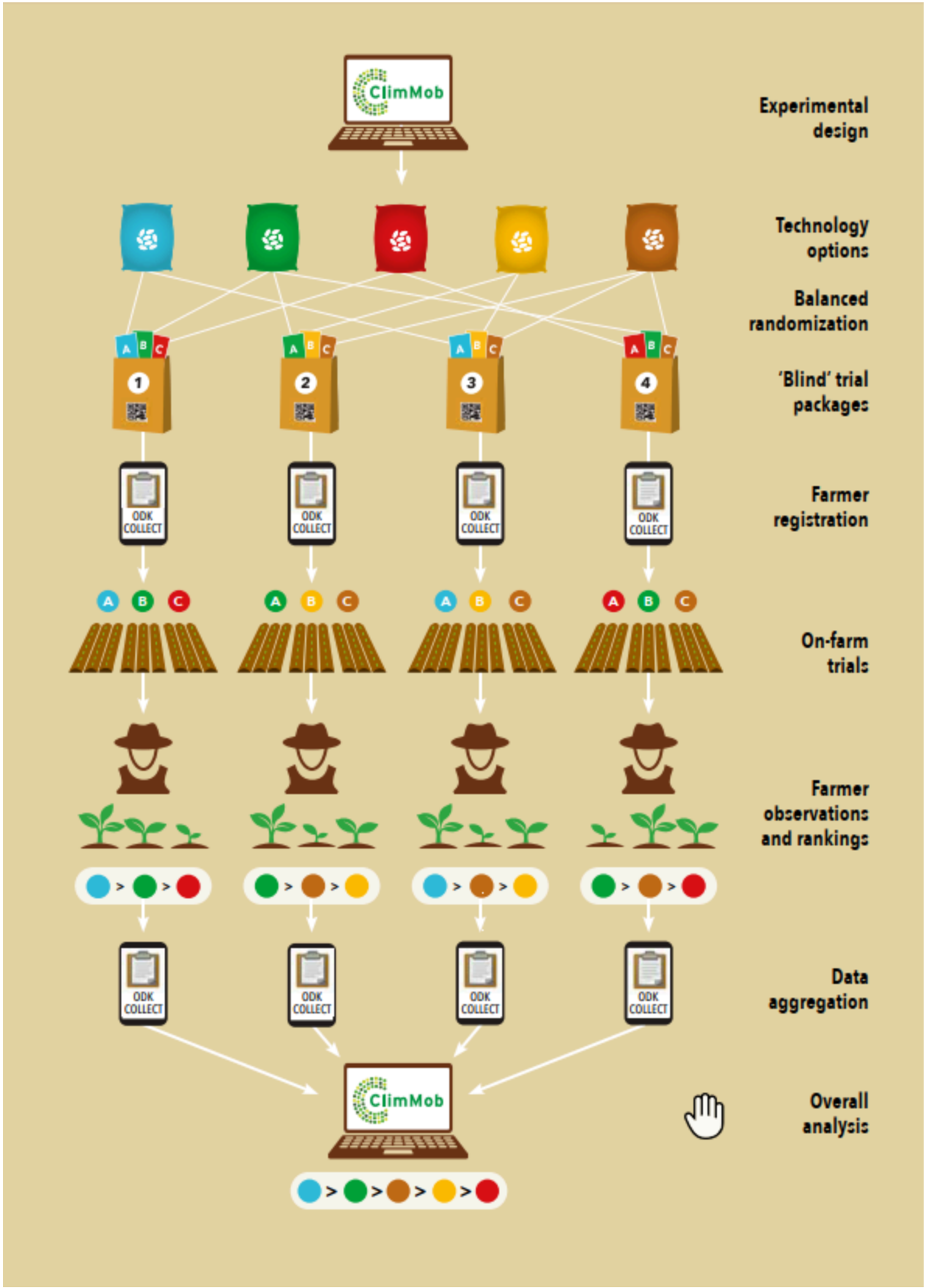
ClimMob was custom-built to streamline the complexity by supporting:

- Project design and planning
- Generation of randomized test packages
- Efficient data collection and storage
- Monitoring of data and project progress
- Automated data analysis and reporting

By simplifying all stages of the workflow, ClimMob makes tricot projects more manageable, scalable, and successful.

Software architecture and design principles

ClimMob’s architecture was shaped by the need for a feasible and project owner-oriented workflow, while also addressing the requirements of breeders, researchers, and field agents. The platform is designed primarily for scientists and project coordinators who lead participatory trials, ensuring they can manage projects efficiently while keeping outputs relevant for farmers and decision-makers. The software and workflow were developed in parallel to ensure technical coherence, usability, and alignment with real-world project management needs.


ClimMob
Experimental design
Technology options
Balanced randomization
'Blind' trial packages
Farmer registration
ODK COLLECT
On-farm trials
Farmer observations and rankings
Data aggregation
Overall analysis

ClimMob is built using Component-Based Software Engineering (CBSE). This allows for a flexible and modular platform that is easy to update and maintain.

ClimMob is based on robust, widely adopted open-source components, including:

- Open Data Kit (ODK)
- ODK Tools
- PyUtilib Component Architecture

All data analysis is conducted through R packages, ensuring reproducibility and transparency.

User-centered development

From the beginning, ClimMob has followed an iterative and user-centered development process, marked by:

- Ongoing feedback from users
- Short communication loops between developers and field teams
- Continuous improvements based on real-world use

This has resulted in a platform that adapts to the evolving needs of agricultural innovation projects.

Who uses ClimMob—and how?

ClimMob was built to support a range of users within participatory testing projects:

- Implementers (project leaders) - They benefit from tools for project setup, assigning field agents, and managing test packages. ClimMob also offers

automatic statistical reports, enabling data-informed decision-making.

- Field agents - They register participants and collect data using the ODK Collect app. This ensures data entry is quick, efficient, and synchronized with ClimMob.

- Testers (participants) - They receive their test results soon after data submission. This rapid feedback helps them learn from peers and adopt the most promising technologies.

What’s next for ClimMob?

Ongoing development of ClimMob focuses on:

- Improving user experience (UI/UX)
- Expanding data types and media (e.g. audio, photos, sensor data)
- Enhancing integration with other platforms
- Strengthening support for data-driven agricultural decision-making

Create a ClimMob account

Create your personal account on ClimMob. If you have already registered an account, you can log in straight away.

How-to:

Visit the ClimMob online software.

On the left upper corner, click on Login or register an account.

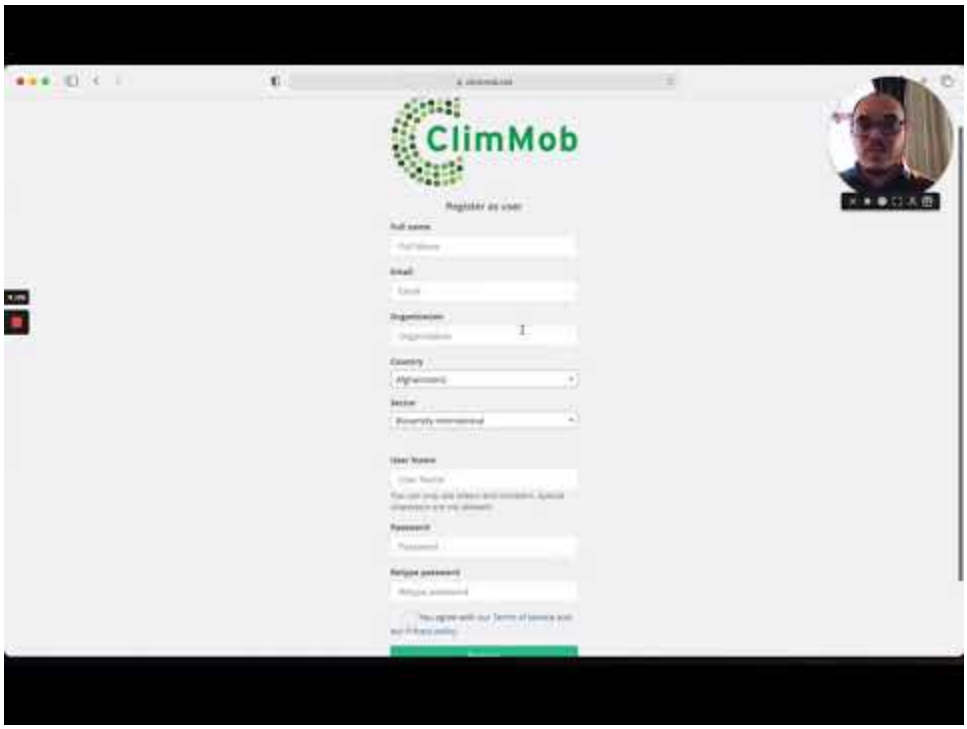
If you already have an account, enter your username and password and click on Login (green button).

If you don't have an account, click on Create an account (white button) which you will find under Login.

1. Fill in all the requested fields:

    a. Full name: your name and surname
    b. Email: your email address c. Organization: the organization you are working for, e.g. Alliance Bioversity – CIAT
    d. Country: select your country from the drop-down menu
    e. Sector: select the type of sector you are working for from the drop-down menu
    f. Username: the name you will use to enter the ClimMob dashboard
    g. Password: the password you will use to enter the ClimMob dashboard
    h. Retype password: retype the password you have entered above
    i. Agree with our Terms of service and our Privacy Policy
    j. Finally, click on register and your account will be set

Video tutorial - Create an account



Get familiar with ClimMob

When users log into ClimMob for the first time, they are welcomed with a guided setup designed to help them configure the platform before creating their first project. This workflow ensures that key components are defined early, streamlining future project setup.

Navigate the main menu

The main menu is located on the left side of the screen and gives access to key areas of the platform, including your projects, library items, and tools.

Here is the order in which these onboarding messages appear:

Libraries

Libraries are centralized repositories for elements that will be reused in multiple projects, such as agents, technologies, and questions.

- Field agents: are the individuals responsible for registering farmers and collecting data in the field. You'll define them once and assign them across multiple projects.
- Technologies: are the options that farmers will evaluate—for example, different seed varieties, soil treatments, or planting methods. These are stored in the library for future use.
- Questions: ClimMob provides a rich library of premade evaluation questions developed by the 1000FARMS team, available in multiple languages and ready to use across projects. This library helps ensure consistency and comparability in data collection. In addition, you can also define your own custom questions, which will then be stored and can be reused in future projects.

Downloads

This menu option gives access to tools and resources needed for field implementation, including:

- Field data collection templates
- Survey forms
- ClimMob documentation
- R analysis tools

Version: current

Checklist

This table can be used as a checklist for planning a tricot experiment.

Click here to open the checklist in PDF format for printing

✔	Step	Task	Key Actions	Responsible
☐	**1.Preparation**	Define scope	Identify local problems; select technology options; determine evaluation criteria; decide target area & farmer numbers	Researchers + Implementers
☐		Prepare materials	Produce quality seed/inputs; prepare observation cards, brochures, and training materials	Researchers
☐	**2.Design**	Create project in ClimMob	Register account; set up	Implementers

✔	Step	Task	Key Actions	Responsible
			project using SOP; assign field agents; input technology options; revise data collection questions	
☐		Randomization & packages	Generate trial packages with QR codes; label bags; prepare balanced sets	Implementers
☐	**3.Recruitment**	Farmer selection	Identify volunteers (men/ women, different ages & roles); ensure commitment	Field agents
☐		Mobilization	Outreach via meetings, posters, word of mouth	Field agents
☐	**4.Distribution**	Training workshop	Train farmers in tricot method, trial setup, and	Implementers + Field agents

✔	Step	Task	Key Actions	Responsible
			observation cards	
☐		Distribute trial packages	Provide QR-coded packages with 3 options, observation card, and brochure	Field agents
☐		Register farmers	Use ODK Collect to record farmer details and package code	Field agents
☐	**5.Execution**	On-farm trials	Farmers plant/ manage 3 plots side by side under normal practices	Farmers
☐	**6.Observation**	Field evaluations	Farmers record “best” and “worst” for each criterion on observation cards	Farmers
☐		Follow-up	Provide reminders/ support via calls/	Field agents

✔	Step	Task	Key Actions	Responsible
			visits; assist with card filling if needed	
☐	**7.Compilation**	Collect data	Field agents gather observation cards/data; input via ODK Collect; upload to ClimMob	Field agents
☐	**8.Analysis**	Process data	Use ClimMob to generate reports (technology rankings, explanatory variable analysis)	Implementers
☐		Outputs	Produce analysis report (researchers) + infosheets (farmers)	Implementers
☐	**9.Feedback**	Final workshops	Share overall results; distribute	Implementers + Field agents

✔	Step	Task	Key Actions	Responsible
			infosheets; facilitate farmer group discussions	
☐		Practical training	Provide additional agronomy lessons (e.g., seed storage)	Implementers
☐	**10.Evaluation**	Assess cycle	Gather farmer + agent feedback; evaluate indicators (completion rate, gender ratio, adoption, repeat participation, diffusion)	Researchers + Implementers
☐		Plan next cycle	Adjust technology pool (drop poor options, add new); expand farmer participation	All stakeholders

Version: current

📄 Download the Design chapter as a PDF

Product management

Harish Gandhi, Agnes Mbugua Gitonga

Introduction

In modern plant breeding, success is no longer measured solely by yield improvements. As agricultural systems face mounting pressures from climate change, population growth, food security challenges, and shifting consumer demands, the need to develop crop varieties that are not only productive but also resilient, marketable, and accessible has never been greater. The complexity of global markets, regional growing conditions, and diverse end-user demands necessitate a more structured and market-oriented breeding strategy. Therefore, numerous factors should be considered in product management and advancement, including variety release, commercialization, and seed marketing investments. Breeders should ask: does this product meet the minimum threshold to advance? To answer this, breeders need a strategic framework to guide them in the development of new crop varieties by clearly defining the market requirements they must meet.

What is a Target Product Profile?

A Target Product Profile (TPP) is a formal document that serves as a blueprint for breeders, outlining the key traits and performance benchmarks required for

a new product to succeed in a specific market segment. It ensures alignment between the breeding objectives and the needs of growers, processors, and consumers. Each TPP is tailored to a distinct market segment and captures both agronomic and market-related traits.

The standard TPP template includes:

- Required traits
- Measurement scales for each trait
- Minimum threshold scores
- Trait prioritization (essential vs. nice-to-have)
- Breeding objective for each trait (improvement or maintenance)
- Seed production/multiplication requirements
- Traits necessary for product registration
- Benchmarking against current market-leading products

This structured approach helps teams make informed decisions during parent selection and product advancement stages.

Classification of traits

Traits within a TPP are organized into two main categories based on their significance and role in the breeding process:

1. Essential traits: Must be present in all new products for the market segment. They are critical to meeting or exceeding stakeholder expectations (e.g., disease resistance, yield stability). Within essential traits there two categories:

- Improve traits: A subset of essential traits that are actively targeted for enhancement through breeding. For example, improving drought tolerance or increasing protein content.

- Threshold traits: Another subset of essential traits, but here the goal is to maintain current levels rather than improve them, ensuring continuity of performance (e.g., established disease resistance levels).

2. Nice-to-have traits: Traits that add value but are not mandatory for the product to succeed in the market. Their inclusion can provide a competitive edge but is not essential (e.g., aesthetic appeal, niche taste preferences).

Design and application of TPPs

The TPP template is intentionally designed to enable cross-comparison within crops, allowing breeders to quickly assess how different market segments vary in trait requirements. This supports a more refined breeding pipeline where resources can be allocated efficiently.

Key applications:

1. Product Advancement: TPPs are used at every stage of product development to ensure alignment with market needs. Product advancement also creates a platform to review current TPPs to ensure they are up to date with market dynamics.

See blog: Drylands crops elevating product design team’s role toward impactful product selection | GloMIP

2. Parent selection: Facilitates the selection of breeding parents that possess the desired traits.

3. Market differentiation: Helps identify traits that can distinguish one product from another within or across segments.

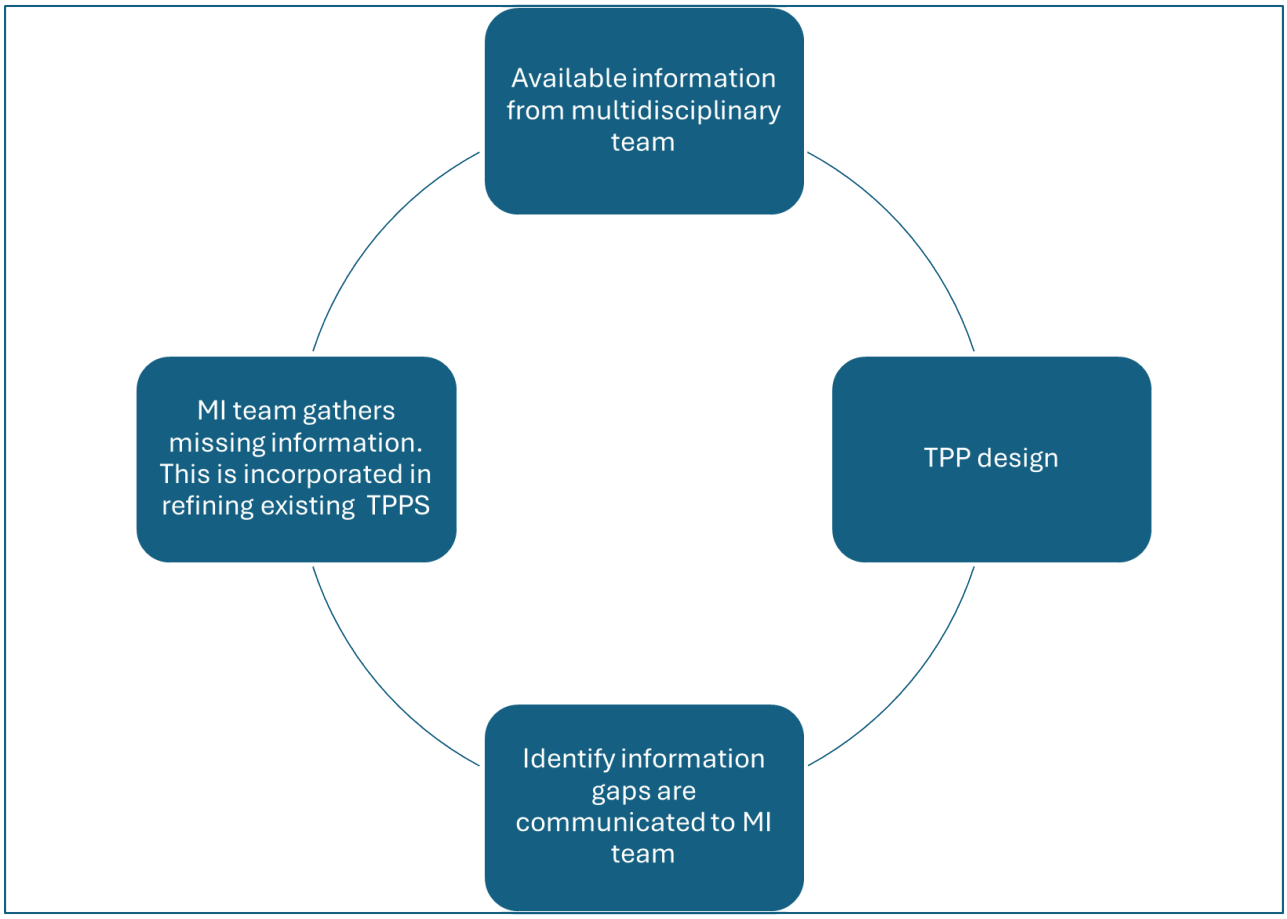
Challenges in TPP development

One of the key challenges in developing effective TPPs is the lack of complete or reliable information on some traits. In many cases, decisions must be made based on available data, even when it is limited or incomplete. This creates a level of uncertainty in the initial versions of a TPP.

To address this issue, the TPP design process is inherently iterative. As knowledge gaps are identified, they are actively fed back to the Market Intelligence team, who are responsible for gathering additional insights, whether through grower feedback, processor surveys, agronomic studies, or market analysis.

This ongoing feedback loop ensures that the TPP is continuously refined and remains aligned with evolving market needs. It also reinforces the collaborative nature of TPP development, requiring input from multiple disciplines and a willingness to adapt as new information becomes available. For example, the Market intelligence team did work on groundnuts market in Tanzania through concept testing, the results of this work informed the traits prioritization in the respective TPPs.

See blog: Market Segments for Groundnuts: Recent Insights from Tanzania | GloMIP



Developing a Functional TPP

A robust TPP begins with a well-defined market segment. If the segment is too broad, the trait list becomes excessively long and unfocused, risking the omission of key requirements. Conversely, if it is too narrow, there may be insufficient differentiation between products, reducing the strategic value of the TPP.

To develop an effective TPP:

1. Engage a multidisciplinary team: Involve experts from breeding, seed production, regulatory affairs, marketing, and customer relations to capture a comprehensive view of product requirements.

2. Incorporate market intelligence: Use data on competitor products, customer feedback, and regional agronomic trends to inform trait prioritization.

3. Ensure adaptability: While the TPP serves as a guiding framework, it should be revisited and revised as market dynamics evolve.

Conclusion

Target Product Profiles provide a disciplined, market-driven approach to plant breeding. By defining clear goals based on real-world demands, TPPs help breeders focus their efforts, streamline decision-making, and ultimately deliver better, more competitive products to the market. Their strategic use ensures that new varieties not only perform well in the field but also succeed in the hands of farmers, processors, and consumers alike. For more information, TPPs can be accessed on GloMIP.

Version: current

Sampling

Béla Teeken, Jill Cairns, Mainassara Abdou Zaman-Allah

Introduction

On-farm testing increasingly relies on trial designs that are practical for farmers yet robust enough to generate reliable evidence across diverse environments. The tricot approach meets this need by asking participating farmers to test small, manageable sets of technologies under their own management and local conditions, and to provide simple, preference based rankings for key traits (for example, earliness, or taste). Because tricot uses incomplete blocks distributed across many farms, its statistical power comes from replication over space and seasons rather than from large, researcher-managed plots.

A successful tricot trial therefore begins with a thoughtful socio-economic and geographic sampling strategy that captures relevant differences among households and landscapes, so results reflect who farms where—and under what constraints. Farm selection should aim to represent the target population of environments and management practices, while ensuring sufficient numbers of independent farms to capture variability and support subgroup analyses (for instance, by soil type or rainfall zone).

Socioeconomic sampling

Recruiting experienced participants

Participatory variety selection often recruits farmers using broad demographic categories such as age, sex, education, occupation, or farm size, without considering the specific tasks people perform or their expertise. When gender is considered, the usual practice is simply to include equal numbers of men and women evaluating the trials, regardless of their experience with the crop.

Another limitation is that participants are often those comfortable speaking in research settings. This may exclude highly skilled people whose knowledge is mainly practical or embodied. For demand-led breeding approaches, breeders need detailed information on farming practices, processing, food preparation, and marketing, which can only be provided by people directly involved in these activities.

To address this issue, tricot trials use purposive sampling based on a task group approach with an explicit gender dimension. Task groups refer to categories of people who perform similar crop-related activities—such as cultivation, processing, or marketing—within locally defined social groups.A task group approach is also in line with a much more performative way of participation instead of only a deliberative one (Richards, 2005).

From a demand-led perspective, breeders need information on the suitability of improved varieties within users' livelihoods and therefore need feedback from skilled farmers, processors, and marketers. These actors provide insights into agronomic performance, processing qualities, food characteristics, and market demand.

A task group approach and gender

Sex-disaggregated data collection protocols on variety preferences are problematic as they put upfront sex and gender differences as an explanatory factor. This approach can obscure how gender roles intersect with other locally relevant

identities such as occupation, migration status, ethnicity, age, or economic status. Instead of beginning with gender categories, the task group approach identifies who performs which tasks within the crop value chain.

Focusing on tasks connects directly to practical activities such as cultivation, processing, food preparation, and marketing. This helps researchers access knowledge, skills, and working conditions without treating gender as the primary analytical entry point. By emphasizing work and expertise, discussions about gendered roles often emerge naturally. Knorr-Cetina (Knorr Cetina, 1999) would call this building epistemic cultures based on fascination and content of the work.

Participatory variety selection exercises organized around task groups therefore provide a useful way to capture practical knowledge about crop traits. Individuals may belong to multiple task groups—for example farmer-processors or farmer-marketers—and the degree of their involvement across tasks provides insights into gender roles and value-chain dynamics.

Practical implementation of a task group approach

After defining a regional sampling frame (e.g. selecting communities in areas where the crop is widely grow), the next step is identifying participants within each community. The following stages can guide this process.

1. Identify relevant tasks Determine which crop-related activities are relevant to the study, such as cultivation, processing, food preparation, or marketing.

2. Identify locally defined social groups This can be done through meetings with community leaders, key informants, transect walks, and interviews with people involved in crop-related work. This includes the disadvantaged and the less better off, and explicitly try to avoid leadership effect (e.g. (Humphreys et al., 2006)) and state that the village leading elite is not to determine only who participates: cultivate a democratic and equity focused discussion and debate on studying experienced based crop related expertise that exist among the different social groups.

3. Map tasks within social groups Within each locally relevant group, identify who performs which activities in producing, processing, and marketing the crop. Participants should be selected based on demonstrated knowledge and practical experience.

4. Include relevant groups only Groups not involved in the crop value chain should not be included as participants.

5. Organize participants locally In Nigerian cassava trials, ten participants per community were organized under one lead farmer responsible for coordinating communication and data collection. Allowing participants to select their own lead farmer helped ensure local legitimacy and ownership of the activity.

N.B. Remember that trial visits and research station staff costs should be reduced to a minimum, so it is very important to invest in choosing and building the right reliable local management unit and this works best using local respected persons and authorities.

6. Determine compensation mechanisms Participants should receive modest compensation acknowledging their effort without creating incentives that overshadow intrinsic motivation. Investing time in establishing a reliable local coordination structure reduces the need for frequent visits by research staff and improves the consistency of data collection.

Table 1. Example of local social groups based on interaction with a village community in the Southwest of Nigeria focusing on cassava. Apparently ‘ethnic group’ was found important to distinguish different people. The groups highlighted in grey are the groups included among the tricot participants as the others are not involved in cassava work.

Locally Relevant Social Group*	Share of Local Population (oral or record share) [B1.4a]	Language (record language) [B1.4b]	Associated Livelihood(s) or Crops [B1.4c]	Tasks Related to Cassava (Women)	Tasks Related to Cassava (Men)	Better Off Group(s)? (Yes=1, No=2) [B1.4d]	Politically Active & Influential Group(s)? (Yes=1, No=2) [B1.4e]
i. Ilaje (originally from Ondo state)	1000	Yoruba dialect	Fishing, selling of fish			2	2
ii. Agatu (Immigrants from Benue state)	500	Agatu	Farming (subsistence and cash crops), farm labourer. Includes cassava	Farming (weeding, harvesting), processing, marketing	Farming (weeding, planting, harvesting), marketing of fresh roots	2	2
iii. Markurdi (Immigrants from Benue state)	100	Tiv/Igede	Farming (subsistence and cash crops), farm labourer. Includes cassava	Farming (weeding), processing, marketing	Farming, marketing of fresh roots	2	2
iv. Hausa	10	Hausa	Trading, fishing			2	2
v. Cotonou (Immigrants from Benin republic)	50	Fon/Ewe	Farming (subsistence and cash crops), particularly cultivate vegetables, tomatoes, and peppers. Includes cassava	Farming (planting, weeding), processing, marketing	Farming and occasional processing	2	2
vii. Fulani	150	Fulfulde	Cattle rearing			2	2
viii. Yoruba	18145	Yoruba	Farming (food and cash	More of processing,	Farming, marketing	1	1

Locally Relevant Social Group*	Share of Local Population (oral or record share) [B1.4a]	Language (record language) [B1.4b]	Associated Livelihood(s) or Crops [B1.4c]	Tasks Related to Cassava (Women)	Tasks Related to Cassava (Men)	Better Off Group(s)? (Yes=1, No=2) [B1.4d]	Politically Active & Influential Group(s)? (Yes=1, No=2) [B1.4e]
			crops), trading. Includes cassava	some farming (weeding), firm marketing	of fresh roots		

Participant selection and preparation

Participant recruitment should be purposive and based on interaction with community leaders and key informants to identify representatives of locally relevant social groups. Participants should represent these groups roughly in proportion to their presence in the community.

Selection should focus on tasks and skills rather than demographic categories such as age, although some age diversity should be maintained where possible.

Adequate time should be invested in ensuring the commitment of participants and the reliability of the lead farmer, as communication and coordination often occur through them by telephone. Preparation of participant teams should begin one to two months before distributing planting materials.

If participants withdraw when planting materials arrive (e.g. de Boef and Thijssen (2007)) they should be replaced with individuals representing similar social and task groups.

Table 2. Chosen participants in one community in Southwest Nigeria who participated in the tricot evaluation based on a task group approach (using information in Table 1).

Participant	Local social group	Skill	Sex	Age
Name 1	Yoruba	Farming, selling fresh	M	30
Name 2	Yoruba	Farming, selling fresh	M	24
Name 3	Yoruba	Farming, processing, selling	F	45
Name 4	Yoruba	Farming, processing, selling	F	50
Name 5	Agatu	Farming, processing	F	35
Name 6	Agatu	Farming	M	50

Participant	Local social group	Skill	Sex	Age
Name 7	Makurdi	Farming, selling fresh	M	25
Name 8	Makurdi	Farming, processing, selling	F	55
Name 9	Cotonou	Farming, processing, selling	M	28
Name 10	Cotonou	Farming, processing	F	22

Lead farmer trainings

Lead farmer trainings are organized to explain how to evaluate tricot plots and coordinate participants. Ideally these trainings take place after trial plots have been installed so farmers already understand the trial setup, although they can also occur earlier if necessary.

In Nigeria, organizing trainings at the state level rather than nationally allowed more practical field exercises and accommodated regional language differences.

Evaluation parameters should reflect farmer-expressed characteristics rather than breeder terminology. Based on earlier interviews, a simple guide with four to five parameters is prepared, asking participants to identify the best and worst variety for each parameter before providing an overall ranking.

Training ensures that lead farmers clearly understand each parameter, and translation into local languages is essential for consistent interpretation.

Administering a RHoMIS core social questionnaire

For the further sake of social differentiation and allowing to segment the dataset later, a Rural Household Multi-indicator Survey (RHoMIS) core social questionnaire should be administered to each of the chosen participants.

This survey may be conducted during distribution of planting materials or during a mid-season field visit, which also allows researchers to confirm that trials have been properly established. Linking RHoMIS data to participant tasks enables analysis of how socio-economic conditions influence trial management, performance, and preferences.

Making tricot inclusive: Gender and social heterogenteity

External validity of tricot trials has an important social science aspect. As has been indicated above, tricot trials imply sampling a representative range of use contexts, which are characterized not only by environmental variation, but also by gender and social heterogeneity, which will have an effect on variety preferences through various proximate causal factors.

Firstly, crop management tends to reflect cultural and socio-economic conditions and identities (Adekambi et al., 2020). For example, the ability to purchase fertilizers or spend sufficient labor on weeding will influence how the trial plots are managed and will influence perceptions of variety performance.

Another example is that farmers and processors might favor a particular variety because of its suitability for preparing a food product that is locally important or consumed by a particular social segment of the population. For example,

farmers' orientation towards market production and household consumption can influence how they perceive traits related to marketability, cooking or taste (Adekambi et al., 2020).

Thirdly, the degree to which farmers that participate in tricot trials have adequate knowledge of a different aspect of variety performance will depend on their involvement in different agronomic, processing and culinary activities (Teeken et al., 2020).

Gender plays an important role in these dynamics because tasks within crop value chains are often gendered (Weltzien et al., 2019). However, tricot analyses have not consistently detected strong statistical differences between men and women, even though trait prioritization studies often show gender-related differences. One reason may be that gender interacts with other social variables, such as income, occupation, migration status, or ethnicity, which are rarely captured in analyses.

Traditional methods such as free-listing exercises may also have limitations. They reflect salience in discourse rather than relative importance in real decision-making contexts and may be influenced by leadership effects or translation issues (Richards, 2005). Newer approaches based on pairwise comparisons offer alternatives that better capture trade-offs among traits (Byrne et al., 2012; Steinke et al., 2017).

Two methodological innovations address these challenges.

First, the RHoMIS survey provides standardized information on household characteristics, gendered control of activities and income, farming systems, and socio-economic indicators (Hammond et al., 2017; van Wijk et al., 2020). A shortened version is used in tricot trials to reduce respondent fatigue while enabling analysis of how social factors influence trial outcomes.

Second, participant recruitment moves beyond simple gender quotas toward purposive sampling based on locally identified social groups and task expertise. Qualitative research identifies these groups, and participants are selected to ensure representation of relevant expertise across the value chain. Random interviews within these groups verify participants' experience in cultivation, processing, or marketing.

This approach allows gender analysis to be conducted after data collection, comparing preferences among men and women within the same task groups and across different social identities.

Task groups develop specialized knowledge, language, and practices. Recruiting participants from these groups ensures that tricot trials draw on real expertise and capture the diversity of user preferences across the crop value chain. Task groups can be identified through ethnographic methods such as interviews, transect walks, and market observations.

By combining task-group sampling with standardized socio-economic data, tricot trials can generate socially inclusive insights into varietal preferences while still identifying cross-cutting traits that breeders can target across regions and user groups.

Ethics, privacy and rights on traditional knowledge

Tricot involves human subjects and must therefore observe certain research ethics standards. In general terms, the application of tricot must minimize the possible risks, discomfort, nuisances and costs for participants while maximizing the benefits that they and other farmers may obtain (directly or indirectly) from the trial data obtained through tricot.

Tricot is also subject to privacy issues, and data management needs to conform to General Data Protection Regulation.

In general, this will mean the following for tricot trials:

- Research ethics clearing is obtained from the relevant Institutional Review Board (IRB).
- Research ethics clearance may be also necessary from a national organization. For this purpose, tricot users must take national laws and guidelines into account.
- Prior informed consent of no Personally Identifiable Information (PII) publication.
- Participants are given the right to withdraw from the study while it is executed.
- Participants are given the right to withdraw their data from the study while it is in the course of being executed.
- Participants can indicate if they want to be recognized with their name in the publications based on the data. This does not compromise privacy (names cannot be linked to personal identifiable information such as addresses, telephone numbers or coordinates).

In practice, this means the following for the further development of the tricot approach and the ClimMob platform:

- ClimMob should provide features to make it easy for trial designers to follow the principles and procedures indicated above.
- Automatically generated document to request IRB clearance.
- Standardized, short prior informed consent forms and practical ways to implement paper-based signature + photograph of the document, electronic signature, or spoken approval (audio).
- Names of participants that want to be named in the research publication exported by the platform.
- Application of privacy-preserving methods before exporting data. This process can be automated through the automatic detection of potential personally identifiable information (PII), confidential data, or other protected content, resulting in shareable data.
- Throughout the design of an experiment, ClimMob should provide cues to prompt users to consider research ethics, privacy and traditional knowledge rights in the design of tricot trials.
- ClimMob needs to be GDPR-compliant to users (cookie policy, explicit notice about usage of data). The version available at the moment of writing already has this implemented.

A more complex topic that deserves separate discussion is that tricot may be affected by national laws on the access to genetic resources and associated traditional knowledge and the sharing of benefits arising from their use (ABS, for short). There are two aspects in which tricot is affected by ABS, via the use of traditional varieties and via the use of traditional knowledge held by participants. We consider both aspects.

Firstly, tricot may need to observe ABS rules when using traditional varieties. tricot is usually applied to test the performance of new, improved varieties. However, in some cases, genetic materials of traditional varieties are to make comparisons. Although the utilization of the check varieties does not fall within the activities that are usually subject to ABS requirements in most countries, whether or not ABS obligations apply will depend on the definition of utilization adopted by the country of provenance of the variety (i.e., the country where the research is implemented). Therefore, tricot users will need to analyze the applicable access rules in the country where they are operating, obtain the access permits and negotiate mutually agreed terms when necessary.

If the country where the traditional varieties come from is a party to the International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty), the acquisition of the traditional varieties for their use in tricot may be subject to the terms and conditions of the Plant Treaty’s multilateral system of access and benefit-sharing. In this case, access to the samples would be facilitated by the Standard Material Transfer Agreement. Since the purpose is not to breed the traditional varieties or incorporate them in new, improved lines, the multilateral system’s mandatory monetary benefit-sharing conditions would not apply, and thus the tricot users would not have any benefit-sharing obligation. However, they would have the obligation to transfer the varieties they have obtained with the SMTA under the same terms and conditions as those of the multilateral system, whenever the recipients of such material are going to use it for conservation, research, training and breeding.

Secondly, tricot may be exposed to ABS laws when using traditional knowledge. Farmers’ ability to perceive crop

characteristics is often considered to be part of traditional knowledge related to genetic resources (Mancini et al., 2017). In tricot trials, farmers use their skills to produce new knowledge, which would usually not fall under national ABS laws, but whose use may be anyway subject to rules and protocols related to the interaction with indigenous and local communities, the access to their knowledge and their natural resources. Even if the country has not yet enacted ABS legislation in relation to genetic resources and/or traditional knowledge, or even if the existing laws and regulation do not apply to tricot trials in a particular context, it is wise to observe, the CBD and the Nagoya Protocol principles in the management of farmers' varieties and knowledge in tricot trials, as 'best practice', as recommended by the Guidelines on the Nagoya Protocol for CGIAR Research Centers. This means, among other things, sharing non-monetary benefits back with the participants, in the form of informational results, best performing varieties and other types of technologies.

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Trial size

Joost van Heerwaarden, Marie-Angélique Laporte

🧮 Sample calculator 🧮 Seed calculator

Sample size

As for any experiment, deciding on appropriate sample size is important when designing tricot trials. Since determining differences in the performance of options is the aim of variety trials, the number of replicates per options (n) determines the statistical power. As can be seen in Figure 1, statistical power increases with n, and a quite substantial number of replicates may be required when differences between options are small, or residual (i.e. random) variation is large.

For example, detecting a difference in average yield equal to the 0.7 times the residual standard deviation (i.e. a so-called Cohen’s d of 0.7) with 95% probability would require approximately 30 replicates per option. It is important to note that tricot ranking data contains less information than direct measurements and consequently, about twice as many replicates are needed to achieve equivalent power. Also, rank based estimates of option performance may be unreliable when n is too small and a minimum of 30 replicates should be aimed for.

Tricot trials are designed to be fully balanced, so once the number of replicates, n, and the number of options (noptions) is decided, it is straightforward to calculate the required resources. The following equations are helpful in this regard.

To calculate the number of plots required:

`Nplots = nfarms × 3 = noptions × n`

To calculate the number of farms required:

`nfarms = (noptions × n)/3`

To calculate the sample size, n, for an existing design:

`n = (nfarms × 3)/ noptions`

Interactive sample size calculator

This calculator assumes that the tricot format is being used (blocks of size 3). It is based on Talsma (2018).

It calculates how many samples are needed to achieve a certain Cohen's d (effect size relative to the standard deviation of the technology options tested) with 95% probability. It does not take into account the data return rate. For a single season, a Cohen's d of between 0.7 and 1.0 is reasonable. For a consumer preference test, a Cohen's d between 0.2 and 0.5 is recommended.

Interactive sample size calculator

Uses the formulas from the Excel tricot sample size file, assuming 3 products per subject, alpha = 0.05, and beta = 0.05. This version does not include return rate.

Effect size to be detected

0.7

Example values: 0.7–1.0 for agronomic trials, 0.2–0.5 for consumer preference

Total number of technologies to be tested

12

Number of varieties or technologies being compared

Total number of participants needed

187

Plots required

561

Interactive seed needs calculator

The calculator assumes that the tricot format is being used (blocks of size 3). The units of the “Seed quantity per plot” are the same as results (for example, kilograms but also number of plants can be used).

Interactive seed needs calculator

Assumes a tricot design with blocks of size 3. The units of “Seed quantity per plot” are the same as the calculated result.

Number of options

12

Replicates per option (n)

30

Seed quantity per plot

0.2

Unit

kg

Buffer (%)

10

Total number of participants needed

120

Plots needed

360

Total seed needed

72 kg

Total with buffer

79.2 kg

Locations

Tricot trials often cover different geographical or agroecological areas. In such cases, the most important aspects are sample size, balance, representation. As

mentioned above, rank-based option performance estimates may be quite unreliable when n < 20. This also applies when differential performance across geographies needs to be estimated (Figure 2) so it is recommended to strive for at least 10-20 replicates per geographical area. For multiple environments, sequentially balanced data implies that pairs of options are compared the same number of times in each environment. This can be achieved by using a resolvable incomplete block (alpha) design, that can be generated by specialised software packages. In practice, the designs produced by ClimMob will be sequentially balanced if the same number of farms are assigned to different locations (Figure 3).

Finally, achieving good representation of geographical areas requires sampling multiple locations within the target region. A prototype sampling tool has been developed to aid in creating designs and itineraries for such multi-locational experiments (Figure 4). Logistically, it is convenient to sample multiple farmers per location and to allow detection of location specific effects it is recommended to have at least 10 replicates per location. In the example with 20 options and 7 locations shown in Figure 4. This would require visiting 467 farms in total (67 farms per location). An appropriate balance between coverage of target areas and logistical cost is important, which is why the sampling tool will calculate total travel time for the shortest routes between chosen locations.

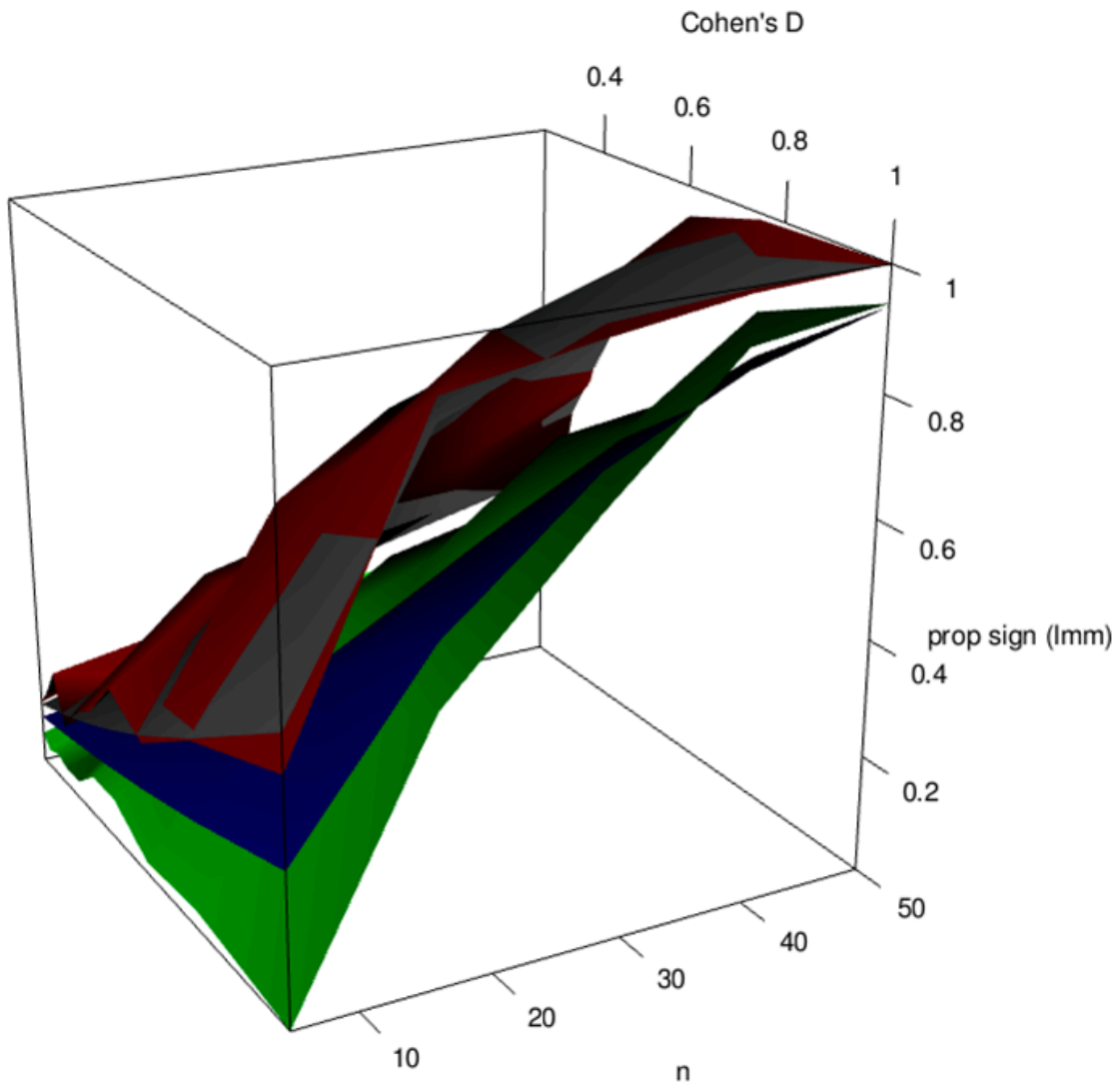

Figure 1. Simulated statistical power to detect a difference between two options (prop sign), as function of sample size (n) and magnitude of difference (Cohen’s D) for a quantitative trait (red) and for ranking data (red). The grey and blue planes indicate the expected values, assuming ranking data has an effective sample size of half compared to quantitative data.

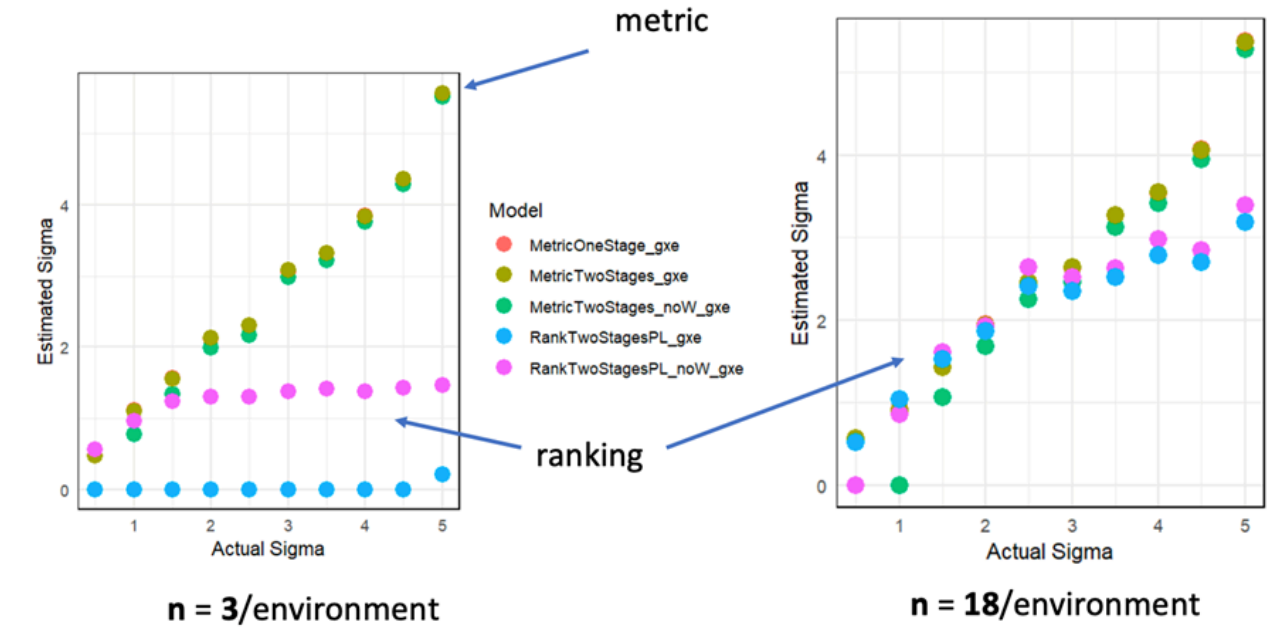

Figure 2. Simulated results demonstrating the effect of sample size on the ability to estimate variation due to option by environment interaction (sigma) using continuous (metric) and ranking data for 3 and 18 replicates per environment (10 environments).

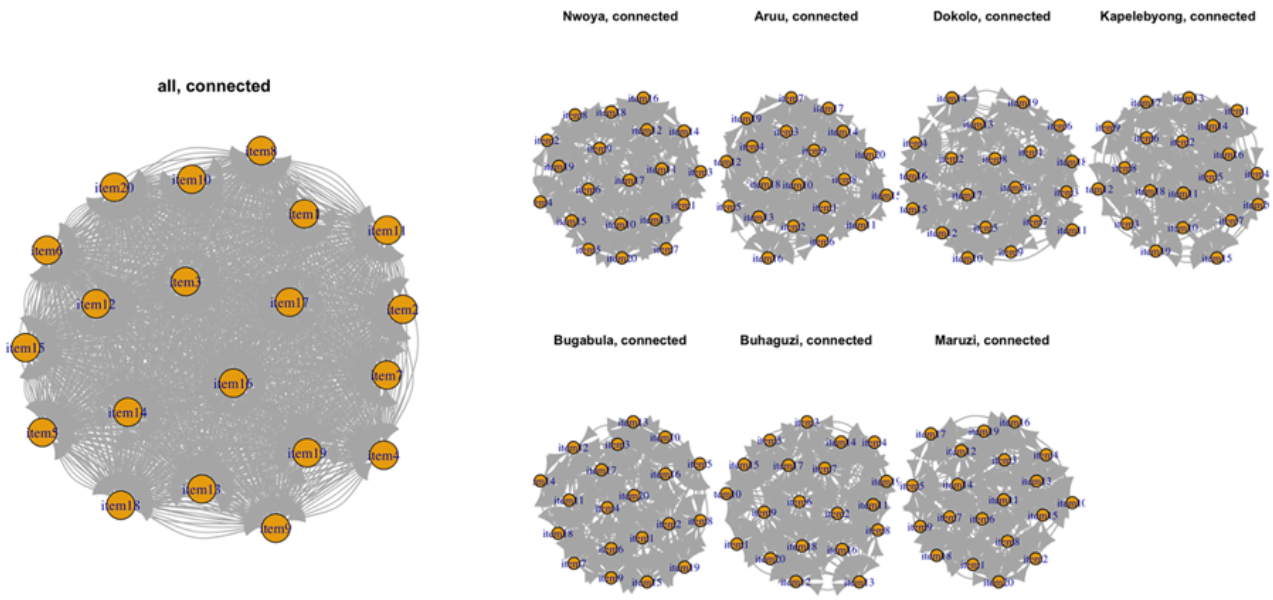

Figure 3. Network graphs showing connectivity and balance in pairwise comparisons for aggregated (left) and disaggregated (right) multi-location data.

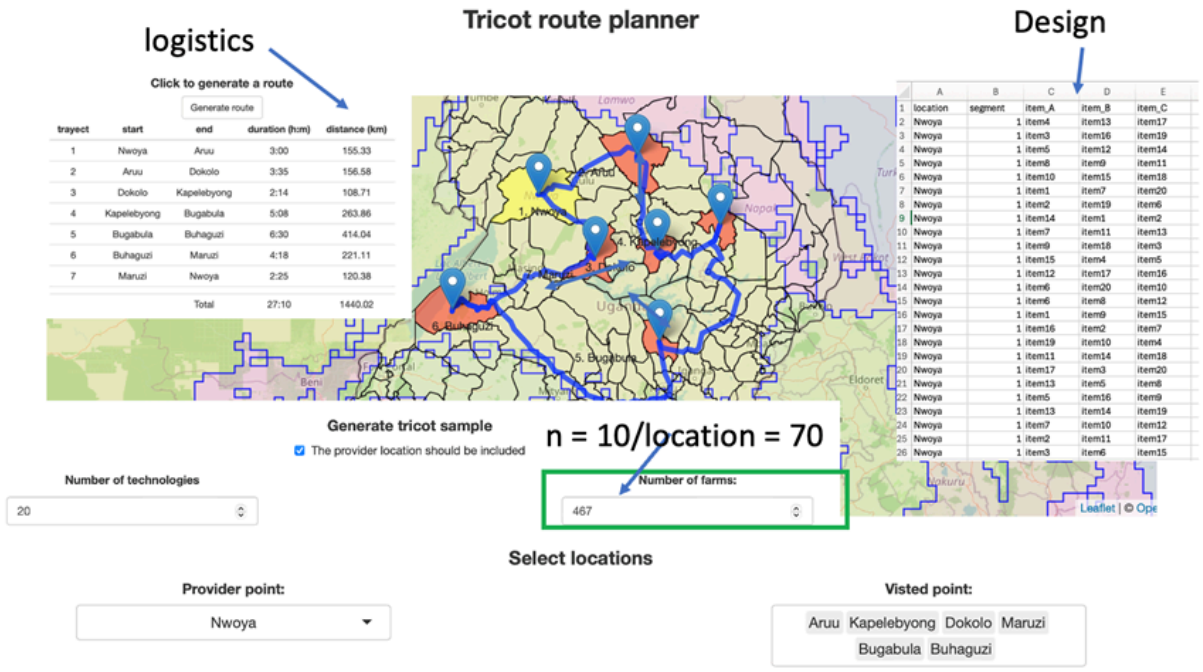

Figure 4. Overview of output of the sampling tool prototype showing the most efficient route among locations covering a an agro-ecological zone.

A recurrent issue is deciding about plot size and the number of plots (replications). In the literature about crop trials, there are several methods to guide decision making. At the same time, this is not just a question of statistics, but also biological considerations are important. For tricot trials, there are a number of additional considerations related to farmers' capacities.

Plot size

Plot sizes should generally be small, for the following reasons.

- With the same amount of seeds, more farmers can participate. Tricot is

about external validity, so capturing the diversity in use contexts is important.
- Small plots sizes allow farmers with small farms to participate. This makes tricot trials more inclusive and representative.
- Small plot sizes increase the variation between farms, but do not systematically bias results upwards or downwards (unless edge/border effects play a strong role, see below).

Tricot plots should not be too small, however.

- Strong edge or border effects should be avoided. This can be avoided by not harvesting border rows.
- If varieties are also tested for processing or culinary characteristics, plots should produce sufficient volume to allow this.

Some remarks on specific crops:

- For potato, competition effects between plots consisting of single ridges seems unimportant for yield, as stolons rarely extend beyond ridges `Connolly 1993`.
- For cassava, interplot competition effects have been found to extend beyond the first row `Elias 2018`.
- For sweetpotato, interplot interaction is thought to be substantial due to above-ground competition `Gruneberg 2019`. For sweetpotato trials, 30 m2 plots with 100 vine cuttings have been recommended for on-farm trials `Gruneberg 2019`. For a tricot trial in Ghana, however, much smaller 6 m2 plots with 20 vine cuttings were used, which is two thirds of the recommended plot size of on-station trials.

Plot size is closely related to the number of seeds that is provided to farmers. In grain crops, breeders often provide seeds based on the average weight needed for a unit of land. However, this can be problematic when there are

seed size differences between varieties. A small-seeded variety would be represented by more seeds. Consequently, the farmer may decide to increase the plant density of a small-seeded variety or add more planting positions. This could bias yield estimates to favour small-seeded varieties. It is therefore recommendable not to provide the same weight of seed for each variety, but the same number of seeds.

Number of plots (or farms)

For a trial with around 12 entries (varieties, lines, etc.) typically 100-200 farms would provide solid results to make recommendations. This means that the trial has a 95% probability of identifying differences (effect sizes) between 0.7 and 1 standard deviations (Cohen’s d). Since trials are done over several seasons, this number will diminish over time. See the interactive sample size calculator below to estimate the number of farms needed.

This is the same order of magnitude that was found in previous on-farm trial work with cereals.

If the trial covers more agro-ecological environments (to which the set of varieties is expected to respond in different ways), the number of farmers should be proportionally higher. Future studies should provide better guidance regarding optimal trial dimensions.

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Standard operating procedures (SOPs)

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📄 Click here for the SOPs

Introduction

Systematic documentation of farmer-generated data is critical for assembling and comparing results across investigations, ultimately enabling the identification of broader geospatial patterns and actionable trends (Brown et al., 2020). This is particularly relevant in tricot trials, since they are embedded within real farming systems and, therefore, conducted under highly heterogeneous conditions, with differences in plot history, management, climate, and household labor shaping both crop performance and farmers' perceptions.

Capturing this diversity in a structured and analytically meaningful way requires common rules for what information is recorded, how, and when (Kool et al., 2020). Standard Operating Procedures (SOPs) are essential to this endeavor. SOPs are formal, validated descriptions of how a task is performed, documented, and communicated. They have been developed with crop-specific breeding teams to ensure that the recorded information has the greatest impact toward varietal improvement.

This section introduces the rationale for SOPs in tricot trials, outlines their core components, and explains how to use them in practice. It also shows how well-

designed SOPs can enhance data quality, support interoperability across digital tools, and strengthen decision-making within breeding programs.

What are SOPs?

Broadly speaking, SOPs can be defined as standardized frameworks that detail what, when, and how to do something, and how to record it, offering step-by-step guidance that is precise enough to ensure coherence but flexible enough to be adapted to local realities (Gough & Hamrell, 2009). In tricot trials, SOPs define how decentralized on-farm experiments must be designed, established, evaluated, and documented so that farmer-generated data remain consistent across crops, seasons, and regions.

SOPs bring together a set of benefits that can be understood across four closely related domains: practical, methodological, ethical, and communicational.

- Practical efficiency: SOPs reduce setup effort and uncertainty, allowing teams to focus on facilitation and learning rather than repeatedly redesigning protocols — essential as tricot networks scale.
- Methodological consistency: Standardizing variable definitions, measurement scales, and growth-stage logic ensures data from thousands of farmer-managed plots can be compared and analyzed together.
- Scientific attribution: Consistent procedures mean observed differences in crop performance can be attributed to real biological or environmental factors, not implementation inconsistencies.
- Communication & shared language: SOPs align breeders, extensionists, and farmers around common procedures, clarify farmer roles, and support result interpretation across environments and seasons.

SOPs also play a critical role in ethics and governance. SOPs reduce the need for trial-by-trial ethical clearance while strengthening compliance and

transparency, because they embed informed consent procedures, data protection rules, and the handling of personally identifiable information at the protocol level. This approach protects participants, builds trust across farmer networks, and supports responsible data sharing. Ethical considerations thus become an integral part of the experimental infrastructure rather than an external administrative requirement.

Without SOPs, the vulnerabilities of large, distributed on-farm networks quickly become evident. Small inconsistencies in question phrasing, timing, or enumerator interpretation can cascade into major analytical obstacles. Missing or ambiguous variables undermine automated data cleaning, slow survey harmonization, and jeopardize comparisons across environments or seasons. In extensive tricot networks, even minor deviations can compromise the comparability and reliability of results. SOPs therefore function not simply as operational tools, but as essential scientific infrastructure that secures the rigor, interpretability, and collective value of participatory breeding data (Valle, 2021; van Etten et al., 2020).

What SOPs contain: core structure and cross-crop harmonization

Although each crop protocol is tailored to specific botanical characteristics and target product profiles, SOPs follow a unified architecture built around four core elements: (1) household and trial characterization, (2) crop growth-stage modules with trait-specific measurements including yield, (3) comparative tricot ranking questions, and (4) socio-economic components. For crops oriented toward human consumption, SOPs may also include a fifth element focused on consumer evaluation. This common structure ensures methodological consistency while remaining flexible enough to accommodate crop-specific requirements.

1. Trial and household characterization: establishing context

For crop variety trials, all SOPs begin with a standardized set of questions that capture farmer characteristics, plot conditions, and management practices. Across crops, the characterization module includes recurring variables:

- Farmer demographics: age, gender, contact information, and administrative location.
- Experience variables: years cultivating the crop; previous participation in tricot.
- Trial establishment details: planting date, delivery timing, previous land use, slope, shade, and land preparation method.
- Plot configuration: row spacing, plant density, plot size, and number of rows.
- Intercropping: presence and identity of intercrops.

2. Crop-growth stage modules: crop-specific content

After characterization, SOPs are organized around distinct growth stages, each associated with a specific window of days after planting. Although the number and timing of stages vary by crop, the following modules are consistent:

- Early establishment: which captures germination, seedling vigor, planting configuration, and early biotic/abiotic stresses.
- Vegetative: which collects canopy characteristics, stress responses, and farmer management.
- Maturity: covering traits such as flowering, earliness, survival, and signs of physiological readiness for harvest.
- Harvest: which collects yield, harvested area, management comparisons, and key morphological attributes relevant to farmer decision-making.
- Post-harvest: which captures qualities such as storability, marketability, and consumption traits. The framework is flexible enough to adapt the stages to the different crop cycles. For example, leafy vegetables require repeated harvest modules, given their multi-cut nature, resulting in first

harvest and second harvest blocks, each with yield and quality metrics.

3. Ranking questions

The SOPs contain a core set of tricot ranking questions, which ask farmers to compare the three varieties in their package. These questions are always paired (positive/best and negative/worst), framed around observable traits, and aligned with the Target Product Profiles. Despite crop differences, certain ranking traits appear universally:

- Germination time and rate
- Vegetative vigor
- Tolerance to pests and diseases
- Tolerance to abiotic stress
- Yield
- Overall preference

Then, SOPs introduce crop-specific criteria. For example, millet's SOP includes criteria such as panicle length, threshability, malting quality, and stover yield; while forages' SOP includes criteria such as livestock feeding preference, regrowth, and shade tolerance.

4. Consumer evaluation

For consumer trials, SOPs may include an additional consumer evaluation component that captures traits related to use, preparation, and eating quality. Consumer evaluation typically focuses on sensory and use-related traits such as:

- Taste
- Aroma
- Texture
- Overall acceptability

These traits are particularly relevant for crops such as pumpkins, leafy vegetables, roots and tubers, where culinary quality, cooking behavior, and sensory attributes strongly influence varietal choice. Depending on the crop and context, the evaluation may take place at the household level, during food preparation, or at the point of consumption, and may involve the farmer, other household members, or specific end users.

5. Socio-economic information

SOPs conclude with modules that contextualize varietal performance within farmer realities:

- Socio-economic surveys, conducted separately using RHoMIS across all crop protocols.

These components ensure that varietal evaluation goes beyond agronomy to encompass market, household, and culinary dimensions, critical for user-driven breeding.

How to read an SOP

Understanding how to read an SOP is essential for implementing tricot trials consistently and confidently. Although SOPs contain detailed technical information, they follow a clear internal logic that becomes intuitive once the reader knows where to look and how to interpret each section. The visual below offers a step-by-step guide to navigating an SOP—from grasping the purpose of the trial to identifying design requirements, timing windows, variable definitions, and tricot ranking questions.

How to read an SOP

1. START WITH THE INTRODUCTION

What is the trial about?
Which crop? Which season?

Introduction

This document provides a standardised overview of the basic information that will be collected during a forage Tricot trial. Further traits and variables can be added, but this will need to be done by the project manager in ClimMob.
The protocol provides an overview of the data collection moments during the trials, and the variables and traits collected at each data collection moment. Farmers evaluate varieties in their on-farm trials and provide comparative observations by ranking the varieties based on their performance throughout their growth and post-harvest qualities including taste and consumption preferences.

2. IDENTIFY TRIAL DESIGN ELEMENTS

Instructions for field setup

Trial dimensions

Farmers can choose their plot size, and if they need to register it in the OFT (on-farm trial) characterisation. All plots (A, B, C) in the OFT must have the same dimensions and be placed side by side in the farmer's field. Potential edge effects remain a research question. Therefore, we recommend calculating the yield **for the entire plot**, including edges, rather than solely focusing on the interior plants.
In ClimMob we prepared a tool to help you calculate the number of seeds needed for each package. First, you must define the plot size and plant density. Check the tool here <Trial dimensions – ClimMob Documentation>

3. CHECK DATA COLLECTION TIMING

See Table 1:
Growth-stage windows (First column)
Days after planting (Second column)

Table 1. Data collection moments and traits

Data collection moments	Interval (after planting) days	OFT/HH Characterization	Traits
Farmer registration (Questions 1-13)	At package distribution	Informed consent Farmer name Package code Point of delivery Age Gender ADM 1 ADM 2 ADM 3 Telephone primary Telephone secondary Experience with the crop years Experience with tricot times	

4. READ VARIABLES CAREFULLY

See Table 2:
Definitions of each variable (Third column)
Units and response types (Fourth column)
TIP: Note that the colours of each section indicate the data collection moment

Table 2. Household and trial characterisation questions

No.	Variable	Question	Type	Options
1	Informed consent	Do you willingly accept to host tricot trial and provide required information from the trial that can be used for research and publication purposes?	yes/no	
2	Farmer name	What is the farmer's name?	Text	
3	Package code	Scan the QR code	QR Code	
4	Point of delivery	Take the GPS coordinates of the point of delivery	GPS	
5	Age	What is the age of the owner and manager of the trial?	Integer	
6	Gender	Gender of the owner and manager of the trial	Select one	Male Female Rather not say
7	ADM 1	What is the administrative level 1 location of the trial?	Select one	List of participating administrative level 1 units.
8	ADM 2	What is the administrative level 2 location of the trial?	Select one	List of participating administrative level 2 units.

5. UNDERSTAND TRICOT QUESTIONS

See Table 3:
Identify positive and negative pairs

Table 3: Tricot questions for variety ranking

Trait	Statement (positive/best)	Statement (negative/worst)
Germination Rate	Which option germinated more plants?	Which option germinated less plants?
Disease and pest tolerance	Which variety is most resistant to pests and diseases?	Which variety is least resistant to pests and diseases?
Abiotic stress tolerance	Which variety is most tolerant to drought?	Which variety is least tolerant to drought?
Shade tolerance	Which option grows best under tree shade?	Which option grows worst under tree shade?

How SOPs are developed

Crop-specific SOPs can be developed through four simple steps that any team can adopt, adapt, and improve.

1. Identify trait priorities: Breeding teams, agronomists, and farmers define traits relevant to the Target Product Profiles. For example, pumpkin incorporates taste and flesh quality due to its importance in household consumption, while pearl millet includes stover traits because of its dual-purpose nature.

2. Define variables and units: Crop teams define the variables to be observed, allocated to the stage where they are best observed (e.g., vigor at vegetative stage; panicle length at maturity) building on two complementary question sets available in this book as well as on Climmob:

- A core set of questions, applicable across all crops, which should be included systematically. These core questions ensure a minimum level of consistency and comparability across trials, crops, and regions.
- A curated question library containing additional, crop-specific questions that can be selected and added as needed, depending on the objectives of the trial and the biology of the crop.

While new questions can always be created in order to align the trials to the TPPs, we strongly encourage teams to first review and reuse the existing question sets. Doing so facilitates aligning SOPs with data ontologies (Crop Ontology) and ClimMob architecture.

3. Upload to ClimMob and test the digital workflow: Once the SOP is drafted, it is operationalized through ClimMob. A pilot test can be conducted to check the clarity of question phrasing, the feasibility of measurement tasks,

compatibility with field conditions, and potential misunderstandings or missing variables.

4. Adjust and publish open: Following field piloting and feedback, the SOP can undergo final adjustments to correct ambiguities, refine trait definitions, align units or timing windows, and ensure consistency with cross-crop standards. Once refined, the SOP is published openly and versioned so that teams, partners, and researchers can access, reuse, and cite it.

SOPs and interoperability

The development of SOPs goes hand-in-hand with the use of crop ontologies. Ontologies provide standardized, machine-readable definitions and unique identifiers for traits, measurements, and metadata values. They ensure that synonyms are mapped correctly, that variables have consistent units, and that digital tools as ClimMob, can interpret data unambiguously. Ontologies thus extend the function of SOPs from field practice to data interoperability, enabling clean integration across crops, seasons, and geographies.

For all these reasons, SOPs should be viewed as foundational scientific infrastructure for participatory breeding. They safeguard the integrity of farmer-generated data, they enable large-scale synthesis, and they ensure that the insights produced by tricot trials can meaningfully inform breeding decisions. In short, SOPs are what make tricot both participatory and rigorous, open to farmers' knowledge while firmly grounded in scientific standards.

How ClimMob implements SOPs

ClimMob implements SOPs by translating methodological protocols into structured digital templates. Users select a template for a specific crop, research purpose, or agroecological context. For the same crop, different

protocols may exist. For example, one may support breeding-oriented evaluations that include quantitative yield measurements while another may focus on seed system assessments using simplified evaluation criteria.

When creating a new project on ClimMob, users select a SOP according to their objectives (e.g. sweetpotato protocol) which configures the core components of that specific SOP into the survey form. For example, this could include participant registration, contextual information on the trial and plot, trait observation modules organized according to crop growth stages, and ranking questions following the tricot format. The survey forms are then automatically configured in ClimMob for use by extension agents or enumerators in the field with ODK. This allows researchers to rapidly deploy new projects while maintaining alignment with established SOPs.

A key feature of this is the integration of a curated question library aligned with the SOP framework. The library contains both a set of cross-crop core questions and additional crop-specific questions. Although templates can be adapted when necessary (i.e., to align with specific target product profiles), ClimMob encourages users to prioritize existing questions. This practice helps maintain comparability across datasets, ensures consistency in variable definitions and measurement scales, and facilitates harmonization across trials conducted in different regions or seasons.

Another important aspect of SOP implementation in ClimMob is metadata documentation and multilingual support, which allows protocols to include key project information and to be deployed in multiple languages. This enables projects to operate across diverse linguistic contexts while preserving the standardized methodological structure defined by the SOP.

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Version: current

Create a project in ClimMob

Sofía Acuña, Marilyn Manrow, Brandon Madriz, Kauê de Sousa

Setting up a new ClimMob project

You should have already created a user account in ClimMob (see instructions on how to do that here). To start working with ClimMob, your first step is to create a new project. You can do this in two ways: either by going to the Project Overview section and clicking Create a new project, or by navigating to All projects and selecting Add new project. In both cases, you will be asked to complete a short form with the main project details. Once created, you can always return later to update or adjust the project settings.

To set up a profile for your tricot project. Fields to fill:

1. General information

- Project name: Unique and more descriptive name for the project. We recommend including the technology, the year or time, and the location, to distinguish the project from others, when you manage multiple projects. For example: Bean_Honduras_2019_season1

- Project ID: Short, unique identifier of the project. For example, your initials and year of the project: JV19.

- Description: Add more detail about the project.

- Keywords: To make your project searchable to other users, enter up to X keywords that define your project. Examples: “bean”, “Honduras”.

- Trial coordinator: Your full name, start with your first name, all names separated by a space. By default, it is already filled with your data. Change if the trial coordinator is someone else.

- Email address: Your email address.

- Affiliation: Select one or create a new affiliation, if any of the options applies to your organization.

2. Geographic information

- Select the country where the project will take place

3. Participants

- Number of participants: Enter how many participants will join this project. For example: 200. If you don’t know the exact number yet, better choose a number too high than too low (but still reasonable, as otherwise ClimMob will do a lot of unnecessary computing later on).

4. Technology options labels

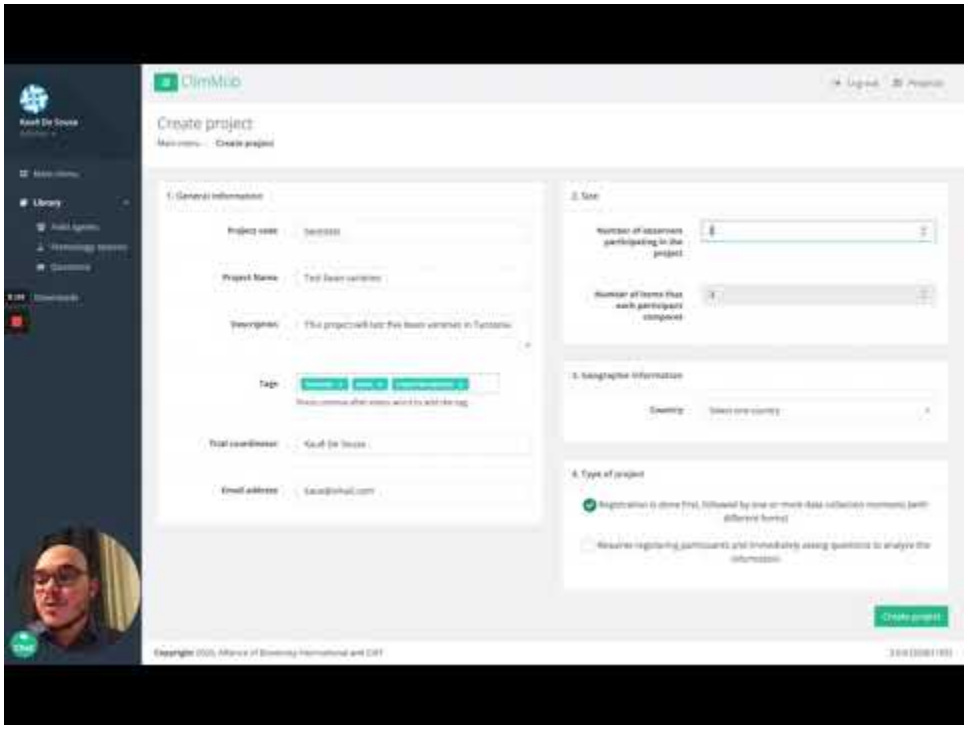
- Number of technology options each participant compares: By default, this is set to ‘3’ and cannot be changed. It’s a reminder that in a tricot project, every participant will receive 3 technology options to compare.
- Name given to the 3 items that each participant compares: by default the names are “Option A, Option B and Option C” but the trial coordinator could decide to change them for something else that participants can relate to better, such as numbers, colors or shapes.

5. Project type

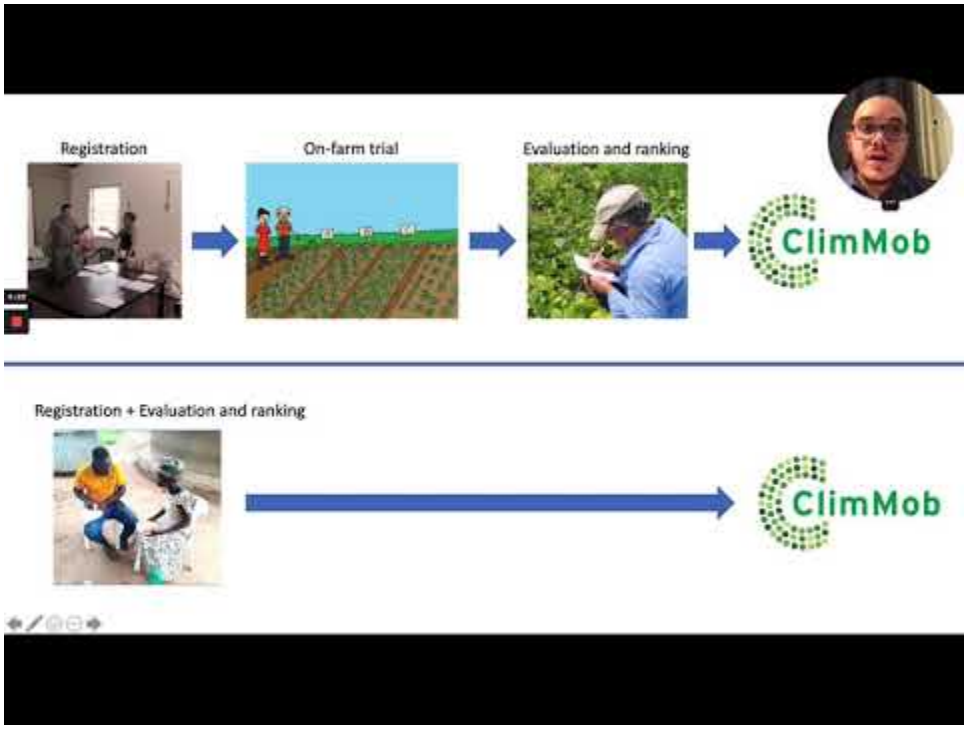
- You can indicate whether the project is a training project. This means the project was created for educational purposes—such as practice, demonstrations, or coursework—and not intended for actual data collection in the field.
- There are three options for experimental site: on-farm testing, home, or public space (e.g., market). Depending on the experimental site selected, you will need to choose between different units of analysis and corresponding objectives (see examples in box below).
- Do you want to create your project from a SOP template? Select if it applies to your project. Read more about SOPs here.
- Finally, you can select up to four languages in which the participant forms will be provided, allowing multilingual data collection as needed.

Video tutorial

Create a new project



Types of projects



Select technology options

In this section, you can specify the technology options you want to compare in your tricot experiment. For example, if you want to test bean varieties, you would add the names of the bean varieties to be tested here. If you want to test which fertilizer regimes, you would add the names of the fertilizer regimes to be tested.

How-to:

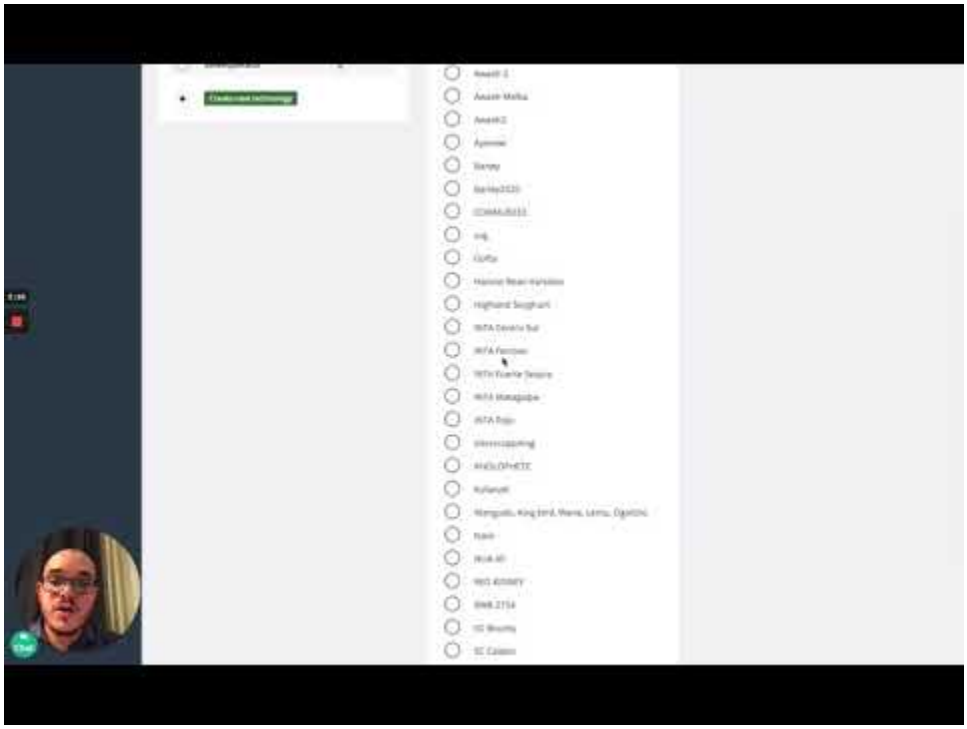
1. On the project overview section click on green button, Select technology options.

2. You will access the list of available technologies in the platform. If the technology you are interested in is there, just click on it and access the

different options (e.g. varieties).

3. If the technology you are interested in is not there, click on + add new technology. This action will redirect you to the library, where you can create new technologies.

Video tutorial - Filling the ClimMob library with new technologies (e.g. varieties) to test in the tricot trials



Prepare data collection form

In this section, you define the different data collection moments for the on-farm evaluation that participants will carry out. At each moment, specific questions will be asked to capture observations. It is important to decide:

- Which traits will be evaluated in the selected technology options?
- When will each trait be evaluated during the planting cycle?

Once set up, these data collection forms will guide field agents and participants during the evaluation process.

How-to:

1. On the project definition section, click Prepare data collection. Here you can add the different data collection moments throughout the planting cycle.

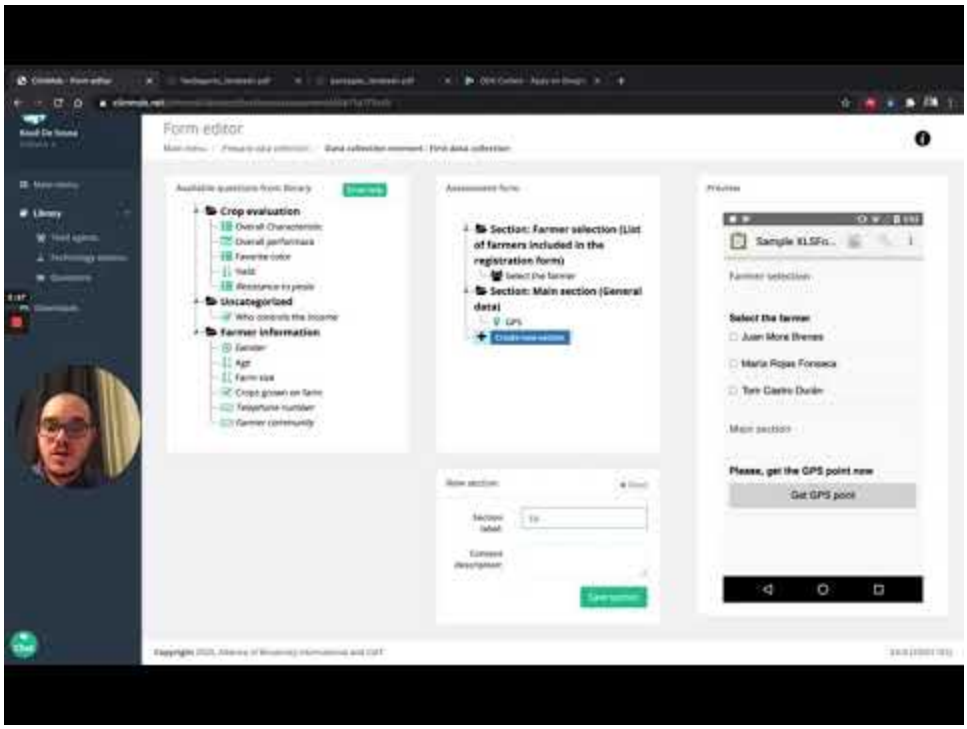
2. After adding the data collection moments, go to the right panel (Active data collection moments) and click Show to view them.

3. For each data collection moment, drag the desired questions from the left panel (available questions from the library) into the middle panel (assessment form). A preview of the selected questions will appear on the right panel (preview)—scroll down to view all questions.

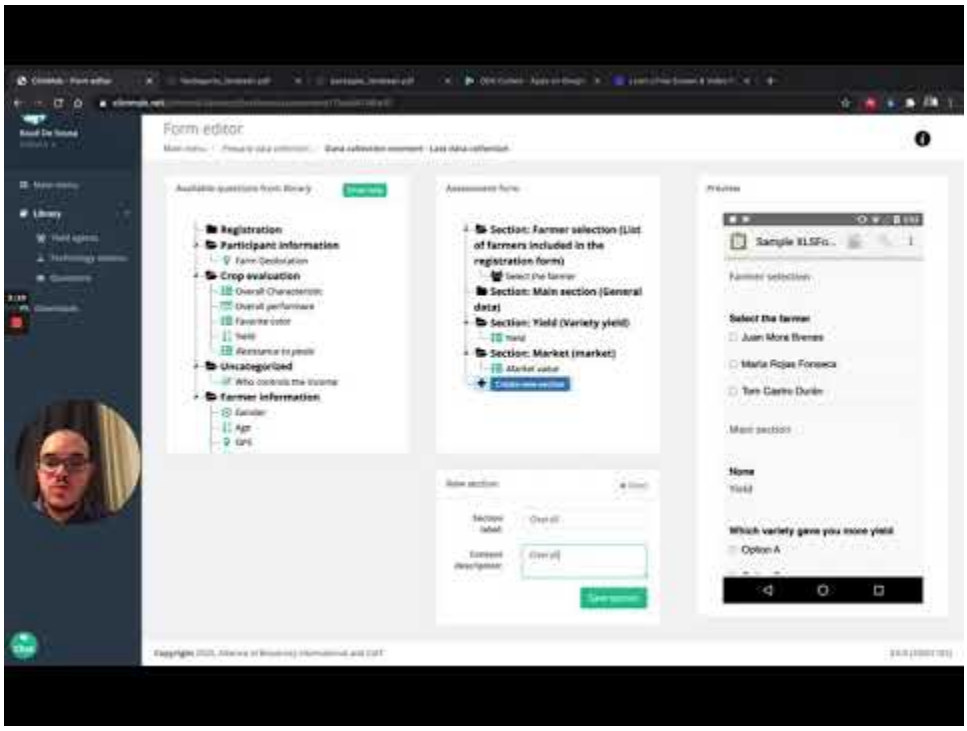
4. If the question you need is not in the library, click Add new question and create it under the most relevant section.

Video tutorials

Project setup - Data collection survey, part 1



Project setup - Data collection survey, part 2



Technology randomization

After setting up your data collection moments and their corresponding questions, the next step is to create test packages through technology randomization. This process ensures that each participant receives a balanced set of technology options for evaluation.

How-to:

1. On the project overview section (right side of the screen), click Generate packages with technology options to open the participant registration form.

2. Set combinations:

- Choose whether to include all technology options or only a selection.
- Define how many packages with each technology option will be generated.
- By default, all technology options are included, and the same number of packages are created for each.

WARNING If you change the number of packages for one technology, you must balance the total by adding or subtracting from others to ensure the same overall number of packages.

3. Review packages and confirm. If the list of packages is not confirmed, it will be lost, and you will need to repeat the randomization.

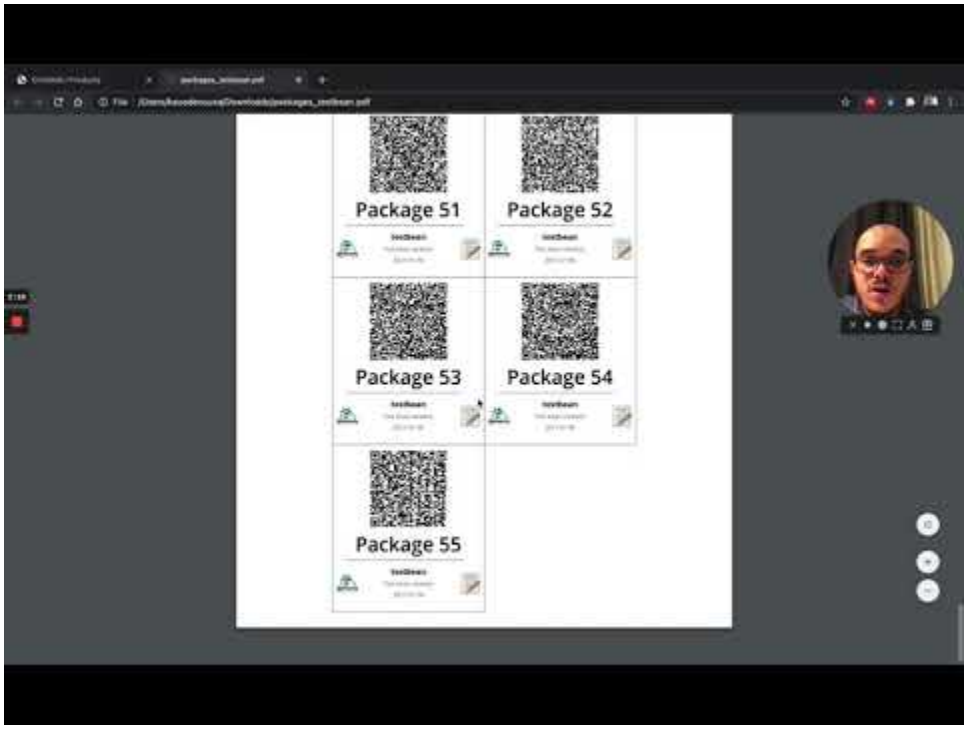
4. Once confirmed, the randomization documents are available in the Downloads section:

- List of packages with QR codes for the registration form → required for preparing test packages.
- List with randomized trial packages (Excel) → shows the technology

combinations assigned to each package. This file is useful when preparing test packages. Do not edit this file.

Video tutorials:

Project setup - Registration files



Version: current

Trial documentation

Sofía Acuña, Marilyn Manrow, Brandon Madriz

Introduction

Trial documentation is a key step to ensure that your project records are complete and ready for analysis. This ClimMob feature allows you to keep track of all the essential aspects of your trial through a set of forms.

You can start filling out the forms at any moment during the project, beginning from its creation. Some forms are typically completed at the start, while others are filled in at the end. **Note: all forms must be completed before moving on to the Data Analysis step and downloading reports.**

How to fill out the forms:

To provide maximum flexibility while maintaining standardized data, the forms include the following features:

- Multi-select options: Most fields allow you to choose more than one answer. Look for the hint "Select all that apply" to document cases where multiple methods or criteria were used (e.g., combining different recruitment locations).
- The "Other" category: If your specific method or resource is not listed in the dropdown menu, select "Other". This will open a dedicated text box for you to provide a custom description, ensuring every detail of your field operations is captured.
- Non-applicable: If a specific question does not apply to your project's

scope, you can select the "Non-applicable" option to proceed.

Structure

The Trial documentation section includes the following eight forms:

1. Contributors

Document the organizations, researchers, or institutions involved in the project, including their roles and responsibilities. This helps acknowledge contributions and ensures transparency.

Note: This form is exclusively for technical and operational contributors. Funding institutions or donors should not be listed here, as they have a dedicated section in the documentation.

When adding a collaborator, you must provide the following details:

- Collaborator’s name: You can search for existing ClimMob users. If the person has a profile, their name will appear for selection. If they are not in the system, you can enter their full name, and the system will label them as an "external contributor."
- Sector: Specify the professional or industrial sector to which the collaborator belongs.
- Organization: Begin typing the affiliation. If it is already in our global database, select it from the list. If it’s a new institution, enter the full name, and ClimMob will add a "-new affiliation" tag to it.
- Role: You can select multiple roles for a single contributor. This field follows the DataCite Metadata Schema, ensuring that roles are standardized for global data citation.
- Activities: Specify the specific tasks performed by the contributor. This

selection is based on the CRediT (Contributor Roles Taxonomy), which allows for a high-level of granularity in identifying specific contributions (e.g., Data curation, Investigation, Software, etc.).

2. Funders

This new, dedicated section allows you to record the financial support behind your trial. Keeping accurate funding records is crucial for transparency, compliance with donor requirements, and institutional reporting.

If your project received external financial support, you can document multiple sources by providing the following details for each:

- Funder name: Search for the name of the donor or institution providing the funds. The system includes a pre-populated list of global funding organizations for consistency.
- Grant title: Enter the official name of the grant or project as specified in the funding agreement.
- Grant number: Provide the unique identification code or reference number assigned by the funder to this specific grant. **Note:** If your research is supported by multiple donors, use the "+ Add other" button to create a separate entry for each funding source.

3. Experimental design

This form consolidates the technical structure of the trial with its strategic alignment. It allows you to document everything from the physical layout of the plots to the specific market targets the research aims to address.

In this form, you will need to specify:

- Plot size: Indicate if a standard plot size was used across the trial. If so,

provide the area in square meters (m2).

- Design remarks: A space to document any specific observations or notes regarding the physical plot design.
- Experimental design: Select the statistical or methodological designs applied in the trial (e.g., incomplete blocks, randomized designs, etc.).
- Special features: Describe any unique elements, such as innovative methodologies, advanced technology usage, or specific environmental conditions that influenced the trial's execution.
- Market segments: Identify the specific market segments associated with the project. These options are synchronized with the Global Market Intelligence Platform (GloMIP) (https://glomip.cgiar.org/).
- Target product profile (TPP) IDs: Associate the project with specific TPP IDs from the GloMIP platform. This ensures that the trial results are directly linked to standardized global breeding goals and product requirements.

4. Genotypes

This section provides a detailed technical profile of the technologies being tested. To save time and ensure consistency, ClimMob automatically lists the genotypes you included during the project setup.

Your task in this form is to review the automatically generated list and complete the descriptive fields. While this information is used for documentation and metadata purposes—and does not affect the statistical results of the trial—it is vital for the long-term interpretation of the data.

For each genotype, you should provide:

- Genotype name: The original name as registered in the project.
- Final genotype name: Use this field if you need to standardize the name for final reporting or publication.
- Entry type: Classify the material (e.g., historical check, farmer check,

commercial check, evaluation entry, release candidate, etc.).

Table 1. Entry type options used in on-farm or breeding trials and their descriptions.

Entry type option	Description
Historical check	A variety that was widely used in the past but is no longer the primary choice. Used to measure genetic gain over time.
Farmer check	The local variety or material currently managed and preferred by the farmers in the trial area. Essential for calculating "win rates."
Commercial check	A leading variety currently available in the local market. Used to compare the performance of new materials against the best current commercial options.
Comparative check	A specific entry used as a benchmark for certain traits (e.g., a known drought-tolerant variety used to compare new drought-tolerant lines).
Evaluation entry	The primary experimental material, line, or technology being tested in the trial for potential adoption or further breeding.
Release candidate	An advanced line that has shown superior performance and is in the final stages of the official regulatory process for commercial release.

Entry type option	Description
Replacement candidate	A specific material intended to replace an existing variety that has become susceptible to pests, diseases, or changing climate conditions.

- Release year: If applicable, the year the variety was officially released.
- Crossing year: The year the specific cross was made (for breeding lines).
- Origin: The geographic or institutional source of the genetic material.
- Target traits: Specify the key characteristics being evaluated (e.g., drought tolerance, pest resistance, yield).

Table 2. Target trait options used to classify the primary focus of evaluation in on-farm or breeding trials.

Target trait option	Description
Drought tolerance	The ability of the genotype to maintain growth and productivity during periods of low water availability or significant water stress.
Pest resistance	The capacity of the material to withstand or minimize damage caused by insects or other animal pests.
Disease resistance	The ability of the plant to prevent or recover from infections caused by pathogens such as fungi, bacteria, or viruses.

Target trait option	Description
Product quality	Characteristics related to the final use of the crop, including nutritional content, taste, texture, appearance, or industrial processing qualities.
Yield	The total quantity of harvested product (e.g., grain, tubers, fruit) per unit of area, representing the overall productivity.
Other	Use this option for specific traits not covered above, such as cold tolerance, early maturity, or soil salinity resistance. (Specify in the Other traits column).

- Remarks: A free-text field for any additional technical notes or observations specific to that genotype.
- External references link: Links to external sources that provide additional information about the genotype.

5. Participant recruitment

Understanding how participants are selected and engaged is fundamental for the statistical validity and ethical integrity of a tricot trial. This form uses multi-select fields to document the sampling and recruitment process accurately.

Complete the following sections by selecting all options that apply to your project:

- Sample size calculation: Select the methods used to determine the number of participants. This provides transparency on whether the trial has

sufficient statistical power.

Table 3. Sample size calculation options used to document how participant numbers were determined in on-farm or breeding trials.

Sample size calculation options	Description
ClimMob sample size calculator	Sample size was determined using the built-in ClimMob/ Tricot calculator tool.
Statistical power analysis	Determination of the minimum number of participants needed to ensure the trial has enough statistical strength to reliably detect significant differences between genotypes.
Plackett-Luce model	Specifically estimated for trials using the Plackett-Luce model for ranking or choice comparisons.
Based on seed availability	The number of participants was limited by the actual amount of seed or technology units available.
Target number agreed with donors/ project	The size was dictated by project goals or formal agreements with donors rather than statistics.

Sample size calculation options	Description
Guidelines or published methods	Determined following established scientific literature or standardized institutional guidelines.

- Selection criteria: Document the specific attributes or requirements used to choose participants (e.g., gender, farming expertise, or socioeconomic conditions).

Table 4. Selection criteria options used to document how participants were identified and recruited for on-farm or breeding trials.

Selection criteria options	Description
Based on prior studies or existing datasets	Participants were selected based on findings from previous research or by using existing data that identified relevant groups or geographical areas.
Knowledge and skills for the task	Selection was based on the participants' technical expertise or specific skills required to execute the trial activities effectively.
Gender	Used when the project aims for a specific gender balance or targets a specific gender group (e.g.,

Selection criteria options	Description
	focusing on women farmers).
Experience with the crop under study	Participants were included because they have a proven track record of growing or managing the specific crop being evaluated.
Household characteristics from survey data	Selection was driven by household-level indicators such as demographics, landholding size, or socioeconomic status collected through surveys.
Random selection	Participants were chosen through formalized sampling procedures (random, purposive, or open) to ensure scientific impartiality.
Selection from pre-existing lists or registers of farmers	Selected from existing registrations, cooperative memberships, or organized community groups.
Interest in the project	Selection was based on the participants' expressed motivation and alignment with the project's specific goals.
Voluntary participation	Participants self-selected by volunteering their time, often driven by curiosity or the desire to test new agricultural practices.

Selection criteria options	Description
Hierarchical or multi-stage sampling	Defined through nested selection levels (e.g., choosing districts, then communities, then farmers).

- Recruitment approach: Specify how you reached out to potential participants, such as open public announcements or direct invitations through farmer organizations.

Table 5. Recruitment approach options used to document how participants were invited or enrolled in on-farm or breeding trials.

Recruitment approach options	Description
Open recruitment	Public calls or announcements (via radio, posters, or social media) open to anyone interested within a target area.
Invitation through their organization	Participants are contacted through formal structures such as farmer groups, cooperatives, or NGOs.
Extension officer recommendation	Recruitment facilitated by agricultural agents or extension officers who identify suitable candidates.
Community	Potential participants are invited or suggested by local

Recruitment approach options	Description
leader invitation	authorities, village chiefs, or traditional leaders.
Community meetings	Recruitment occurs during collective gatherings or through community-level decision-making processes.
Training sessions	Participants are recruited during technical workshops, demonstration days, or field schools.
Targeted approach	Direct, one-on-one recruitment of specific individuals who meet pre-defined project criteria.
Voluntary sign-up	Participants proactively register their interest or approach project staff to join the initiative.

- Recruitment locations: Identify the physical or social spaces where the engagement took place (e.g., community centers, local markets, or cooperative meetings).

Table 6. Recruitment location options used to document where participant recruitment activities took place for on-farm or breeding trials.

Recruitment location options	Description
Meetings with community groups	Recruitment occurred during organized sessions with farmer groups, cooperatives, training

Recruitment location options	Description
	workshops, or other local gatherings.
Community centers	Activities took place at local halls, community centers, or venues that serve as central public meeting points.
Markets	Recruitment was carried out at local marketplaces or trading hubs where community members naturally gather.
Households (door-to-door visits)	Recruitment was conducted directly at the participants’ homes through one-on-one visits or private meetings.
Public events	Engagement happened during large-scale gatherings such as regional fairs, agricultural exhibitions, or public festivals.
Digital communication (email, messaging apps, etc.)	Recruitment was conducted remotely using electronic means like WhatsApp, email, or other online messaging platforms.

- Formalization of recruitment: Detail how the agreement to participate was officially recorded. This is a critical step for ethical compliance and informed consent.

Table 7. Formalization method options used to document how participant

agreement or enrollment was formally established in on-farm or breeding trials.

Formalization method options	Description
Verbal consent	Participants gave their explicit oral agreement to take part in the study.
Signed individual consent forms	Each participant provided a written signature on a personal consent form before registration.
Consent forms signed by a community representative	A recognized leader, village chief, or representative signed the authorization on behalf of the participants.
Invitation letter	Participants were officially engaged, and their participation was formalized through a formal invitation process.

Pro Tip: If your specific method is not listed in a dropdown, you can often select "Other" to provide a custom description, ensuring no detail of your field operations is left out.

6. Capacity building

This section documents the training and empowerment activities conducted with the participants. Proper documentation of capacity building is essential for ensuring the reliability of the citizen science data collected and for acknowledging the knowledge transfer process.

Complete the following fields by selecting all methods and topics that apply:

- Tricot approach explanation: Select the methods used to explain the logic of the tricot methodology (e.g., blind ranking, the "A, B, C" packages) to the participants.

Table 8. Tricot approach explanation options used to document how participants were introduced to and trained on the tricot method.

Tricot approach explanation options	Description
Group training sessions before trial implementation	Formal training sessions with groups of participants, typically organized before the trial implementation begins.
Workshops with structured activities	Multi-hour or multi-day events involving presentations, practical exercises, and group discussions.
Field demonstrations and hands-on practice	Practical, hands-on sessions in the field where participants practice planting, labeling, or data collection.
Meetings with farmer groups	Explanations provided during the regular, scheduled meetings of existing farmer cooperatives or groups.
Meetings with community	Explanations delivered during broader community gatherings or local association meetings.

Tricot approach explanation options	Description
associations	
One-on-one household visits	Direct, personalized explanation conducted at the participants’ homes.
One-on-one farm visits	Direct, personalized explanation conducted specifically in the participants’ fields.
Presentations using visual materials	Use of slides, posters, pictures, or diagrams to facilitate the understanding of the tricot method.
Through trained extension officers or field agents	A "train-the-trainers" approach where field agents are briefed first and then cascade the knowledge to participants.
Informal verbal explanation without formal training	Simple oral explanation provided during conversations, without formal materials or organized sessions.

- Trial instructions: Identify the specific types of technical guidance provided, such as agronomic management, trial setup, or sensory evaluation protocols.

Table 9. Trial instructions options used to document the types of guidance provided to participants for implementing and assessing on-farm or breeding trials.

Trial instructions options	Description
Agronomic management	Guidance on crop care practices during the trial, such as planting density, spacing, irrigation, weeding, fertilization, or pest management.
How to set up the trial	Instructions on how to establish the tricot trial, including field preparation, plot arrangement, randomization of varieties, and labeling.
Food product preparation method	For trials involving sensory testing, training on standardized preparation and cooking procedures to ensure all samples are assessed under the same conditions.
Data collection	Directions on how participants should record trial information, including what observations to capture and how to use data booklets or digital tools.

- Training setup: Document how the sessions were organized, whether through individual visits, group workshops, or 0ther formats.
- Follow-up procedures: Specify the mechanisms used to support participants during the trial and ensure timely data collection (e.g., monitoring visits, phone reminders).

Table 10. Follow-up procedures options used to document how participants were monitored and supported during on-farm or breeding trials.

Follow-up procedures options	Description
Follow-up visits	On-site visits by enumerators or project staff to monitor progress, answer questions, and ensure protocol adherence.
Reminders and remote communication	Phone calls, SMS, WhatsApp, or social media used to remotely remind participants about data collection or procedures.
Peer visits	Monitoring or support provided by fellow participants, where peers check in on each other to encourage compliance.
Lead farmer supervision	Oversight conducted by designated lead farmers responsible for guiding and supporting other participants in their group.
Training or guidance	Targeted technical support provided during the trial to reinforce procedures, clarify instructions, or assist with data collection tools.

- Additional inputs: List any physical resources provided to participants to facilitate the trial, such as fertilizers, tools, or labels.

Table 11. Additional inputs options used to document supplementary materials or resources provided to participants for on-farm or breeding trials.

Additional inputs options	Description
Fertilizers	Chemical or organic fertilizers supplied specifically for use in the trial plots.
Agrochemicals	Pesticides, herbicides, or other chemical inputs provided for trial management.
Seeds	Specific seeds provided to participants to carry out the trial.
Planting material	Tubers, cuttings, seedlings, or other vegetative material supplied for planting.
Tools or materials	Physical resources provided to support trial activities or data recording (e.g., field books, pens, ODK forms, or data sheets).

7. Data collection

This form documents the practical flow of information from the field to your database. Accurately recording these methods is vital for assessing data quality and understanding the level of interaction between researchers and participants.

Complete the following two categories by selecting all options that apply:

- Data collection method: Specify the interaction method employed to

gather information from participants.

Table 12. Data collection method options used to document how trial observations and participant responses were collected in on-farm or breeding trials.

Data collection method options	Description
Direct phone calls	Data collected remotely through phone calls made directly to the participants by the project team.
Farm visits	Data collected in person on the farmers’ fields by enumerators, development agents, or project staff.
Lead farmers interview	Data collected through designated lead farmers or seed ambassadors who interviewed or monitored other participants.
Direct completed by the farmer with ODK	Participants recorded and submitted their own data directly using the ODK Collect application.

- Data collection input: Identify the specific tools or platforms used to record and store the data.

Table 13. Data collection input options used to document the tools or channels through which trial data were entered into digital systems.

Data collection input options	Description
ODK Collect	Data entered via the ODK Collect mobile application, designed for offline data collection on Android devices.
Enketo	Web-based forms used through a browser on mobile or desktop, ideal for online entry without app installation.
QR + web form	Participants or enumerators access digital survey forms by scanning a unique QR code linked directly to a web-based questionnaire.
Excel sheet	Data manually compiled into spreadsheet files (.xlsx or .csv) before being uploaded to the ClimMob platform.
API	Data transferred automatically from an external system or third-party application through an Application Programming Interface.

8. Results communication

The final step in the trial documentation ensures that the knowledge loop is closed. This form documents how the findings were shared with the participants and, crucially, how their feedback was gathered to improve future research cycles.

Complete this section by selecting all methods used for both communication and feedback:

- Methods to communicate results: Specify the channels used to return the analyzed data and conclusions to the farmers.

Table 14. Methods to communicate results options used to document how trial findings were shared with participants and stakeholders.

Methods to communicate results options	Description
Group meetings	Meetings organized with trial participants to share and discuss results collectively.
Information sheets	Results were distributed in written form, such as handouts or printed summaries.
Individual visits	Results were communicated directly during one-on-one farm or household visits.
Feedback sessions	Structured sessions designed specifically to present results and gather participants’ input.
Reports	Results were delivered as formal or detailed written reports.
Field days	Results were presented during demonstration or field events.
Phone calls	Results were shared directly with participants through phone communication.
Social media platforms	Results were shared through digital channels such as WhatsApp or Facebook groups.

- Methods to collect feedback: Document how you captured the participants' opinions, concerns, or suggestions regarding the trial process and the technologies tested.

Table 15. Methods to collect feedback options used to document how participant feedback on trial implementation and results was gathered.

Methods to collect feedback options	Description
Group meetings	Participants share their views, concerns, and suggestions collectively during organized community meetings.
Individual visits	One-on-one discussions with participants conducted at their homes or in their fields for personalized feedback.
Phone calls	Feedback collected directly through phone conversations between project staff and participants.
Feedback sessions	Structured sessions specifically designed to capture participants’ opinions regarding the trial process and variety performance.
Surveys / questionnaires	Structured forms (either paper or digital) completed by participants to provide quantitative or qualitative data on their experience.

Version: current

Design example: Bean trial protocol

Kauê de Sousa

Introduction

To illustrate how to design an tricot experiment, this section provides an overview of the basic information that will be collected during a bean trial. Further traits and variables can be added, but this will need to be done by the project manager in ClimMob.

The bean SOP indicates the data collection moments during the trials and the variables and traits collected at each data collection moment. Farmers evaluate varieties in their on-farm trials and provide comparative observations by ranking the varieties based on their performance throughout their growth and post-harvest qualities including taste and consumption preferences.

A separate SOP for bean consumer analysis will be developed to understand taste and preferences of non-tricot farmer consumers to strengthen inclusive and informed breeding decisions.

A more in-depth overview of the steps required for developing an on-farm trial project using tricot ClimMob is available here:

Data collection moments and traits

to be collected

Table 1 outlines the data collection moments, time intervals of data collection and traits to be collected during the bean tricot trial.

Table 1. Data collection moments and traits

Data collection moments	Interval (after planting) days	OFT/HH Characterization	Traits
Farmer registration	At package distribution	Informed consent Farmer name Package code Point of delivery Age Sex Education level Civil status ADM 1 ADM 2 ADM 3 Telephone primary Telephone secondary Experience with the crop Experience with the crop years	

Data collection moments	Interval (after planting) days	OFT/HH Characterization	Traits
		Experience with tricot Experience with tricot times	
Agronomic Performance	15	Assessment date On time Planting date Trial GPS Trial site Vs main Previous land use Mode of land preparation Slope Shade Planting density main Planting method Plant population Plant distance Plant distance unit Row distance Row distance unit Number of rows Local variety Intercropping	Germination rate Tolerance to Pests Tolerance to Diseases Tolerance to a biotic stress

Data collection moments	Interval (after planting) days	OFT/HH Characterization	Traits
		Intercropped with Basal fertilizer Basal fertilizer quantity Plot loss Plot loss reason Diseases any Diseases severity	
Maturity	40	Assessment date Plant population Plot loss Plot loss reason Diseases any Diseases severity Irrigation Top dressing Top dressing quantity Pesticide use Pesticide frequency Herbicide use Herbicide frequency	Tolerance to diseases Tolerance to pests Tolerance to abiotic stress Leaf quality

Data collection moments	Interval (after planting) days	OFT/HH Characterization	Traits
Harvest	60-90	Assessment date Harvesting date Plot loss Plot loss reason Plant population Management Management prioritized Management why Yield quantitative Yield quantitative unit	Maturity Yield qualitative tricot Marketability Seed size Leaf quality for consumption
Post-harvest	90-150	Assessment date Type of storage Storage problems specification Storage duration Sales Crop drying Crop drying duration Leaves used Best why Worst why Grow again	Tolerance to storage problems Storability Marketability Taste Overall performance Comparison with local

Data collection moments	Interval (after planting) days	OFT/HH Characterization	Traits
Socio-economic survey	Anytime	RHoMIS developed separately	

Household and trial characterization questions

Table 2 contains questions that will be asked on household and trial characteristics to complement tricot questions

Table 2. Household/trial characterization.

Variable	Question	Type	Options
Informed consent	Do you willingly accept to host tricot trial and provide required information from the trial that can be used for research and publication purposes?	yes/no	
Farmer name	What is the farmer’s name?	Text	
Package		QR Code	

Variable	Question	Type	Options
code			
Point of delivery	Take the GPS coordinates of the point of delivery	GPS	
Age	What is the age of the owner and manager of the trial?	Integer	
Sex	Gender of the owner and manager of the trial	Select one	Male Female Rather not say
Education level	What is the education level of the manager of the trial?	Select one	No formal education Primary Secondary University
Civil status	What is the marital status of the manager of the trial?	Select one	Single Married/living with a partner Widowed Other specify
ADM 1	What is the administrative level 1 location of the trial?	Select one	List of participating administrative

Variable	Question	Type	Options
			level 1 units.
ADM 2	What is the administrative level 2 location of the trial?	Select one	List of participating administrative level 2 units.
ADM 3	What is the administrative level 3 location of the trial?	Select one	List of participating administrative level 3 units.
Telephone primary	What is the farmer’s primary telephone number?	Integer	
Telephone secondary	What is the farmer’s secondary telephone number?	Integer	
Experience with the crop	Have you cultivated this crop before?	Yes/No	
Experience with the crop years	If yes, for how many years have you been cultivating it?	Integer	
Experience with tricot	Have you participated in a tricot trial before?	Yes/No	

Variable	Question	Type	Options
Experience with tricot times	If yes, how many times? Zero if first time.	Integer	
Assessment date	On which date did you do the assessment of your trial plot?	Date	
On time	Was your trial package delivered on time?	Choose one	Too early – package delivered early 1-3 days Early enough for timely planting Too late - planting delayed 1-3 days Too late - planting delayed 4-9 days Too late - planting delayed 10-20 days Too late -

Variable	Question	Type	Options
			planting delayed 21 days or more Other
Planting date	On which date did you plant the tubers?	Date	
Trial GPS	Take GPS using ODK	GPS	
Trial site Vs main	Are any of these options different between your trial plot and your main field?	Choose multiple	Soil Slope Shading effect Other none
Previous land use	What was the previous land use of the on-farm plot site?	Text	
Mode of land preparation	How did you prepare the land of the trial plot?	Choose one	Tractor Hand hoes Animals No land preparation Other
Slope	What is the slope of the area	Select	Flat

Variable	Question	Type	Options
	you established your tricot trial?	one	Slight Strong
Shade	Is the area you have established your tricot trial affected by shade?	Select one	No Yes, partial Yes, total
Planting density main	Is the planting density of the trial plots the same as on your main plot?	Select one	Higher About the same Lower
Planting method	How were the plants planted?	Choose one	Broadcast Rows Other (text)
Plant population	How many plants survived for each variety?	Integer (tricot-complex)	Count A Count B Count C
Plant distance	How much space did you leave between plants?	Integer	
Plant distance unit	Please select the unit of measure	Select one	Centimeters Meters Feet Inches Other

Variable	Question	Type	Options
Row distance	How much space did you leave between rows?	Integer	
Row distance unit	Please select the unit of measure	Select one	Centimeters Meters Feet Inches Other
Number of rows	How many rows did you plant for each variety?	Integer (detailed)	Count A Count B Count C
Local variety	What is the name of your best local variety you usually grow?	Text	
Intercropping	Have you intercropped in your trial?	Choose one	Yes No
Intercropped with	If yes, with which crop did you intercrop?	Text	
Basal fertilizer	Type of basal fertilizer used in the trial plot?	Choose multiple	NPK DAP Other, specify (text) None

Variable	Question	Type	Options
Basal fertilizer quantity	If any basal fertilizer was used, how much did you use in the trial plot in kilograms?	Integer	
Plot loss	Did you lose any of your trial plots? If yes, which one?	Choose multiple	A B C None
Plot loss reason	What was the reason for you losing variety {$Plot loss}?	Text	
Diseases any	Did you find any disease in the trial?	Choose one	Yes No
Diseases severity	How severe was the impact?	Select one expanded (per plot)	Very severe (>75% of plot affected) Moderate (25%-75% of plot affected) Minor (<25% of plot affected)
Irrigation	Did you use an irrigation system on your plots?	Select one	Yes No

Variable	Question	Type	Options
Top dressing	Which type of top dressing was used in the trial?	Choose multiple	Urea Manure NPK CAN Other
Top dressing quantity	If any top dressing was used, how much did you use in the trial (kg)?	Integer	
Pesticide use	Did you use pesticides on your plots?	Select one	Yes No
Pesticide frequency	If yes, how many times did you apply pesticide?	Integer	
Herbicide use	Did you use herbicides on your plots?	Select one	Yes No
Herbicide frequency	If yes, how many times did you apply herbicide?	Integer	
Harvesting date	When did you harvest your trial?	Date	
Management	Were any of these management practices different between your trial	Choose multiple	None Fertilizer Pesticide

Variable	Question	Type	Options
	plot and the main field?		Irrigation Planting date Other
Management prioritized	If different management strategies were used, which one did you prioritize?	Choose one	Main field Trial plot Treated equally
Management why	If different management strategies were used, why did you treat the main field and your trial plot differently?	Text	
Yield quantitative	What was the yield for each variety?	Integer (tricot complex)	Measure for A Measure for B Measure for C
Yield quantitative unit	What was the unit of measure for yield?	Select one	Kilograms Grams Standard unit of measure (jug, bowl) Other
Best why	Why did you rank this variety as the best?	Text	

Variable	Question	Type	Options
Worst why	Why did you rank this variety as the worst?	Text	
Grow again	If planting material were available for all three varieties, which variety(ies) would you like to grow in the next season?	Multiple	A B C None
Storage problems specification	Did you experience any of the following problems during storage?	Choose multiple	Rodents Mold Insects None
Type of storage	How did you store your grains?	Select one	Sacks Iron drum Traditional setup Other
Storage duration	For how many days after harvest did you store?	Integer	
Sales	Do you plan to sell any grains from the trial?	Select one	Yes No
Crop drying	How did you dry your crop?	Select one	Under the sun Individual

Variable	Question	Type	Options
			drier Communal drier Didn’t dry Other
Crop drying duration	For how long did you dry your crop (in days)?	Integer	
Leaves used	Are the leaves of the crop used for anything?	Select multiple	Human consumption Fodder for animals Left on the ground for mulch Not used

Comparative ranking to assess crop genotypes

Table 3 outlines the questions asked to capture comparative rankings of crop genotypes.

Table 3. Traits and questions for comparative variety ranking.

Trait	Statement (positive/best)	Statement (negative/ worst)
Germination Time	Which variety has the earliest germination?	Which variety has the latest germination?
Germination Rate	Which variety germinated the most plants?	Which variety germinated the fewest plants?
Disease tolerance	Which variety is most tolerant to diseases?	Which variety is least tolerant to diseases?
Pest tolerance	Which variety is most tolerant to pests?	Which variety is least tolerant to pests?
Abiotic stress tolerance	Which variety is most tolerant to abiotic stress (drought, flooding, salty soil, etc.)?	Which variety is least tolerant to abiotic stress (drought, flooding, salty soil)?
Leaf quality at harvest for consumption	Which variety has better quality leaves for human consumption?	Which variety has worst quality leaves for human consumption?
Maturity	Which variety matures earliest?	Which variety matures latest?
Yield tricot	Which variety has the highest yield?	Which variety has the lowest yield?
Seed size	Which variety has the largest seeds?	Which variety has the smallest seeds?

Trait	Statement (positive/best)	Statement (negative/ worst)
Seed size for target use	Which variety has the best seed size for the target use/ market?	Which variety has the worst seed size for the target use/market?
Taste	Which variety has the best taste?	Which variety has the worst taste?
Marketability	Which variety is the most marketable?	Which variety is least marketable?
Overall preference	Overall, which variety has the best performance?	Overall, which variety has the worst performance?
Comparison with local	Which variety is better than the best variety that you usually grow?	Which variety is worse than the best variety that you usually grow?
Storage problems	Which variety is more tolerant to storage problems?	Which variety is more susceptible to storage problems?
Storability	Which variety stores the best/stays best after storage?	Which variety stores the worst/spoils most after storage?

📄 Download the Recruitment chapter as a PDF

Tricot trial recruitment

> Taken from van Etten et al. (2020), page 15

Participant recruitment

Anyone who wishes to participate can get involved in a tricot experiment. Recruiting as many motivated participants as possible is key to the success of the project. The local field agents should help to identify and recruit participants 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 participants before the trial.

However, participants should be:

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

The **sampling sub-chapter of this book** explains the socioeconomic aspects to consider (e.g. gender, age and ethnicity) when recruiting participants for a tricot trial.

Participant group dynamics and

communication

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.

During tricot trials, farmers interact mainly through trusted local networks and group-based collaboration. Strong relationships with local extension officers help mobilize farmers smoothly, build trust, and increase farmers' sense of ownership—making them more open to trying new ideas. Farmers who participate through organized groups showed greater solidarity and are more likely to support activities endorsed by their leaders. Communication and coordination can be strengthened through digital tools such as a shared WhatsApp group that connects lead farmers with researchers and extension staff, enabling quick, real-time information exchange.

Tricot as an iterative process

For on-farm trials, 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.

References

van Etten, J., Manners, R., Steinke, J., & others. (2020). *The tricot approach: Guide for large-scale participatory experiments* [Technical Report]. https://hdl.handle.net/10568/109942

Version: current

Assign field agents

Sofía Acuña, Marilyn Manrow, Brandon Madriz, Kauê de Sousa

Assign field agents in ClimMob

After you create a project in ClimMob and complete the Project Overview, you can add the field agents who will work on this particular project. Field agents are your extension workers in the field who will communicate with the participants and later collect all trial observations using the ODK Collect app.

1. On the Project Overview section, click on Assign field agents.

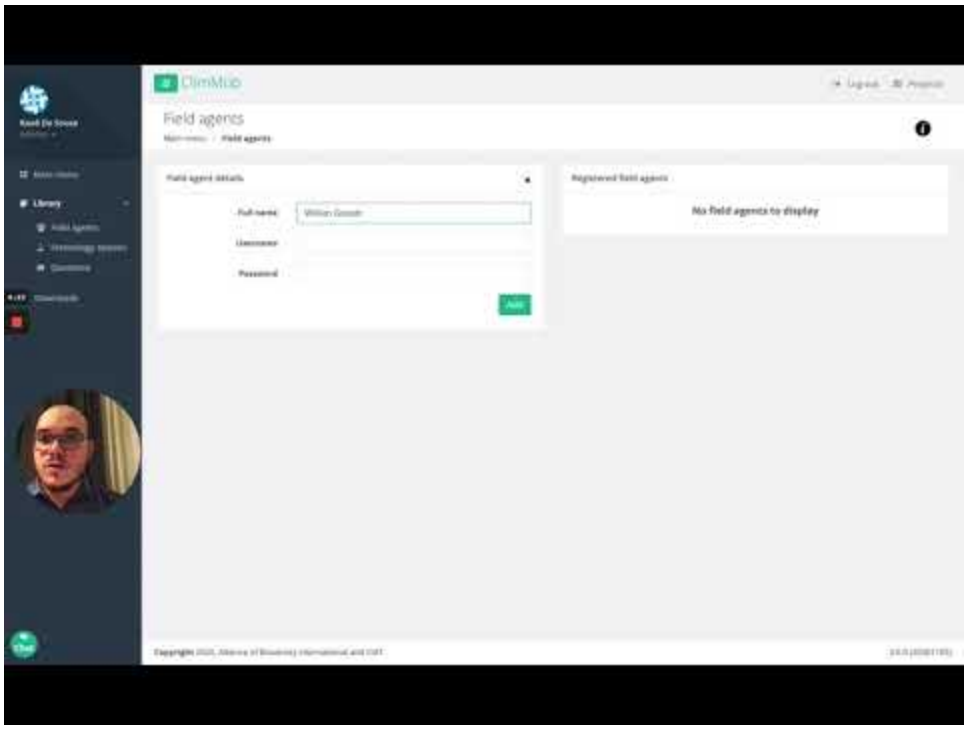
2. If the fields agents you want to work with are already on the left list, just select the ones you would like to work with in this project.

3. If you would like to add new field agents, click on +add new field agent. This will redirect you to the library of field agents, where you can add the information about a new field agent.

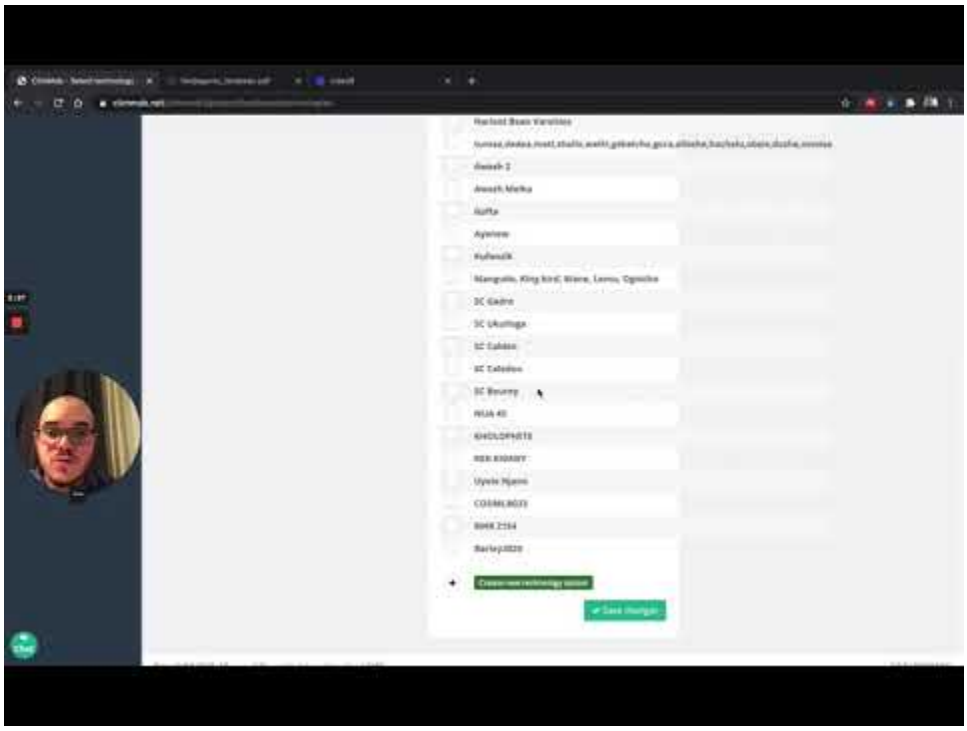
*Note that the field password and username are necessary for ODK Collect.

Video tutorials

Add field agents to your library



Assigning field agents to your ClimMob project



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Register participants

Sofía Acuña, Marilyn Manrow, Brandon Madriz, Kauê de Sousa

Prepare participant registration form in ClimMob

In this section, you can add and manage the administrative questions that field agents will ask participants during registration at the start of the project. These questions are important for two main reasons:

- Administrative purposes: to keep a clear record of who is participating, where they live, and other key details that help organize and monitor the trial.
- Data analysis purposes: to allow deeper insights, for example, checking whether younger participants adopt a technology faster, or whether female participants show a preference for certain options.

Once you have defined the list of questions, they will be available through the ODK Collect app. Field agents can then enter participant information directly into the app during registration.

How-to in ClimMob:

1. On the project definition section, click Prepare participant registration form.

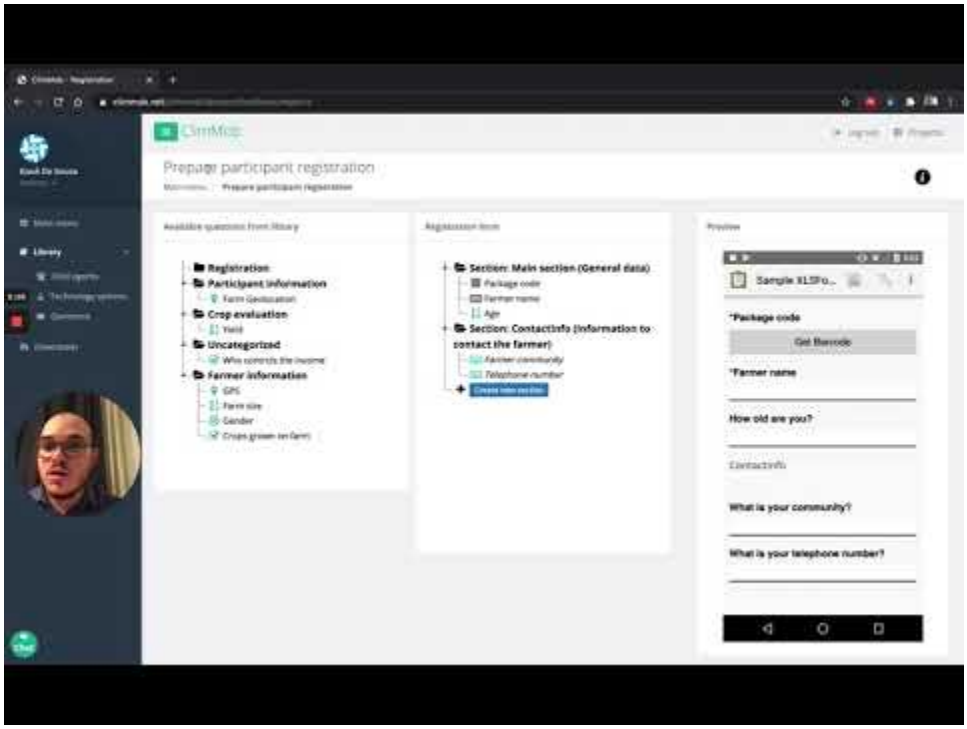
2. Drag the questions you want to include from the left panel (available questions from the library) into the middle panel (assessment form). A preview of the selected questions will appear on the right panel (preview)—scroll down to see all of them.

3. If the question you want is not available in the library, click Add new question and create it under the most relevant section.

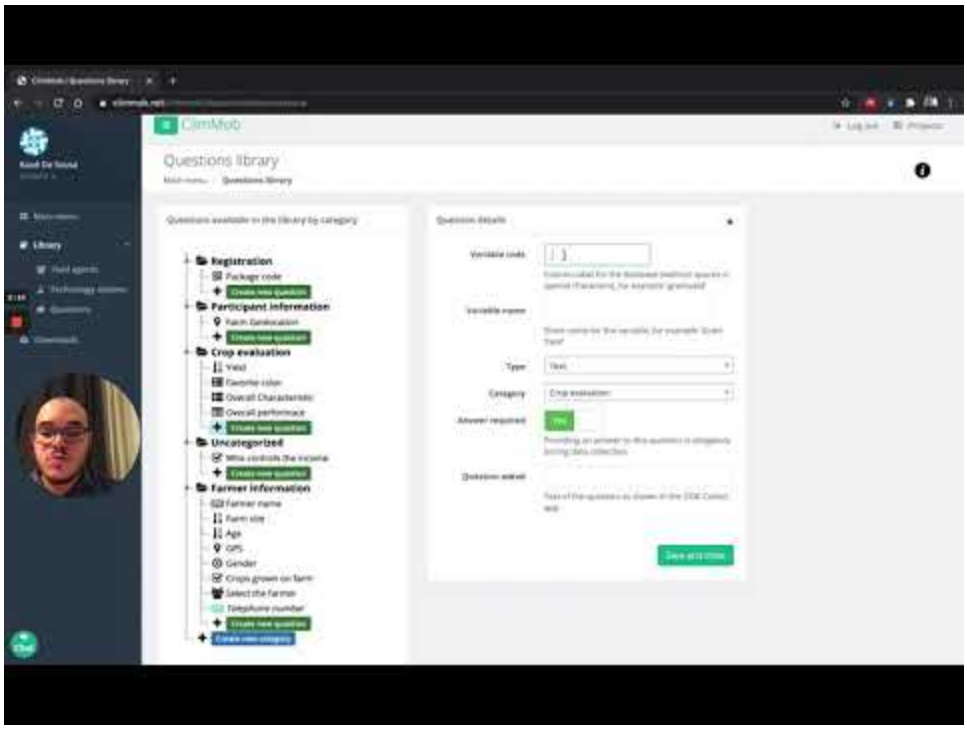
4. The ClimMob library already includes a list of commonly used questions, which you can easily add to the registration form.

Video tutorials

Learn in the following video how to prepare the participant registration form and set up the randomization for the ClimMob project.



Learn how to add new questions to the library



More in-depth information regarding household and farm characteristics can be collected during registration using the pre-developed RHoMIS survey.

Version: current

📄 Download the Distribution chapter as a PDF

Training workshop

> Taken from van Etten et al. (2020), page 17

Farmer training workshop

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.

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.

The project implementers, together with the local field agents, should invite interested farmers to a central location. This can be a village meeting hall or an NGO office. They should 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. A small pictorial guide for farmers on tricot should also be handed out at the training workshop. See this is and other supporting material for communication with farmers here.

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.

Required workshop material and logistics:

- A meeting place for at least 20 people
- Snacks
- Trial packages (see next section here)

References

van Etten, J., Manners, R., Steinke, J., & others. (2020). *The tricot approach: Guide for large-scale participatory experiments* [Technical Report]. https://hdl.handle.net/10568/109942

Version: current

Trial packages

Sofía Acuña, Marilyn Manrow, Brandon Madriz, Kauê de Sousa

Prepare the trial packages

Once your technologies have been randomized in ClimMob (click here for the 'Technology randomization' step in ClimMob), the next step is to create the physical packages with technologies that participants will use for the blind testing.

How-to (three steps):

1. Gather materials

- Collect enough of each technology option that you are testing.
- Example: If you are testing seed varieties, gather sufficient quantities of each seed type.

2. Download package lists from ClimMob (in the Downloads section):

- Randomized trial packages list → shows which combination of three technology options goes into each package.
- Package list with QR codes for participant registration → contains the package number and its unique QR code.

3. Prepare and label the packages

- Assemble each package with its assigned set of three technology options.
- Cut out the corresponding label (from the package list with QR codes).
- Stick the label with the package number and QR code on the package

before distributing it to participants.

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. Find out more about QR code generation here.

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. Find out more about observation cards here.

4. A brochure that explains the entire process to the farmer. Illustrations and other supporting material for communication with farmers can be found here.

Assign and distribute packages

Once you have prepared the packages with the different technology options (see how to do that here), it is time to go to the field to distribute them and register each participant with their corresponding trial package.

How-to:

There are different ways to do this: you can arrange a meeting with all participants or visit them individually at their location.

Using ODK Collect

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.**

1. Open ODK Collect and get the blank registration form.

2. Fill in the form with participant data. The first step is to scan the QR code attached to the package with the three technology options the participant is receiving. This links the package to their individual profile.

3. Once the forms are completed, send them to the server.

Paper (NOT RECOMMENDED, as it takes significantly more time and is more prone to errors):

1. Alternatively, you can register participants using paper forms. These are available under Downloads → Printer-friendly registration form.

2. Enter the data into an Excel file. On the main menu (left side), click on Upload data (green button) → Create template. The template will be generated and available in Downloads → Excel template for uploading registration form data.

3. Once you have filled in the template, go back to the main menu, click on Upload data (green button, left side), and upload the Excel document.

Review, edit and complete registration:

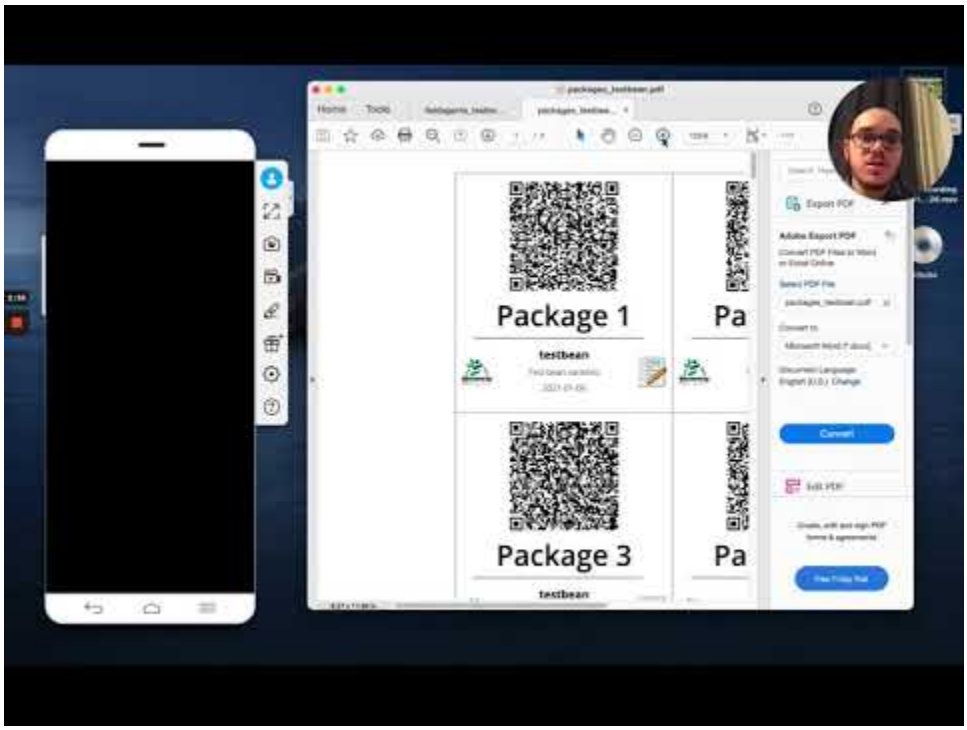
- Click on the green button View data to review the submitted data and edit if necessary.
- Click on the red button, Finish registration once you have registered all participants.

⚠ Please note: This step cannot be undone, so only proceed when you are certain that registration is complete.

Video tutorials:

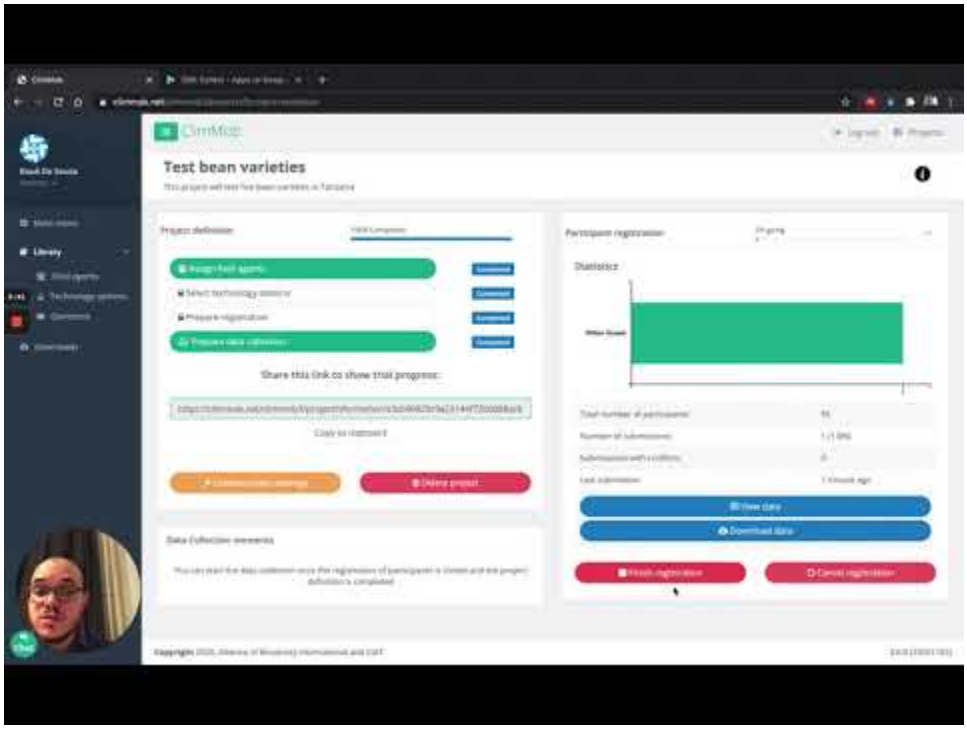
To know more, you can watch the video below from minute 1.58 on:

Link ClimMob with ODK Collect, part 1



You can also watch this second video (from the beginning until minute 2:17):

Link ClimMob with ODK Collect, part 2



📄 Download the Execution chapter as a PDF

Trial execution

> Taken from van Etten et al. (2020), page 19

Trial management

For tricot trials testing crop varieties, the farmers plant and manage the trials independently. Every farmer is responsible for his/her own plot. Carrying out an on-farm trial is simple and 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, farmers are trained in tricot methodology, receive their individual trial packages, see how a trial plot looks (on-site or through video), and receive a brochure about tricot. They then 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.

References

van Etten, J., Manners, R., Steinke, J., & others. (2020). *The tricot approach: Guide for large-scale participatory experiments* [Technical Report].

https://hdl.handle.net/10568/109942

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📄 Download the Observation chapter as a PDF

Trial observation

> Taken from van Etten et al. (2020), page 21

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.

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.

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.

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.

Prepare observation cards

The observation cards contain the questions that participants will answer during their tricot trial about the performance of their assigned technology options. These are always comparison questions, allowing participants to rank their field observations. The questions always follow the same structure, asking for the ‘best’ and the ‘worst’ among the three trial technologies, and should be 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?’.

The questions should be printed on the observation cards that are handed out to participants and should contain images or graphics to guide them. Stock

images can be downloaded in the Resources chapter - Supporting material.

How-to make an observation card (two steps):

1. Define data collection moments

Decide when participants should make their observations during the trial.

Example: For a bean variety test, you might ask participants to observe at three stages:

- Day of sowing (start of the project)
- 30 days after sowing (mid-point)
- Day of harvest (end of the trial)

2. Define observations

Based on the technology options being tested, determine which specific observations participants should make.

Each observation corresponds to one question on the observation card.

Example:

- Plant height → “Which variety grows tallest?”
- Stress tolerance → “Which variety looks healthiest?”



References

van Etten, J., Manners, R., Steinke, J., & others. (2020). *The tricot approach: Guide for large-scale participatory experiments* [Technical Report]. https://hdl.handle.net/10568/109942

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📄 Download the Compilation chapter as a PDF

Data collection

Sofía Acuña, Marilyn Manrow, Brandon Madriz, Kauê de Sousa

Once farmers have started their on-farm trials, the next step is to collect the data generated at the different data collection moments. For each moment, ClimMob generates a specific form with tailored questions (click here to go the 'Prepare data collection form' step in ClimMob). Data can be collected using ODK Collect (recommended) or, alternatively, by uploading an Excel file to the ClimMob platform.

Using ODK Collect (recommended)

1. Each field agent opens ODK Collect on their phone.

2. Tap the three dots (top-right) → Get blank form → select the data collection form.

3. For the first data collection moment:

- Choose Fill blank form
- Select the participant
- Enter the data
- Send the finalized form

4. Back in the ClimMob platform, the project administrator must:

- Check the collected data and correct if necessary (from the main

dashboard, click View data on the right side and select the parameters to review).
- Once verified, go to the main menu, finish the first data collection, and start the next assessment.

5. Repeat this process until all data collection points are completed.

Actions in ODK Collect:

Cancel form: Permanently deletes the form. No further data can be collected, and any existing data will also be deleted.

Using Excel (not recommended)

1. In the ClimMob dashboard, go to the main menu (left side) and click Upload data (green button).

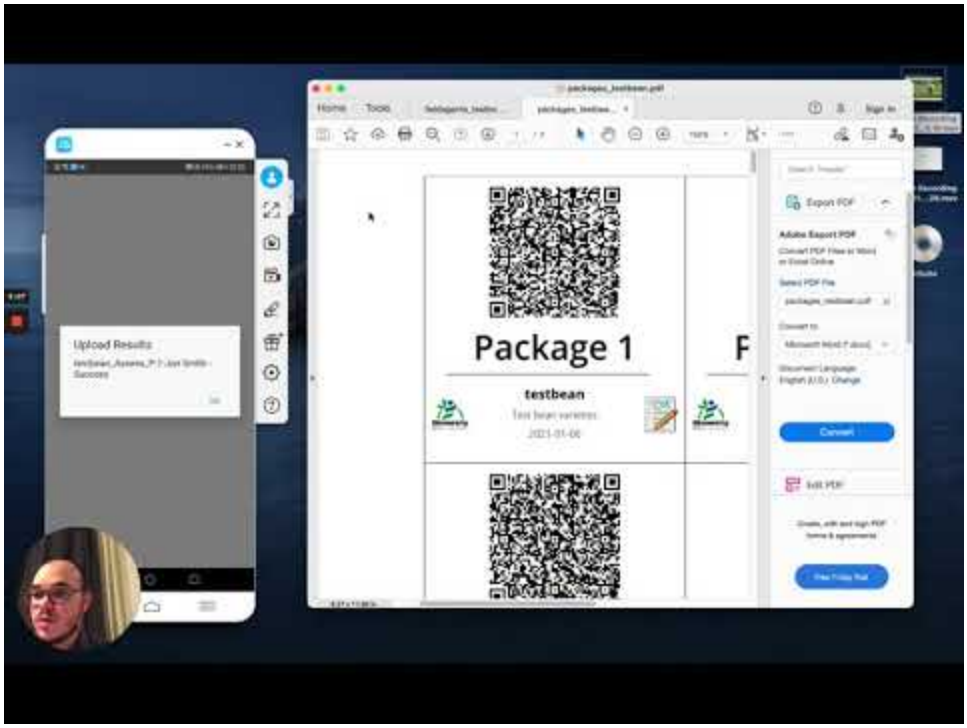
2. Click Create template. The Excel template will be generated and saved in your Downloads as Excel template for uploading assessment form data.

3. Fill in the template with the collected data.

4. Return to the ClimMob main menu → Upload data (green button) → upload the completed Excel file.

Video tutorial:

Data collection with ODK Collect

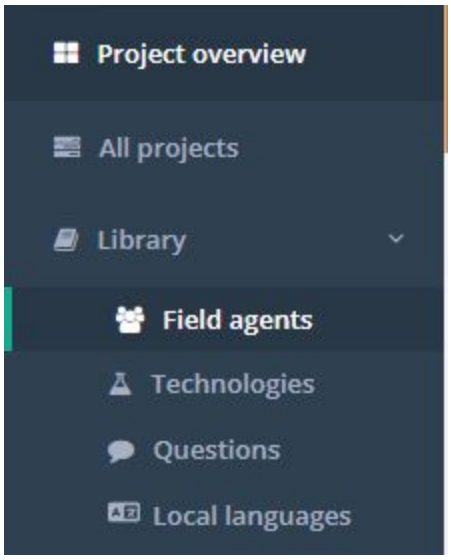


Submit data from a browser

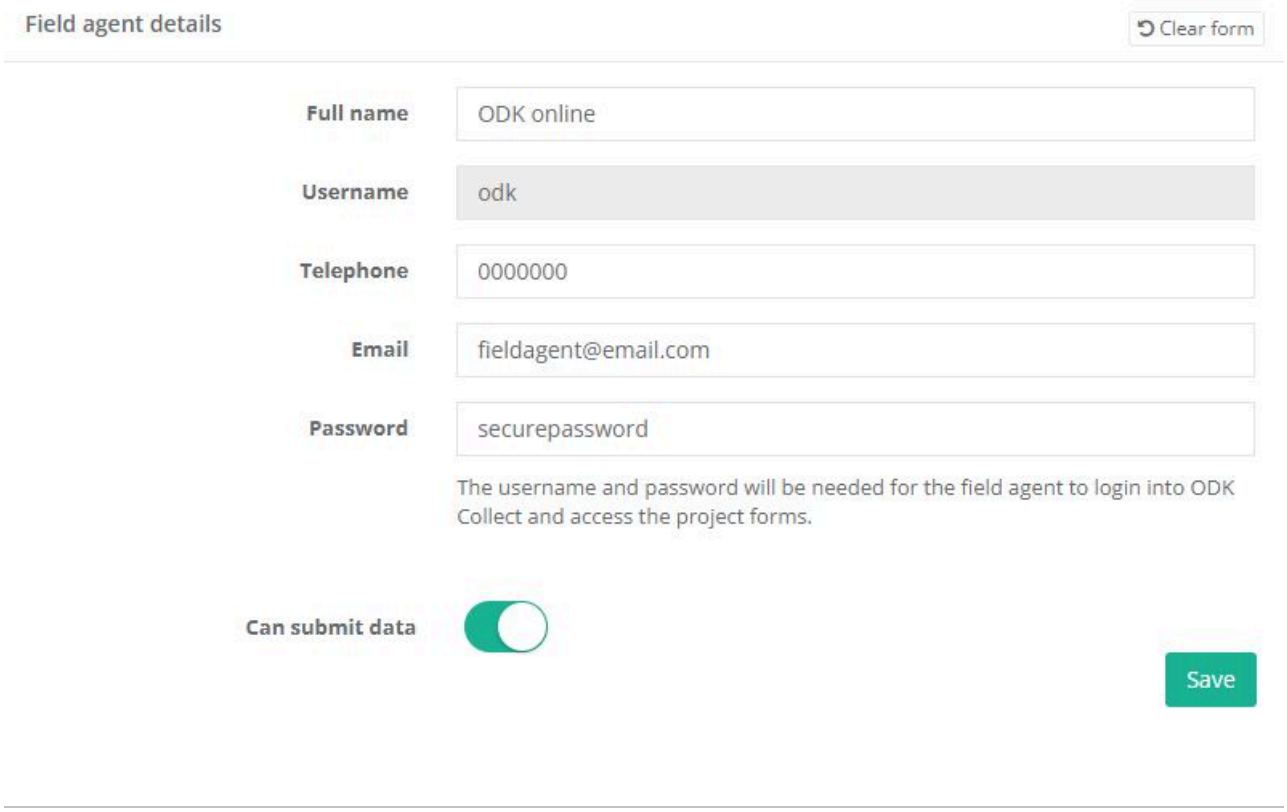
To fill out forms online supported by Enketo, the field agents (enumerators) need to log in using their credentials (username and password). Here we do a quick explanation on how to register a new field agent, that subsequently will login to Enketo to submit data from a browser.

(The following steps are accompanied by the relevant screenshots of ClimMob)

Visit the Field Agents section in the main menu:



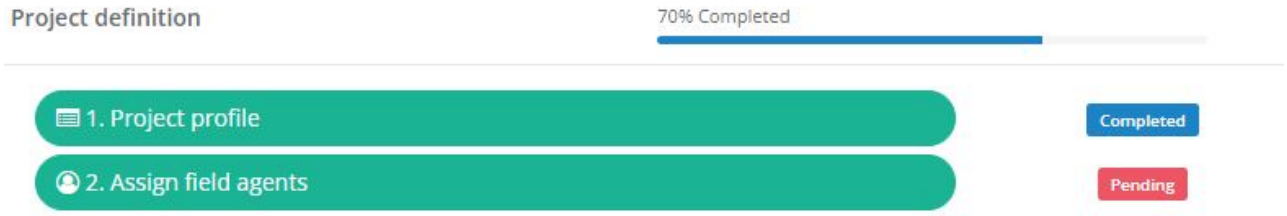
Fill in the form with the credentials of the field agent.



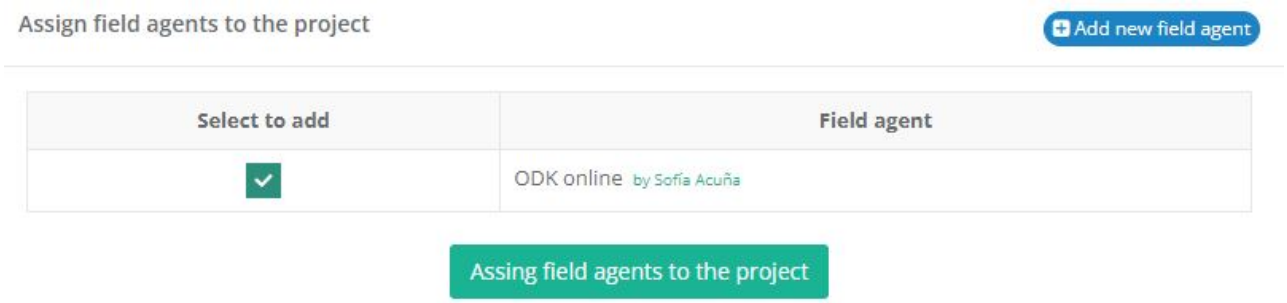
Verify that the field agent has been successfully created in the list of registered field agents:



In the project definition, select “Assign field agents”:



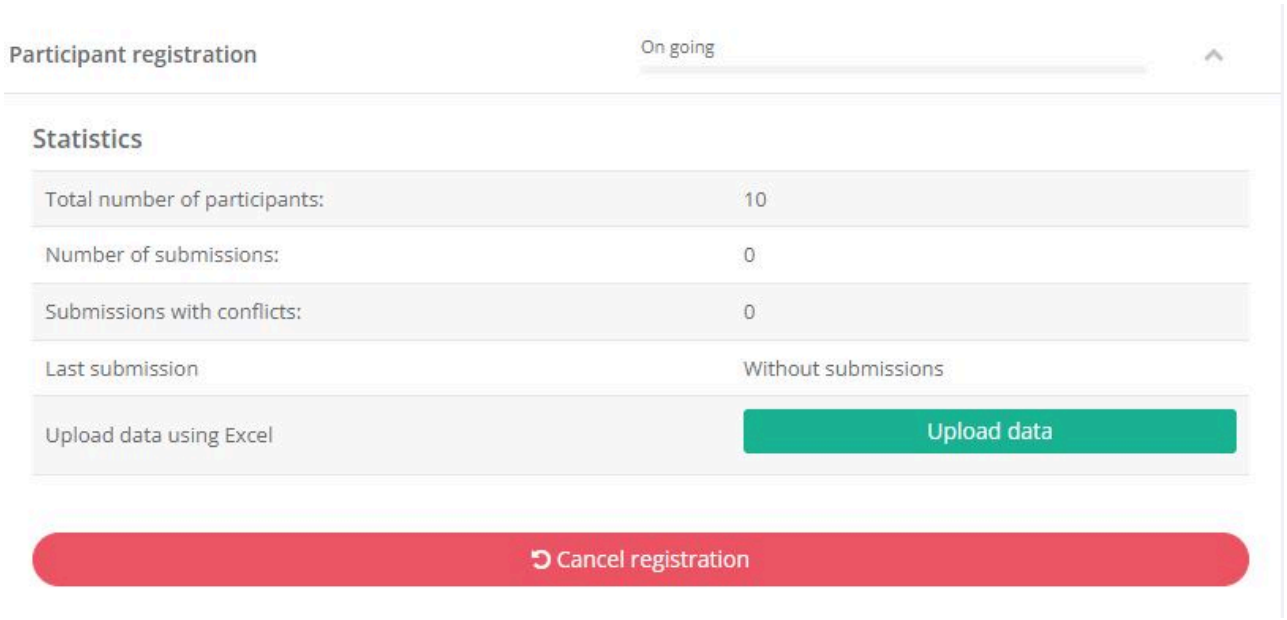
Select the field agent(s):



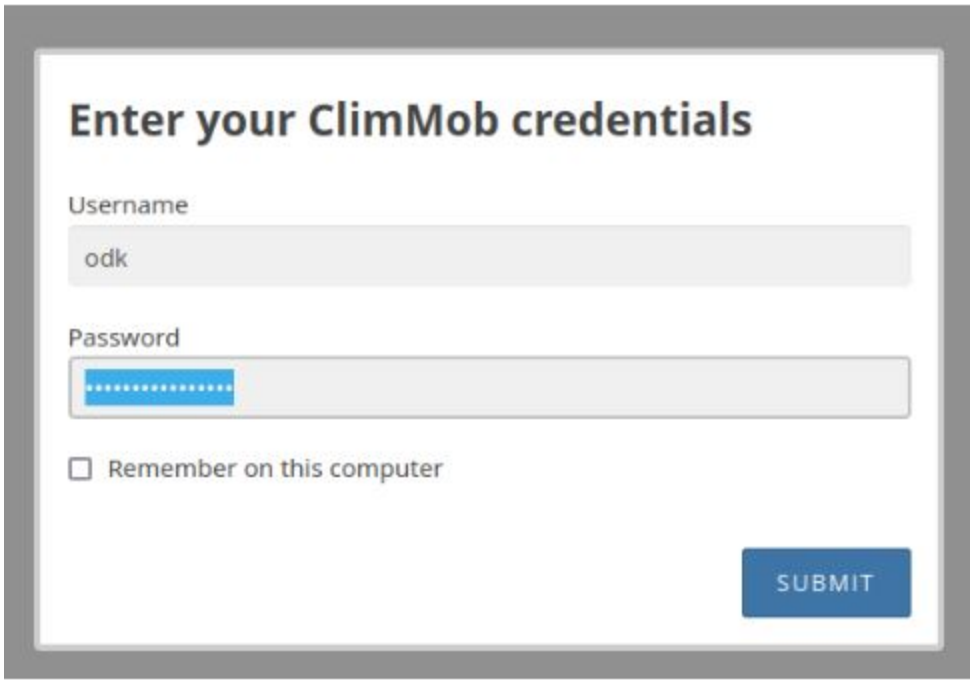
Click on the “Add field agents” button and verify that the user has been assigned to the project.



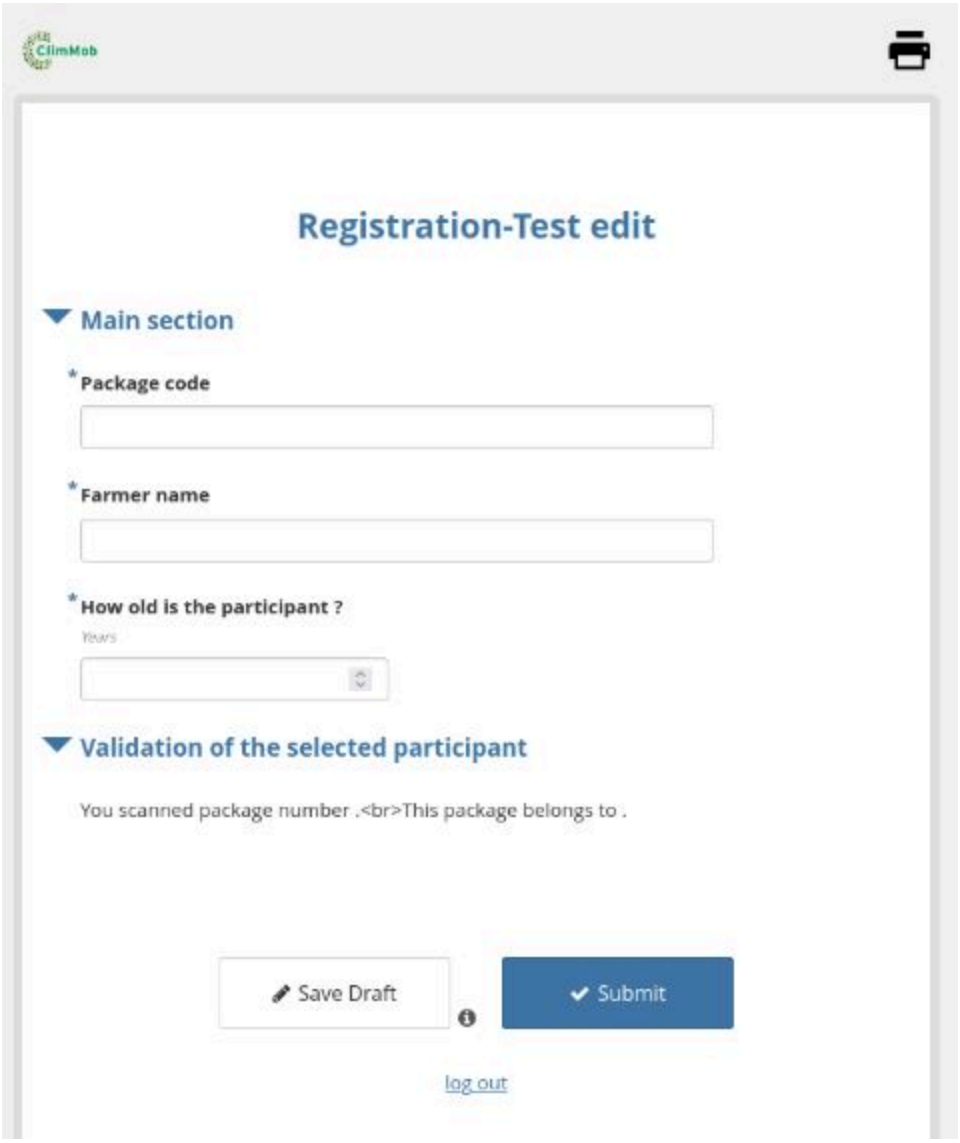
In the main menu, visit the form you wish to fill out using the browser and click on the “Submit data from a browser” button to display the form:



Now the form will be displayed and request the field agent credentials that were registered in the Library.



Once the credentials are provided, the form to be filled in will be displayed:



In the case of the Registration Form, you need to replace the QR code (used in ODK Collect) by a code that follows the pattern: projectownerusername-packagenumber-projectcode~

For example, if the project owner username is: ballen and the project code: prj01 and you assign the package #30 you should write as follows: ballen-30-prj01~

Remember to keep the ~ sign at the end so ClimMob can read the entire code.

Version: current

Download the Analysis chapter as a PDF

Statistical models applied to tricot data

Kauê de Sousa, Joost van Heerwaarden, Hugo Dorado

Introduction

The tricot data consist primarily of rankings provided by farmers, but can also include numeric and continuous measurements such as yield, plant density, disease incidence, or days to maturity. Because the core of tricot relies on comparative evaluation, statistical models that work naturally with relative rather than absolute performance are required. For ranking data, tricot analyses rely primarily on the Plackett–Luce (PL) model (Luce, 1959; Plackett, 1975). This probabilistic model, derived from Luce's Choice Axiom, estimates the probability that an item (e.g. a crop variety) is preferred over others within a set. Each item is assigned a latent parameter often referred to as its "worth" or ability, which reflects its expected performance relative to alternatives.

The PL model has been widely used in fields where choices are made from sets of alternatives, including sports rankings, comparative judgement exercises (Chambers & Cunningham, 2022; Donovan et al., 2025), consumer preference studies (Olaosebikan et al., 2023), and crop variety selection (van Etten et al., 2019). Ranking methods in revealed-choice experiments are rapid, locally adaptable, and cognitively intuitive for respondents, requiring little calibration or training (Coe, 2002). This makes them particularly well suited for decentralized, farmer-led experimentation at scale.

In tricot, farmers typically compare three varieties per trait in an incomplete block design. The PL model is especially appropriate for this structure, as it accommodates partial rankings and comparisons among subsets of all tested varieties. This allows the aggregation of thousands of small, farmer-managed trials into a single coherent statistical analysis. For a full ranking of multiple items, the model expresses the probability of observing a specific order as a product of conditional choice probabilities. In the tricot context, this means that each farmer's ranking contributes information about relative performance, even though each farmer only evaluates a small subset of varieties.

Key advantages of the PL framework for tricot include:

- Ability to handle incomplete and unbalanced designs
- Direct modeling of ordinal (ranking) data

- Straightforward interpretation of relative performance
- Compatibility with covariates and hierarchical extensions

The estimated worth parameters can be transformed into probabilities of outperforming other varieties or into expected ranks, which are highly intuitive for breeders, extension agents, and decision makers.

Modelling heterogeneity using covariates and recursive partitioning

Farmer evaluations are influenced by environmental conditions, management practices, and socioeconomic context. To account for this heterogeneity, the PL model can be extended with covariates. One widely used approach in tricot is model-based recursive partitioning (Strobl et al., 2011). This method identifies subgroups in the data using binary splits based on environmental or socio-economic variables (e.g. rainfall, temperature, soil type, gender of farmer). Within each subgroup, a separate PL model is estimated. The result is a Plackett–Luce tree, which reveals how variety performance changes across contexts and helps define Target Populations of Environments (TPEs) (Figure 1). A TPE is a relatively uniform group of crop production environments (where and how the crop is grown). This approach has proven especially useful for identifying genotype × environment (G×E) interactions (e.g. local adaptations) under real farm conditions, supporting context-specific variety recommendations (van Etten et al., 2019).

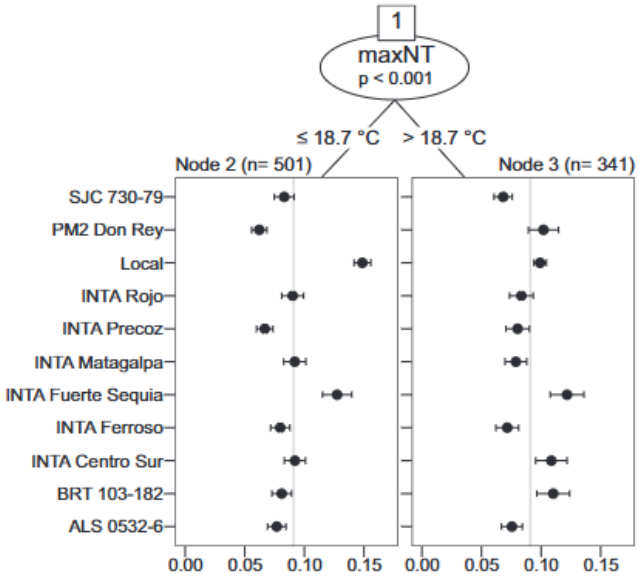


Figure 1. Plackett–Luce tree of tricot trial data and associated climatic data for common bean in Nicaragua. The horizontal axis of each panel is the probability of winning of varieties. In this case, the model selected maxNT, the maximum night temperature during the vegetative and flowering periods, as the covariate. From van Etten et al. (2019).

More recently, developments in Plackett–Luce regression allow the inclusion of linear covariates directly in the model (Alamu et al., 2023; Kang et al., 2025; Turner et al., 2020). This enables:

- Modelling of environmental gradients rather than discrete groups
- Inclusion of option-level covariates (e.g. trait data, genomic data, food lab data)
- More continuous representations of performance variation across environments

These advances bring tricot analysis closer to mainstream quantitative genetics and breeding analytics.

Analysing continous data

Although rankings are central in tricot, many trials also collect quantitative measurements such as yield or disease scores (Nabateregga et al., 2025). These data are typically analysed using linear mixed-effects models (LMMs) or generalized linear mixed models (GLMMs).

Mixed models allow partitioning of variation into components attributable to:

- Variety (genotype)
- Environment
- Farmer or location
- Residual error

They also support estimation of heritability, variance components, and genotype × environment interactions. When tricot trials include both ranking and quantitative data, analyses can be conducted in parallel and later integrated at the interpretation stage. Research is ongoing into joint modelling frameworks that combine ordinal and continuous data within a single statistical structure (Dorado-Betancourt et al., 2026).

Linking tricot with climate and environmental data

A major innovation in tricot analysis has been the integration of seasonal climate data, and other spatial covariates. Van Etten et al. (2019) demonstrated how PL models combined with climate covariates and cross-validation can produce locally specific variety recommendations. This approach allows:

- Identification of environmental drivers of variety performance
- Prediction of performance in new locations
- Development of climate-informed decision support tools

This integration is especially important under increasing climate variability, where static recommendations are insufficient.

Data synthesis across trials

Another major development is the rank-based synthesis of data across multiple trials (Brown et al., 2020). Because the PL model works with relative performance, it allows the combination of datasets from different years, locations, and experimental conditions—even when absolute measurements are not comparable. This is particularly promising for tricot, as it enables:

- Meta-analysis of decentralized trials
- Increased statistical power through aggregation
- Reuse of legacy or small-scale datasets
- Standardized data formats and open data sharing will further increase the value of such synthesis efforts, creating cumulative knowledge across projects and regions.
- Integration of genomic and biological information

In an important extension of the PL framework, de Sousa et al. (2021) incorporated genomic relatedness among varieties as a covariance structure within the model. This increased predictive accuracy, demonstrating that combining farmer evaluations with genomic information can improve selection decisions. This approach opens the door to:

- Decentralized genomic selection
- Testing genetically diverse materials under farmer management
- Better representation of G×E interactions in breeding pipelines

Such methods help bridge participatory research and advanced quantitative genetics.

From rankings to breeding decisions

Breeding programs are often interested in the probability that a new variety outperforms current standards, rather than in exact yield differences. Ranking-based analyses are well suited for this, as PL model outputs can be expressed as probabilities of superiority (Eskridge & Mumm, 1992). This aligns closely with modern breeding strategies that focus on product replacement and incremental gains (Cobb et al., 2019).

Tricot thus provides an efficient way to generate early-stage evidence about the likelihood that a candidate variety will succeed under farmer conditions.

Integrating on-farm and on-station data or lab data

A major challenge (and opportunity) in decentralized variety testing is the integration of on-farm and on-station datasets to support breeding decisions and biological interpretation of farmer preferences. On-station trials, conducted under controlled and replicated conditions, produce precise phenotypic measurements and genotypic estimates (e.g. yield, disease scores, physiological traits) that are essential for breeding decisions. In contrast, on-farm trials provide real-world performance assessments that incorporate the full complexity of farmer management, socio-economic context, and micro-environmental variation.

Kang et al. (2025) demonstrate a concrete example of such integration in potato trials in Rwanda. In this study, genotypic values estimated from on-station trials were incorporated as item covariates in the statistical model analysing farmers' tricot rankings. This strategy allowed the researchers to assess how biological measurements captured in controlled environments influence farmers' relative evaluations. Providing a richer understanding of variety performance across scales and can directly inform breeding decisions on trait prioritization and advancement in breeding pipelines.

Similarly, Alamu et al. (2023) have pioneered the use of item covariates derived from instrumental laboratory data (i.e. color, texture, hardness) in Plackett–Luce regressions, not just to explain consumers' preferences on gari (a cassava sub-product) but also to integrate biological and consumer preference data into a unified framework.

While not always focused on yield traits per se, these methods showcase how external measurements from controlled settings (e.g., instrumental sensory traits) can be used analytically alongside ranking data from decentralized trials.

Integrating on-station data into on-farm analyses can significantly enhance model robustness and interpretability. For example, item covariate models (e.g. Plackett–Luce regression with traits or genotypic values) allow the effects of measured biological traits to be directly estimated on the worth parameters used in ranking analyses.

These models effectively combine absolute performance metrics from station settings with relative performance evaluations from on-farm environments. From a breeding perspective, this integration supports a two-level modelling strategy:

- Predict genetic value and trait responses under controlled conditions, and
- Translate these predictions into expected performance under farmer conditions and diverse environments.

This strategy reflects a growing trend in crop improvement research where data from diverse sources

(e.g. farm trials, climate data, genomic estimates) are systematically combined to support decision-making at both breeding and deployment stages (van Etten et al., 2023).

Future directions for integrated data analysis

From a data analysis perspective, integrating on-farm and on-station data opens important opportunities to strengthen the role of decentralised trials within breeding pipelines. A key direction is the development of multi-level models that jointly analyse ranking data from on-farm trials and quantitative trait measurements from on-station experiments. Recent work shows that ranking-based estimates of genotypic performance can be placed on an underlying continuous scale and then used in mixed-model frameworks similar to those applied in conventional quantitative genetics (Dorado-Betancourt et al., 2026).

Extending these approaches to multi-environment and multi-year datasets will allow more robust estimation of genotypic performance and variability under farmer conditions. Another priority is the integration of environmental covariates into performance models. Linking on-farm results with weather, soil, and management data enables context-specific interpretation of variety performance and supports the definition of Target Populations of Environments. Data-driven breeding frameworks emphasize that combining trial data with environmental characterization improves both representativeness and predictive power (van Etten et al., 2023).

Future analysis will also benefit from multi-trait modelling. Farmers evaluate varieties holistically, and studies of participatory trials show that preferences often reflect combinations of agronomic and end-use traits that differ across farmer segments (Voss et al., 2025). Statistical frameworks that allow simultaneous analysis of multiple traits, whether measured on-station or from on-farm rankings, will better capture these complex performance profiles.

Finally, there is growing scope for data-driven approaches that combine ranking data, quantitative measurements, and genomic or trait covariates within unified models (Alamu et al., 2023; Kang et al., 2025). Such integration will help translate farmer-generated evidence into biologically interpretable parameters, strengthening the connection between decentralized on-farm testing and formal breeding decision-making.

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Version: current

ClimMob data report

Sofía Acuña, Marilyn Manrow, Brandon Madriz, Kauê de Sousa

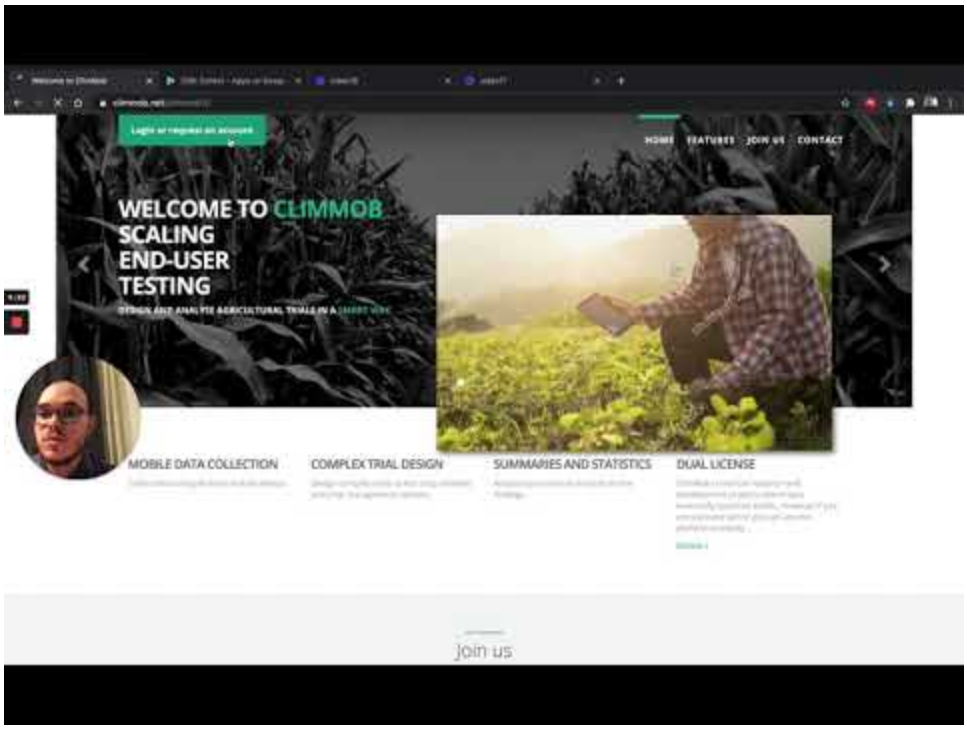
Once all participant data has been collected, it is time to analyze the results. ClimMob provides built-in tools to process your tricot data and generate reports automatically.

How to run the analysis in ClimMob?

1. In the ClimMob project overview section, go to the right side of the screen and click **Start analysis**.
2. Select the variables you want to analyze.
3. ClimMob will process the data and generate a final report.

Video tutorial:

How to conduct data analysis in ClimMob



Final report produced by ClimMob

After the analysis is completed, ClimMob automatically generates a final report summarizing the results of the on-farm trials. This report is designed to help project managers and researchers interpret the outcomes and make evidence-based decisions.

Understanding the report

The final report typically includes:

1. Ranking of technologies: performance of each technology as evaluated by participants.

2. Comparison of variables: results based on the variables selected during the analysis.

3. Visual outputs: tables and graphs that make it easier to interpret preferences and performance.

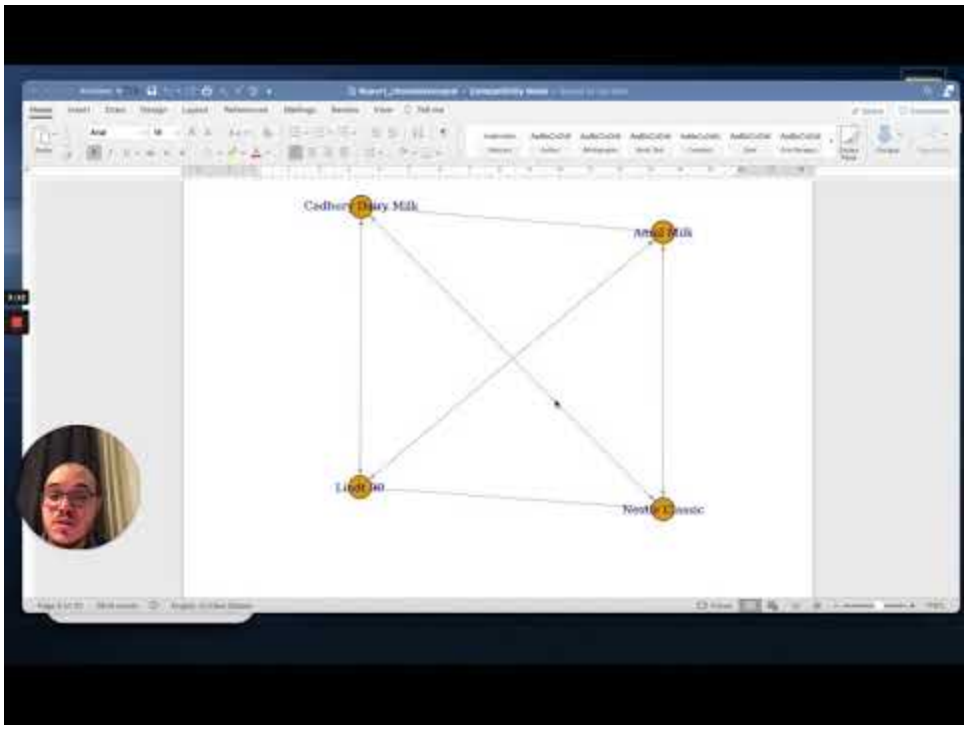
Accessing the report

1. Go to the **Downloads** section of the ClimMob platform.
2. Locate the file generated after your analysis.
3. Open the document to review and share with your team or stakeholders.

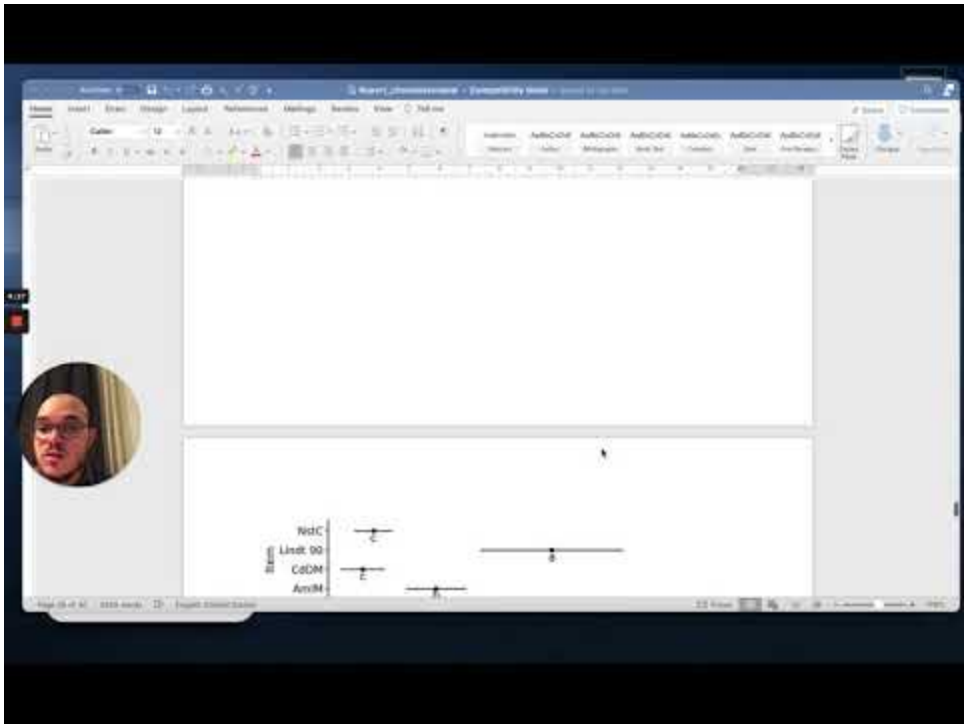
Video tutorials:

An overview of the report produced by ClimMob, part 1 and part 2.

Analysis, read the report, part 1



Analysis, read the report, part 2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Version: current

Analysis in R-instat

Lily Clements, Roger Stern, Rachel Chase

Introduction

R-Instat is an accessible, user-friendly free software specifically designed for statistical analysis in agricultural science. In the context of tricot, R-Instat serves as a practical analytical tool that simplifies and streamlines the complex data workflows typical of tricot trials. This integration enhances data-driven, farmer-led insights in on-farm testing.

Download R-instat here

Get all documentation about R-instat here

Watch a 1000FARMS webinar about R-instat here

Purpose and key features

1. Accessibility: R-Instat provides a user-friendly graphical interface to R's powerful analytical capabilities, making statistical analysis approachable for practitioners and educators who may not be familiar with coding.

2. Tricot Suitability: Tricot experiments generate ranking data and farmer-provided assessments across heterogeneous environments. R-Instat enables efficient processing of such data, including ranking calculations and visual summaries.

3. Educational Integration: IDEMS International's eCampus includes workshops, such as "KMD R-Instat Workshop 2022" and "Tricot Workshop", that embed R-Instat training within broader curricula focused on participatory on-farm trial analysis.

Benefits of using R-Instat in tricot analysis

1. User-Friendly Interface: Eliminates the barrier of coding, enabling agronomists, researchers, and educators to focus on interpretation rather than syntax.

2. Streamlined Workflow: From data cleaning to sub-setting, ranking and visualization, R-Instat centralizes tasks common in tricot analysis.

3. Capacity Building: Facilitates training through structured modules and workshops, democratizing access to participatory data analytics.

4. Scalability: Supports high-volume, decentralized data workflows typical of large-scale tricot deployments.

5. Advanced analysis features: For example R-Instat's climatic menu provides daily data, covering rainfall, temperature, and related data that can be used as environmental covariates in the analysis of trial data.

Step	Activity	Role of R-Instat
Design	Farmers implement tricot trials using a randomized incomplete-block design (three options per block).	Not directly used here but foundational to downstream analysis.

Step	Activity	Role of R-Instat
Data Collection	Farmers collect rankings and trait observations from each plot.	
Analysis	Use R-Instat to perform ranking analyses (e.g., worth estimates, Plackett-Luce models), visualize results, and generate summaries.	Empowers stakeholders to interpret varietal performance across environments.
Reporting	Generate accessible reports that integrate farmer feedback and statistical insights.	Supports the creation of visual and textual outputs for broader dissemination.

Version: current

Advanced data analysis in R

Kauê de Sousa

This section is intended for users who want to work directly with tricot data in R and explore more advanced and customizable analytical approaches. While standard analyses can be performed through ClimMob or R-Instat, working in R allows full control over data processing, modelling, visualization, and reproducibility.

The following set of R packages has been developed to support different steps of the tricot data workflow, from data access to advanced statistical modelling.

climMobTools: Provides an API client to download and manage data directly from the ClimMob platform, making it easier to build reproducible analysis pipelines. https://cran.r-project.org/package=ClimMobTools

gosset: Offers methods for analysing experimental agricultural data, including tools particularly suited for tricot-style ranking data. It supports data preparation, model fitting, trait prioritization, data synthesis, and visualization. https://cran.r-project.org/package=gosset

climatrends: Supports the analysis of climate trends and agroclimatic indicators, which can be linked to on-farm trial data to better understand environmental drivers of performance. https://cran.r-project.org/package=climatrends

chirps: Provides access to CHIRPS and CHIRTS gridded climate data (rainfall and temperature), enabling integration of daily weather information into tricot

analyses. https://cran.r-project.org/package=chirps

PlackettLuce: Implements the Plackett–Luce model in R, which forms the statistical backbone for analysing ranking data in the tricot approach. https://cran.r-project.org/package=PlackettLuce

Two introductory case studies are especially recommended.

Practical example with common beans for trait prioritization and crop performance

Practical example with gari/eba consumer testing

These examples illustrate how tricot data can be analysed in R to connect farmer evaluations, agronomic performance, and breeding decisions within a fully reproducible workflow.

Version: current

📄 Download the Feedback chapter as a PDF

Trial feedback to farmers

Anna Muller, Juan Manuel Londoño

Feedback to farmers

You have concluded your trial on ClimMob. 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.

Farmers are the data producers of this citizen science approach and thus discussing the outcome of the trials is a crucial part of the tricot vision for partnership on the same level. Also, 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.

We recommend that the workshop consists of the following parts (typical duration: **75–110 minutes**, excluding travel and set-up):

1. **Welcome and purpose (Kick-off / introduction) — 5–10 min** Gather and inform the farmer group about the nature of the gathering. You can find support in local leadership (lead farmers or field agents).

2. **The concluded tricot trial — 5–10 min** Briefly explain the objectives, process, and scope of the concluded trial.

3. **Farmer feedback sheet handover and explanation — 20–25 min** The farmers receive their personal infosheets with the names of the technologies that they tested and which technology they preferred. They are given time to review the sheet and ask clarifying questions.

4. **Discussion among farmers (small groups by preference) — 5–10 min (set-up) + 15–20 min (share-back)** Discussion among the farmers is important: everyone can learn from each other. It is recommended to form small groups for this activity (of about 5–7 people), including a facilitator (a field agent or experienced farmer). Groups can discuss why they chose their preferred technology and what stood out in the trial. Groups present their conclusions in a plenary session.

5. **Overall results presentation (group-level results) — 10–15 min** The project implementers or the local field agents present the overall results of the technology evaluation using the farmer feedback sheet. Farmers learn which of these technologies performed best under which conditions. 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. If relevant, provide a short explanation of the Incomplete Block Design (IBD) and how it supports robust comparisons across many farmers.

6. **Certificate handover — ~5 min** They get acknowledged for their work with the tricot certificate (see below).

7. **Quick reflection (optional: NPS) — 5–10 min** Use a simple scale (0–10) to capture how useful farmers found the feedback sheet and session. This can support learning and improvement for future workshops.

8. **Next steps and closing — ~5 min** Inform farmers about next steps in

your engagement: What will the data be used for? How can farmers reach the project implementers? Are more trials planned? What will happen now in the technology development process? Answers to these questions treat farmers as meaningful partners on the same level.

These points should be considered by the field agents:

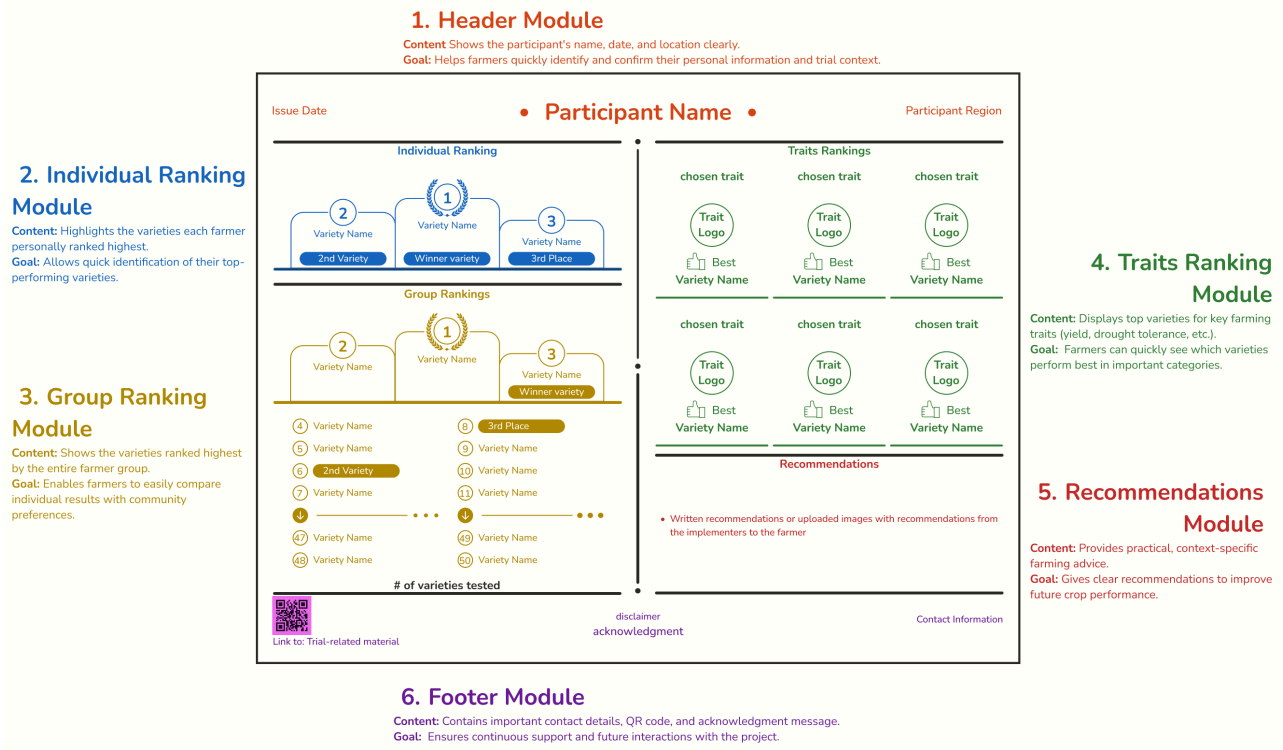
- Discussion among the farmers is important: everyone can learn from each other.
- It is crucial to make it clear that there is no single best technology option. In fact, optimal technology options can differ across farms and farmers.
- Field agents should also annotate feedback provided by the farmers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

Feedback materials

Link to Farmer Feedback Package

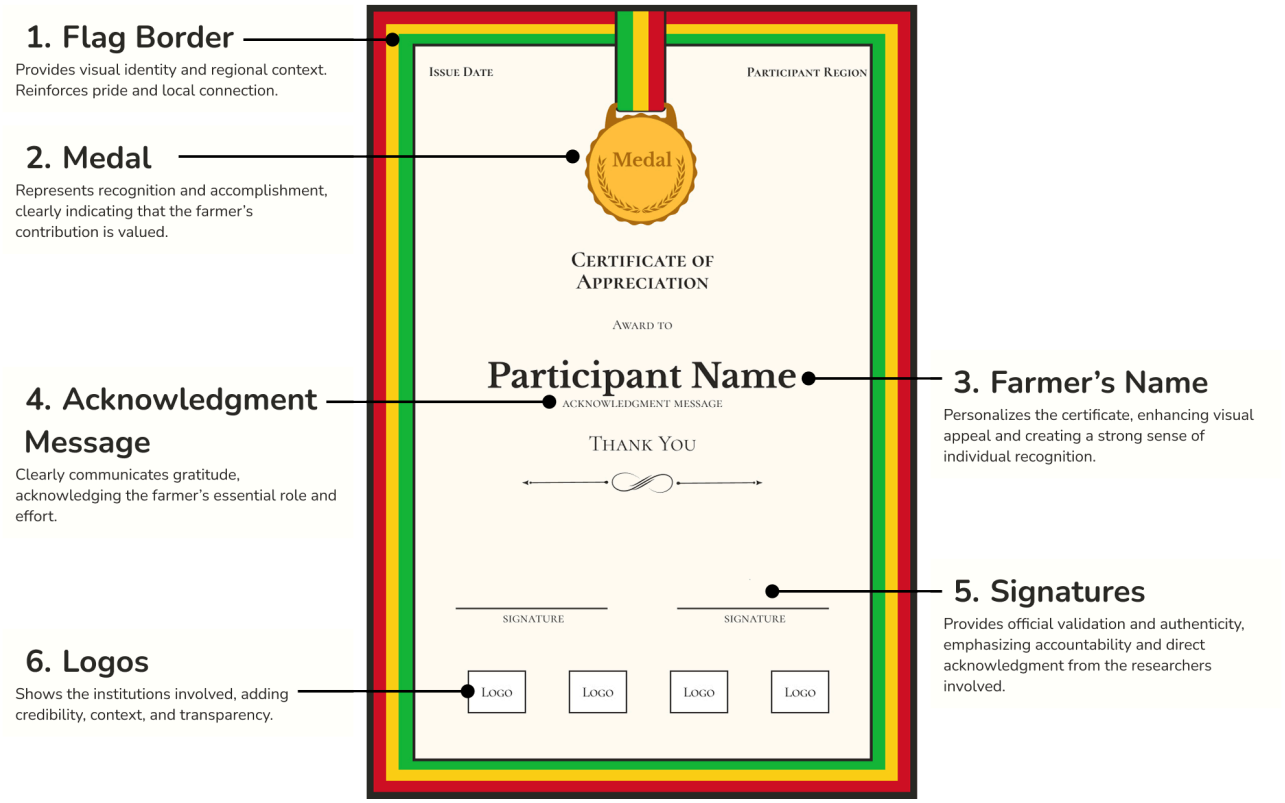
The farmer feedback sheet – the main trial results

This sheet (available in the link above) was designed to present individual and group trial results to farmers in an easily understandable way. It is automatically generated by ClimMob when you request the analysis of your trial results. The sheet contains basic information about which varieties performed best for the farmer and the group. Print this sheet for every farmer in your trial. People who cannot attend the feedback session may still receive this via their neighbors.



The farmer certificate – an acknowledgement of the farmers' contribution

This certificate (available in the link above) was designed to stress the importance of the farmers' contribution to the tricot trial. It is an acknowledgement of their role in the process. You can add the logo of your organization to the certificate. Print this for every farmer and sign.



How to prepare feedback sessions

Budget: Plan resources (team time and money) for this final workshop from the start. Plan your team's time to visit all communities or regions holding trial result workshops. Plan for your team's time to debrief after the workshops and document learnings to integrate them in the planning of next trials.

Group sizes: As with the training and distribution workshop, in most cases the number of attendees should be limited to around 20–25 per event, in a central location accessible to all.

Materials: The success of the feedback session depends highly on implementation of the sheet & certificate. We recommend using the feedback sheet and certificate available here.

Participant feedback examples: IITA feedback handbooks

These reports present the results of a series of tricot trials undertaken in Nigeria by the International Institute of Tropical Agriculture (IITA). They are intended to provide thorough feedback on the trial results to the participating communities, and importantly provide clarity and reference on the identity of all the varieties and who had the winning varieties, so farmers can optimally use the results of the trial to inform their successive practices. This also constitutes a base for a continued community of practice between the trial initiators and the farming communities.

Osun Oyo States Report | Akwa Ibom State Report | Benue State Report | Abia and Imo States Report | All 6 States Report

Also watch click below to watch the video "Cassava breeding in Nigeria adapts tricot on-farm testing to achieve inclusive breeding"



Version: current

Dissemination

> Taken from van Etten et al. (2020), page 13.

Open access publication of the data should be a goal of the trial. Tricot has already published a number of sizable datasets from on-farm trials (de Sousa et al., 2021; Moyo et al., 2021; van Etten et al., 2018). These datasets could become important for other research that repurposes these datasets. Kool et al. (2020) have provided an incisive critique of on-farm testing in agronomy, especially the limited replicability of many trials as authors fail to report contextual factors (crop management) and sampling of locations and participating farmers.

Similarly, a study on PVS in RTB crops reveals that on-farm trials are often documented in a very deficient way and that data are hardly published at all (Valle, 2021). Data publication could become more attractive if it is easy to do and has rewards (citations of datasets repurposed by others). Publishing all data from trials could prevent the so-called file-drawer problem, which means that only certain datasets (for example, novel analyses, striking results) are published, which then lead to biased statistics in meta-analyses.

The tricot approach should address these issues by facilitating and standardizing the way in which on-farm trials are documented and published. Standardization should be done using the insights of the studies cited above. Specifically, metadata on the trials could be standardized and some elements on the trial context could become recommended elements that are easily available from within the software. For example, it is becoming more and more clear that plot use histories and fertilization in preceding seasons of plots are highly influential on yields (Njoroge et al., 2019; Zingore et al., 2007). For this, an existing metadata schema for phenotypic experiments could be adapted

(Papoutsoglou et al., 2020). Also, the data publication process should be automatized, including the anonymization procedure (removing personal identifiable information such as names, addresses and telephone numbers as well as aggregating geographic data to a sufficient level to prevent identification).

Where to share your project:

- Scientific journals
- Repositories like Dataverse, Fairgrounds, Zenodo or CGSpace
- 1000FARMS network - via a webinar or the Community of Practice website

References

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Version: current

Share your project in ClimMob

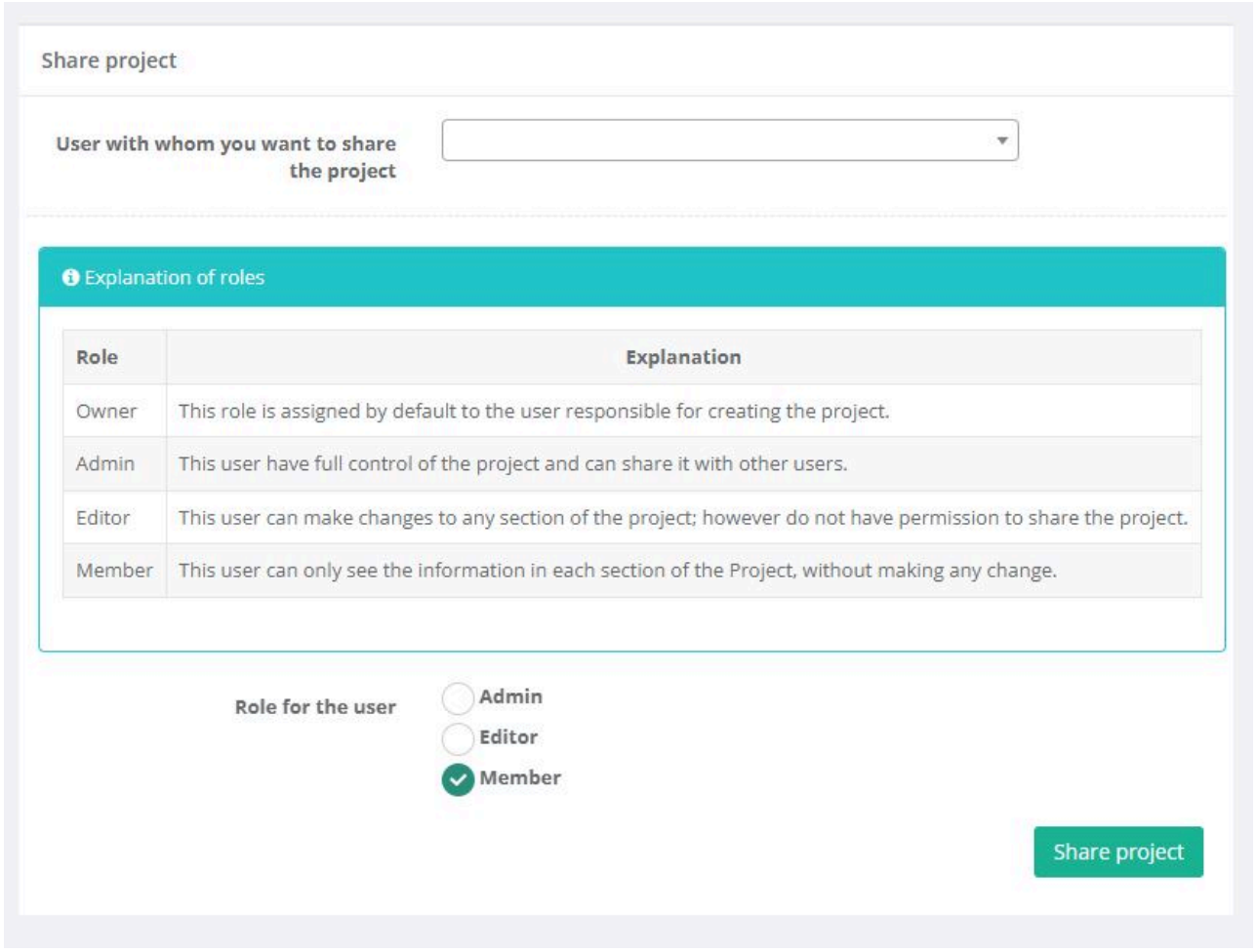
Sofía Acuña, Marilyn Manrow, Brandon Madriz

ClimMob allows you to collaborate by sharing your project with other users. When you invite someone, you must assign a role that defines what level of access they will have:

- Owner – Automatically assigned to the person who created the project. Owners cannot be changed.
- Admin – Full control of the project, including permission to share it with others.
- Editor – Can modify any section of the project but cannot share it with new users.
- Member – Read-only access. Members can view all information but cannot make changes.

How-to share a project with other users:

1. In ClimMob, open the Project overview and go to the Share project section.
2. Enter the email of the user you want to invite.
3. Select the role (Admin, Editor, or Member) that best fits their level of participation.
4. Confirm to share the project. The invited user will now have access according to the role you assigned.


Share project
User with whom you want to share the project
Explanation of roles
Role
Explanation
Owner
This role is assigned by default to the user responsible for creating the project.
Admin
This user have full control of the project and can share it with other users.
Editor
This user can make changes to any section of the project; however do not have permission to share the project.
Member
This user can only see the information in each section of the Project, without making any change.
Role for the user
Admin
Editor
Member
Share project

📄 Download the Evaluation chapter as a PDF

Evaluation

> Taken from van Etten et al. (2020), page 27

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 book 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 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 research.

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 trial can be measured. You can evaluate four indicators in ClimMob, which will give you an idea about the individual trials’ impact, and the project’s overall success.

1. The rate of completed trials: counts 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 balance: it is important to recognize the gender ratio in the cultivation of a particular crop and strive to achieve the same ratio in the trials. For example, maize is considered a “cash crop” in some countries and therefore tend to be male dominated, while other crops like millet tend to be considered womens’ crops. The goal of tricot trials is to get a proportional participation compared to the population growing the specific crop and bring evidence on the effects of these dynamics.

3. Returning farmers: The percentage of farmers who participate again after the first cycle is 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.

References

van Etten, J., Manners, R., Steinke, J., & others. (2020). *The tricot approach: Guide for large-scale participatory experiments* [Technical Report]. https://hdl.handle.net/10568/109942

Version: current

📄 Download the Resources chapter as a PDF

Tricot resources

Curated resources on the tricot approach and ClimMob: key publications, training videos, costing templates, and crop-specific supporting materials.

📄 Publications | 🎬 Training Videos | 💰 Costing Templates | 📄 SOPs | 🌾 Supporting Material | 📄 Spousal Information Letter | 🧑 Farmer Feedback Package

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Publications

Tricot Guide | **Main Publications**

The Tricot Guide

Jacob van Etten, Rhys Manners, Jonathan Steinke, Elsa Matthus, Kauê de Sousa. 2020.
The tricot approach. Guide for large-scale participatory experiments.
Rome (Italy): Alliance of Bioversity International and CIAT.
https://hdl.handle.net/10568/109942

This is a short, full-colour guide intended for practitioners who are not yet familiar with tricot.
It explains the rationale of tricot and gives an overview of the experimental cycle.

Main publications

All publications about the tricot approach are free and open access.

- **Jonathan Steinke, Jacob van Etten and Pablo Mejía-Zelan. 2017. The accuracy of farmer-generated data in an agricultural citizen science methodology.**
  Agronomy for Sustainable Development 37: 32. https://doi.org/10.1007/s13593-017-0441-y

  The above paper shows that farmers provide accurate data in tricot trials. Their rankings converge with expert rankings for four traits. The variation between farmers still allows for accurate overall ranking of the varieties.

- **Eskender Beza, Jonathan Steinke, Jacob van Etten et al. 2017. What are the prospects for large-N citizen science in agriculture? Evidence from three continents on motivation and mobile telephone use of resource-poor farmers participating in “tricot” crop research trials.**
  PLoS ONE 12(5): e0175700. https://doi.org/10.1371/journal.pone.0175700

  This paper investigates the motivation of farmers who participate in tricot trials across three contrasting contexts: Honduras, Ethiopia and India. Farmers are motivated by a wide range of reasons, including intrinsic and extrinsic factors. They do not see it as a pastime, but also do not expect monetary compensation. They expect technical information and access to seeds as reward of their participation.

- **Jacob van Etten, et al. 2019.**
  First experiences with a novel farmer citizen science approach: Crowdsourcing participatory variety selection through on-farm triadic comparisons of technologies (tricot).
  Experimental Agriculture, 55(S1). https://doi.org/10.1017/S0014479716000739

  This paper provides an explanation of the tricot approach, how it compares to previous approaches, and some first applications. Note that it uses the Bradley-Terry model, which was replaced by the Plackett-Luce model in later publications.

- **Jacob van Etten, Kauê de Sousa, […] Jonathan Steinke. 2019.**
  Crop variety management for climate adaptation supported by citizen science.
  PNAS 116(10): 4194-4199. https://doi.org/10.1073/pnas.1813720116

  This paper describes the application of large tricot trials in Nicaragua, Ethiopia and India. It demonstrates the potential of tricot to generate insights into variety adaptation, recommend adapted varieties, and aid smallholder farmers in responding to climate change. It is the first large-scale application of climate analysis on tricot data.

- **Heather Turner, Jacob van Etten, David Firth, Ioannis Kosmidis. 2020.**
  Modelling rankings in R: the PlackettLuce package.
  Comput Stat 35, 1027–1057. https://doi.org/10.1007/s00180-020-00959-3

  This article explains the Plackett-Luce model and its implementation in R, as used by the ClimMob platform.

- **Kauê de Sousa, Jacob van Etten, […] Matteo Dell'Acqua. 2021.**

Data-driven decentralized breeding increases prediction accuracy in a challenging crop production environment.
Communications Biology 4, 944. https://doi.org/10.1038/s42003-021-02463-w

This paper shows that tricot can be effectively combined with genomic selection for highly accurate selection in challenging production environments. Tested with durum wheat in Ethiopia, 3D-breeding doubled prediction accuracy compared to conventional methods, identifying genotypes with superior local adaptation across seasons to improve breeding decisions.

- **David Brown, Sytze de Bruin, Kauê de Sousa, […] Jacob van Etten. 2022.**
  Rank-based data synthesis of common bean on-farm trials across four Central American countries.
  Crop Science. https://doi.org/10.1002/csc2.20817

  This article provides an approach to combine data from different tricot trials to obtain insights for regional analysis using on-farm data.

- **Oladeji Emmanuel Alamu, Béla Teeken, et al. 2023. Establishing the linkage between eba's instrumental and sensory descriptive profiles and their correlation with consumer preferences: implications for cassava breeding.**
  Journal of the Science of Food and Agriculture. https://doi.org/10.1002/jsfa.12518

  This article links tricot data to laboratory instrumental data to understand consumers' preferences with implications for breeding programs.

- **Kauê de Sousa, David Brown, Jonathan Steinke, Jacob van Etten.**

2023. gosset: An R package for analysis and synthesis of ranking data in agricultural experimentation. SoftwareX. https://doi.org/10.1016/j.softx.2023.101402

This paper introduces the gosset package used on ClimMob. It demonstrates the package functionality using the case study of a decentralized on-farm trial of common bean (Phaseolus vulgaris L.) varieties in Nicaragua.

- **Pieter Rutsaert, Jason Donovan, Harriet Mawia, Kauê de Sousa, Jacob van Etten. 2023. Future market segments for hybrid maize in East Africa.** Market Intelligence Brief Series 2. Montpellier: CGIAR. https://hdl.handle.net/10883/22467

  This paper introduces a novel approach to assess market demands in seed systems using decentralized testing under the tricot approach.

- **Carlos Quirós, Kauê de Sousa, […] Jacob van Etten. 2023. ClimMob: Software to Support Experimental Citizen Science in Agriculture.** SSRN. http://dx.doi.org/10.2139/ssrn.4463406

  This paper introduces the ClimMob software.

- **Jacob van Etten, Kauê de Sousa, […] Hale Ann Tufan. 2023. Data-driven approaches can harness crop diversity to address heterogeneous needs for breeding products.** PNAS 120 (14). https://doi.org/10.1073/pnas.2205771120

  This paper brings a perspective on opportunities and challenges of data-driven approaches for crop diversity management (genebanks and breeding) in the context of agricultural research for sustainable development in the Global South.

- **Rachel C. Voss, Jill E. Cairns, Michael Olsen,Francisca Ndinda Muteti, […] Vincent Woyengo 4. 2023. Innovative approaches to integrating gender into conventional maize breeding : lessons from the Seed Production Technology for Africa project.** Frontiers in Sociology. https://doi.org/10.3389/fsoc.2023.1254595

  This case study showed how the maize-focused SPTA project integrated gender into breeding through breeder–social scientist collaboration, culminating in decentralized on-farm variety trials using tricot.

- **Kauê de Sousa, Jacob van Etten, Rhys Manners, Erna Abidin, […] Mainassara Zaman-Allah. 2024.**
  The tricot approach: an agile framework for decentralized on-farm testing supported by citizen science. A retrospective. Agronomy for Sustainable Development. https://doi.org/10.1007/s13593-023-00937-1

  This paper reviews the development, validation, and large-scale evolution of the decentralized, citizen-science-based tricot method—highlighting its low cost, data validity and reliability at scale, and its ability to capture socio-economic and climatic heterogeneity to enhance crop variety decision-making in smallholder agriculture.

- **Ann Ritah Nanyonjo, Stephen Angudubo, Paula Iragaba, […] Robert Sezi Kawuki. 2024. On-farm evaluation of cassava clones using the triadic comparison of technology options approach.** Crop Science, 64, 2679–2697. https://doi.org/10.1002/csc2.21293

  This paper found that rainfall patterns shaped cassava clone performance more than sociocultural factors, identifying several elite clones as strong candidates for release.

- **Martina Occelli, Jorge Sellare, Kauê de Sousa, […] Jacob van Etten.**

2024. Group-based and citizen science on-farm variety selection approaches for bean growers in Central America. Agricultural Economics. https://doi.org/10.1111/agec.12819

This paper found that both tricot-PVS and traditional group-PVS participation equally promoted on-farm varietal diversification among Central American bean growers, but group-PVS more effectively enhanced household food security—likely due to its positive impact on agronomic management.

- **Rachel Voss, Kauê de Sousa, Sognigbé N'Danikou, […] Maarten van Zonneveld. 2025. Citizen science informs demand-driven breeding of opportunity crops.** Plants, People, Planet, 1–14. https://doi.org/10.1002/ppp3.70035

  This paper used tricot trials with 2,063 farmers in West and East Africa, showing that farmer preferences for leafy amaranth varied by traits and demographics, guiding demand-driven breeding.

- **K. Sharma, E. Atieno, J. Mugo, K. de Sousa, J. van Etten, S. Nyawade. 2025. Understanding farmer preferences through citizen science: Insights on potato varieties in Nigeria.** Journal of Agriculture and Food Research 23. https://doi.org/10.1016/j.jafr.2025.102135

  This paper used tricot trials in Nigeria to reveal farmers preferred three CIP potato genotypes for yield, resistance, and storability, underscoring the value of participatory, data-driven breeding.

- **Mabel Nabateregga, Hugo Dorado-Betancourt, Svein Solberg, […] Kauê de Sousa. 2025. Accuracy of farmer-generated yield estimations of common bean in decentralised on-farm trials in sub–Saharan Africa.**

European Journal of Agronomy. https://doi.org/10.1016/j.eja.2025.127730

This paper showed that farmer-generated yield estimates in Tanzanian tricot bean trials closely matched technician and researcher measurements, proving them accurate, scalable, and cost-effective for breeding decisions.

- **Geon Kang, Kauê de Sousa, Rhys Manners, Jacob van Etten, […] Stefanie Griebel. 2025.**
  Integrating environmental, socio-economic, and biological data in a farmer-led potato trial for enhanced varietal assessment in Rwanda. Experimental Agriculture. 61(18), pp 1-26. https://doi.org/10.1017/S0014479725100100

  This paper found through tricot trials in Rwanda that farmers favored older potato varieties, with yield and marketability—shaped by temperature and income—driving adoption more than on-station performance.

- **Jason Donovan, Pieter Rutsaert, Harriet Mawia, Kauê de Sousa, Jacob van Etten. 2025.**
  Farmers' preferences for the next generation of maize hybrids: application of product concept testing in Kenya and Uganda.
  Experimental Agriculture. https://doi.org/10.1017/S001447972500002X

  This paper applied video-based product concept testing with 2,400 farmers in Kenya and Uganda, finding that "Resilience," "Drought escape," and "Intercropping" seed concepts were most preferred, highlighting opportunities for future maize breeding beyond yield-focused traits.

- **Jill E. Cairns, Mainassara Zaman-Allah, Federic Baudron, Rachel C. Voss, […] Boddupalli M. Prasanna. 2025. Know your men and women farmers: Ensuring host farmers in participatory trials**

represent heterogeneity within the target environment. Plants, People, Planet. https://doi.org/10.1002/ppp3.70070

This paper evaluated whether women and men host farmers recruited for participatory breeding on-farm trials in Zimbabwe were representative of the wider smallholder population, and pilots a comprehensive farm-typology method to better capture heterogeneity when selecting future trial hosts.

Training videos

All videos about ClimMob and tricot are on the ClimMob YouTube channel: https://www.youtube.com/channel/UCmqo4KCZwX8R-H4SNkXfuSA/playlists

📌 Introduction to tricot

General introduction to tricot as an on-farm testing approach, explaining the rationale and underlying concepts.

Watch playlist →

🖥️ ClimMob software

Step-by-step videos on how to set up an experiment on ClimMob.

Watch playlist →

📊 Data analysis with R

Advanced analyses using R packages complementary to ClimMob's trial-level analysis.

Watch playlist →

Costing Templates

Standardized costing templates have been developed to estimate and compare the costs of tricot trials across crops, geographies, and scales.

📄 Guidelines for the Costing Templates

🌾 Costing Template for Grain Crops

🍌 Costing Template for Roots Tubers and Banana (RTB)

Standard Operating Procedures (SOPs)

Introduction to SOPs | 🥬 Amaranth | 🥜 Bambara groundnut | Cowpea | 🌾 Finger millet | 🥬 Jute mallow | 🥗 Leafy vegetables | 🌽 Maize | 🌾 Pearl millet | 🎃 Pumpkin | 🌿 Sesame | 🍠 Sweet potato

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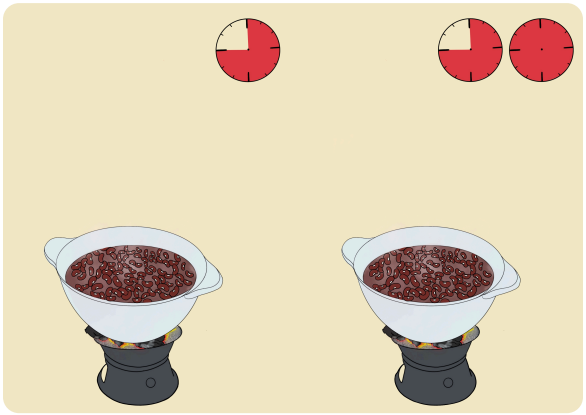
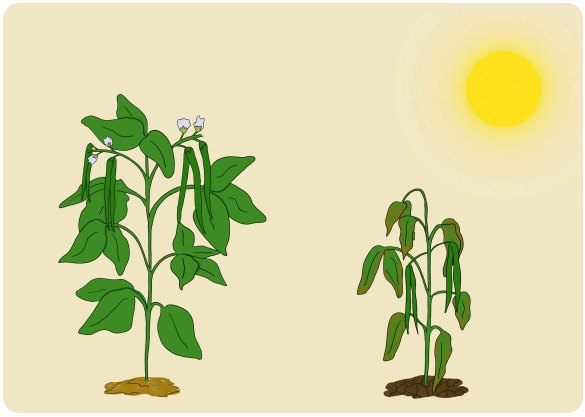
Supporting Material

The following downloadable images illustrate traits, symptoms, and conditions commonly used in tricot trials.

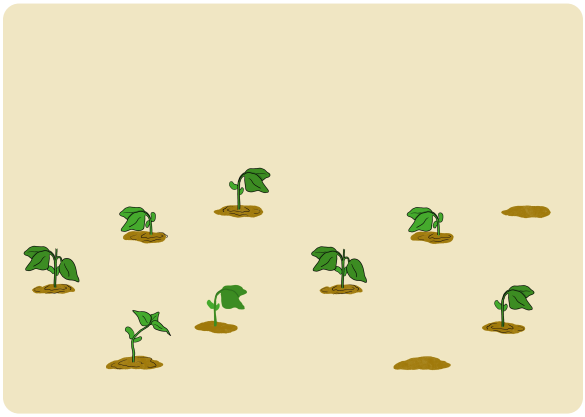
Beans



Bean cooking time



Bean drought tolerance



Bean germination



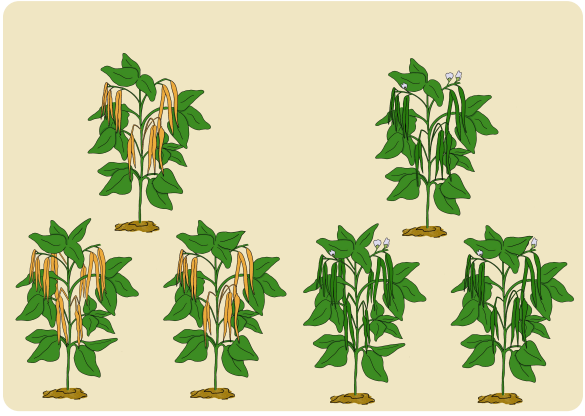
Bean grain yield



Bean marketability (bills)



Bean marketability (coins)



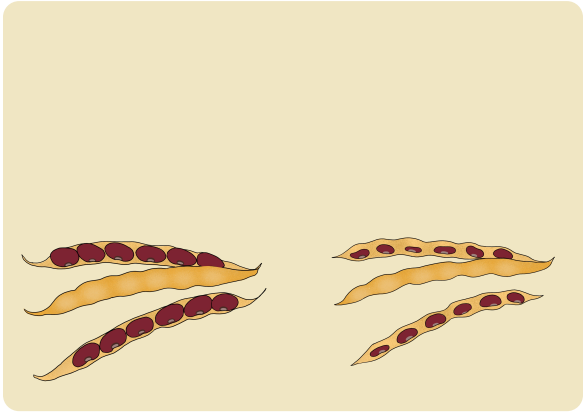
Bean maturity



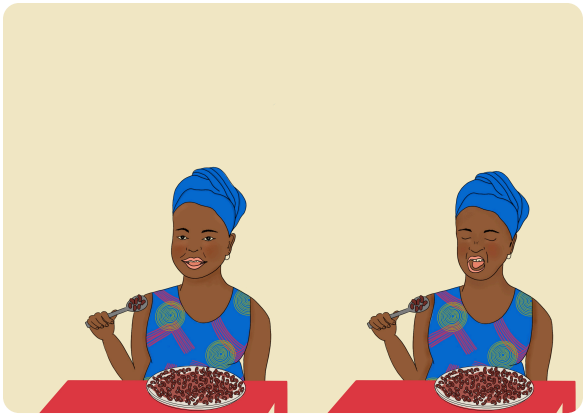
Bean pest resistance



Bean plant survival



Bean seed size



Bean taste

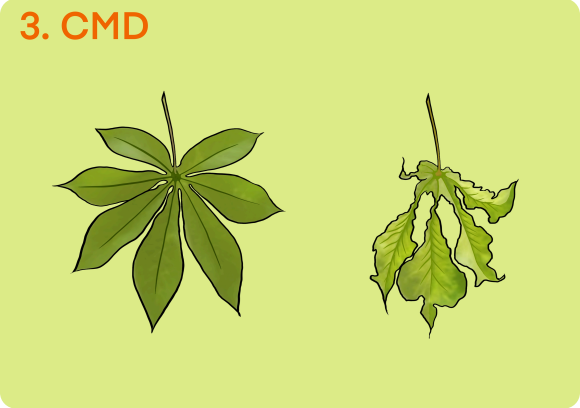


Bean vigor

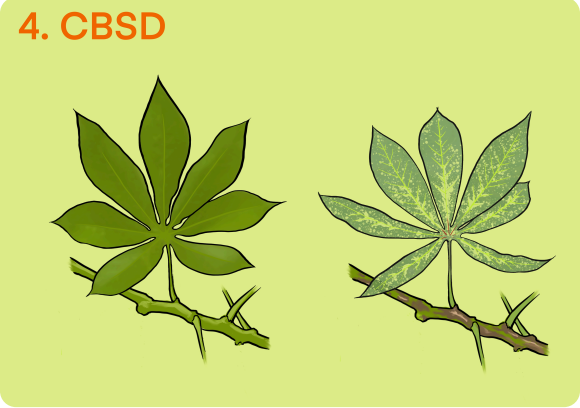
Cassava



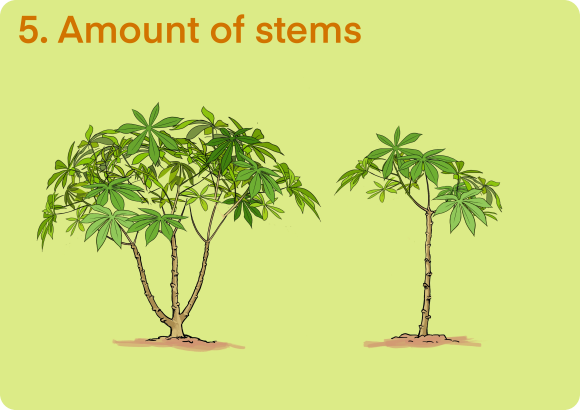
Cassava establishment



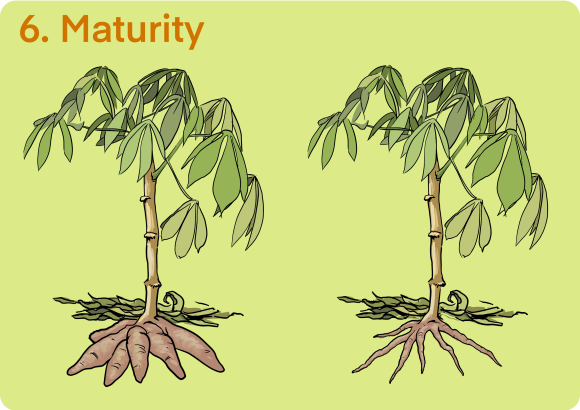
Cassava CMD



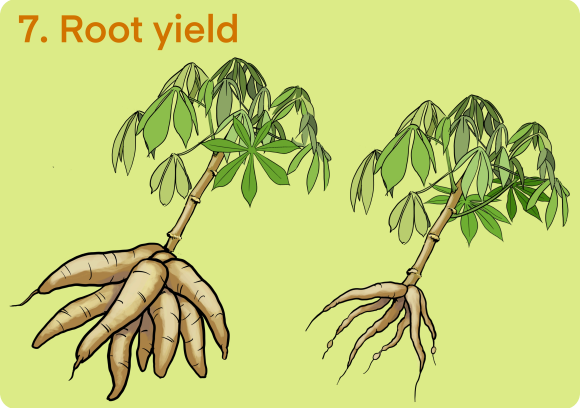
Cassava CBSD



Cassava amount of stems



Cassava maturity



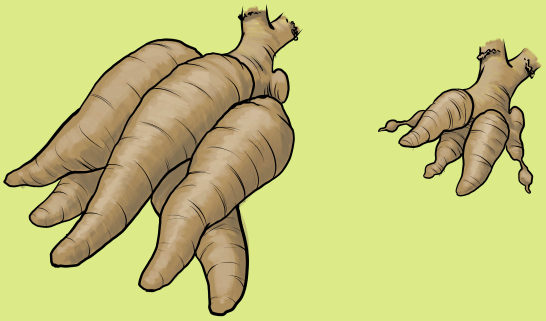
Cassava root yield

8. Root shape



Cassava root shape

9. Root size

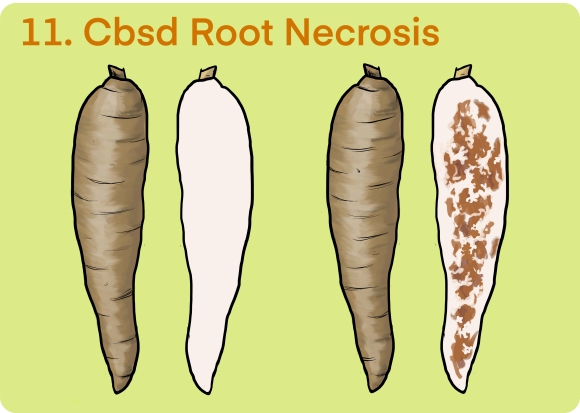


Cassava root size

10. Flesh colour



Cassava flesh colour



Cassava CBSD root necrosis

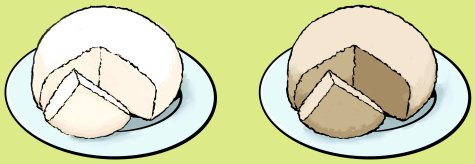


Cassava taste



Cassava flour yield

14. Ugali Colour



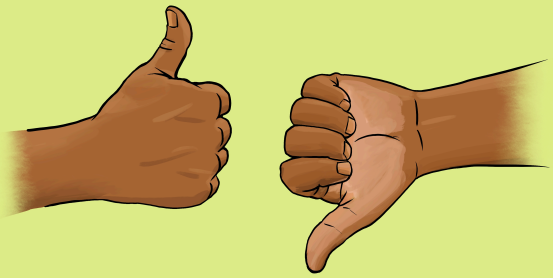
Cassava Ugali colour

15. Ugali Taste



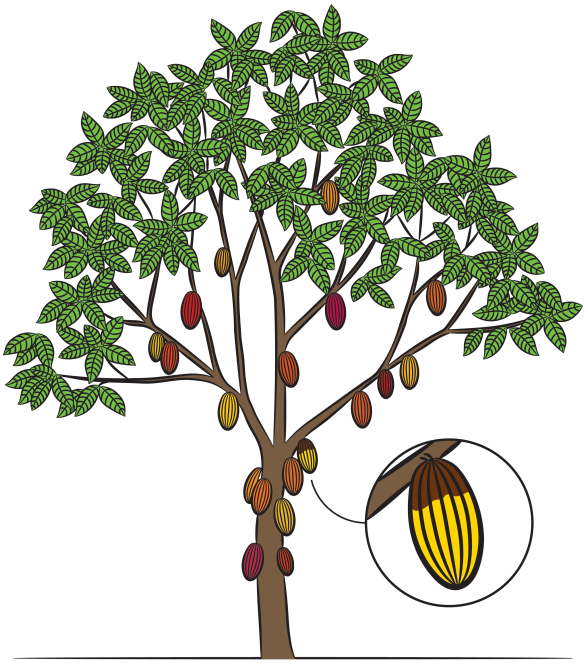
Cassava Ugali taste

16. Overall Acceptance

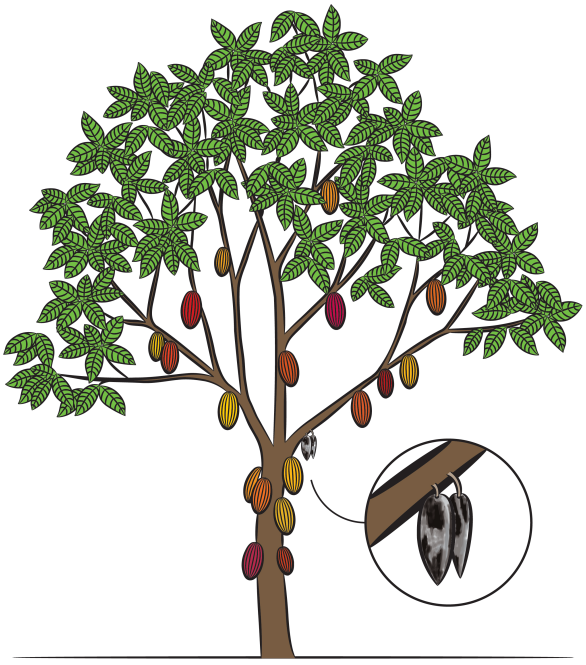


Cassava overall acceptance

Cocoa



Cocoa phytophthora



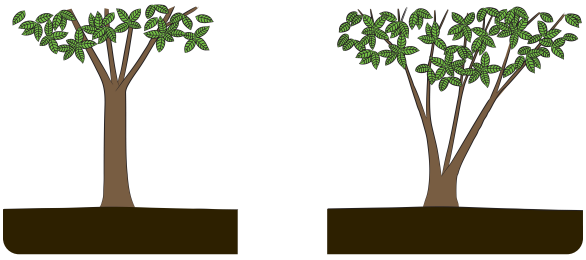
Cocoa cherelle



Cocoa diameter



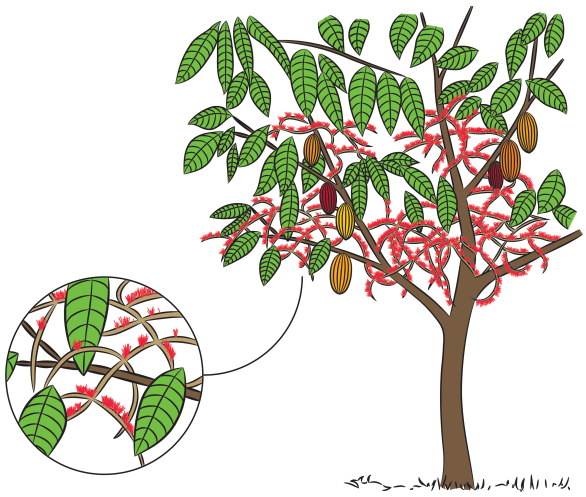
Cocoa height



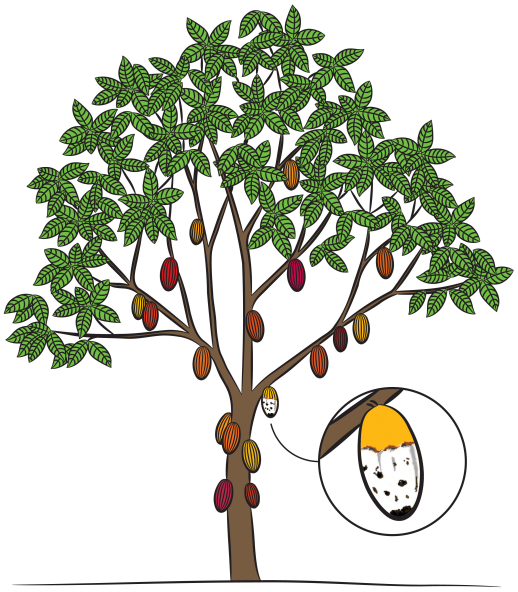
Cocoa jorquette



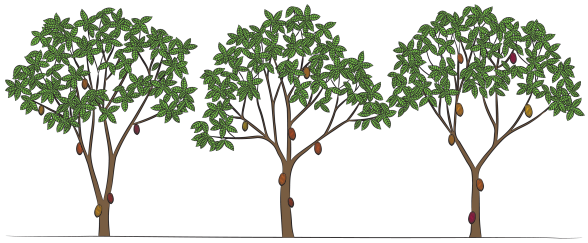
Cocoa leaf

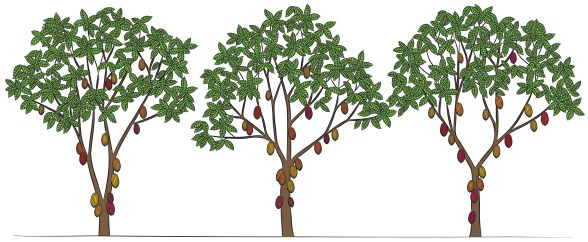


Cocoa mistletoes

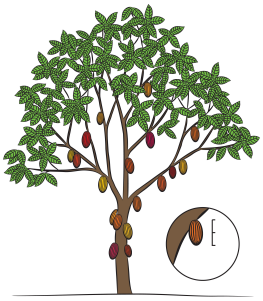
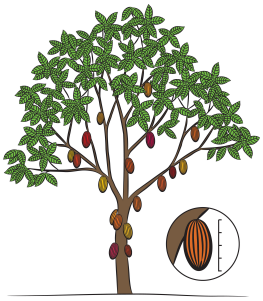


Cocoa monilia





Cocoa number

Cocoa size




Cocoa yield

Cowpea



Cowpea drought



Cowpea germination



Cowpea grain yield



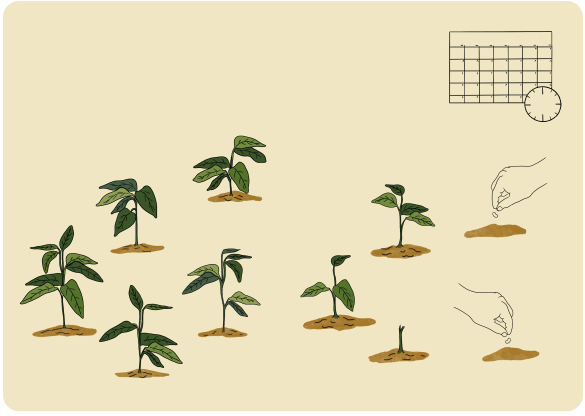
Cowpea maturity



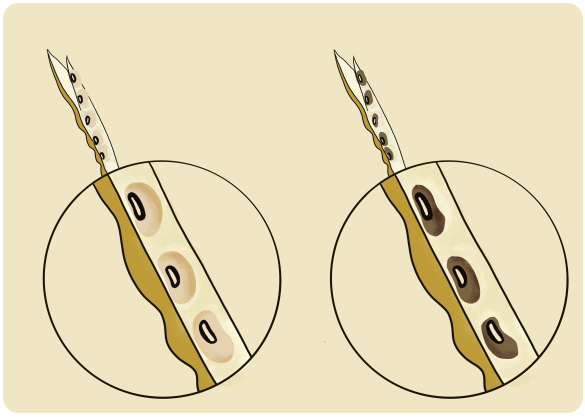
Cowpea pest resistance



Cowpea plant survival



Cowpea replanting



Cowpea seed color



Cowpea seed size

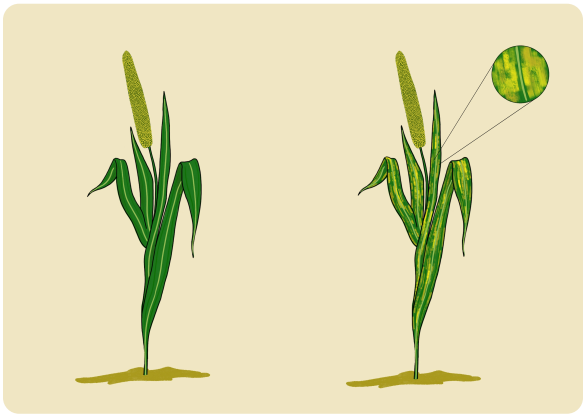


Cowpea striga

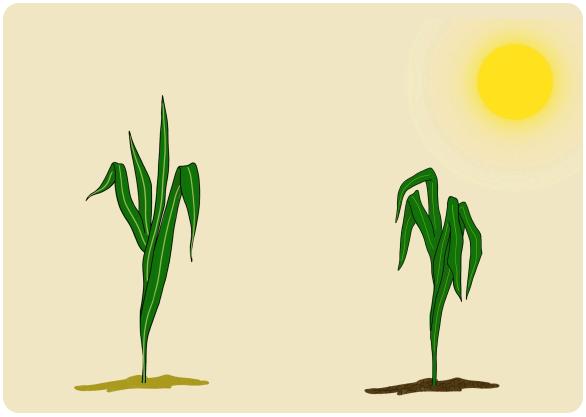


Cowpea vigor

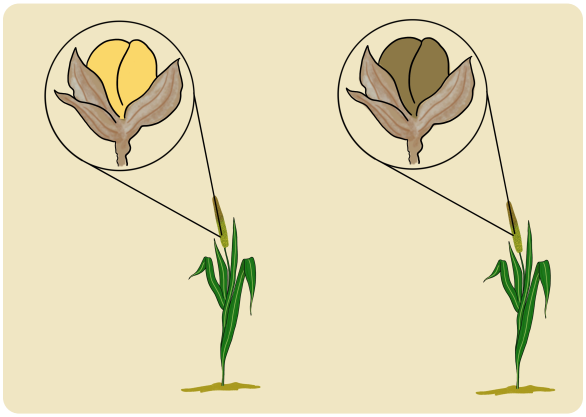
Millet



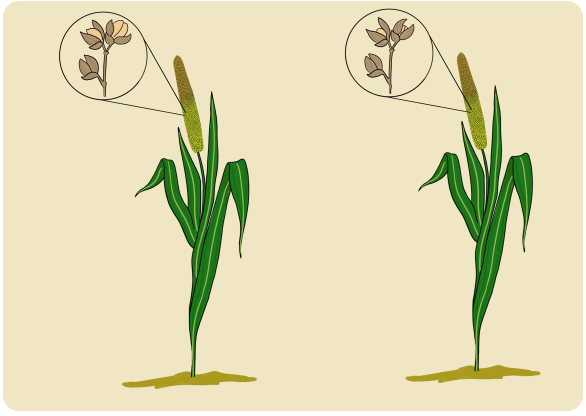
Millet downy mildew resistance



Millet drought resistance



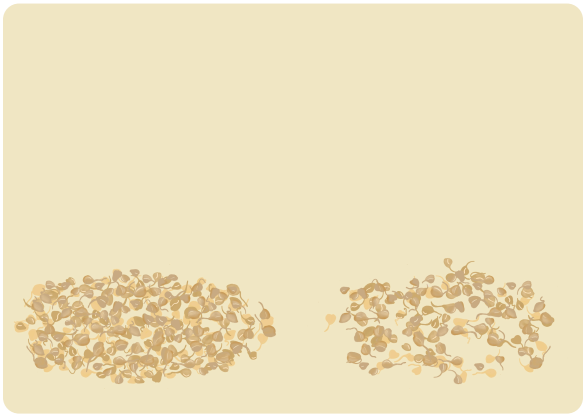
Millet grain color



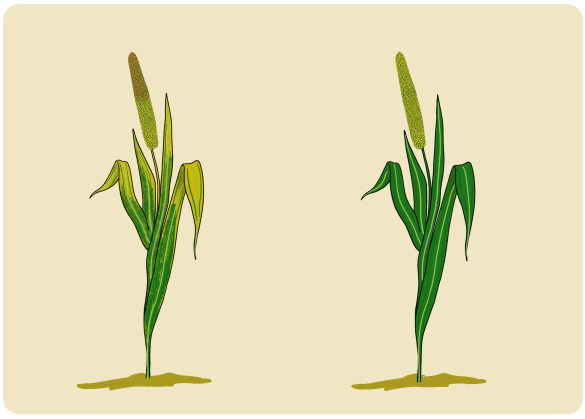
Millet grain size



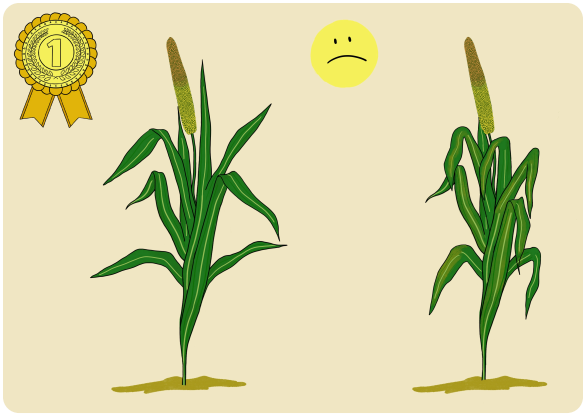
Millet grain yield



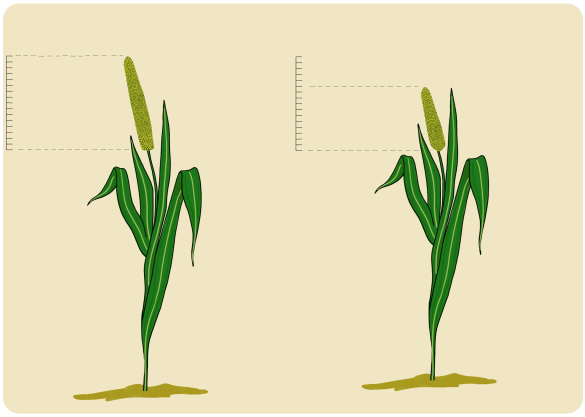
Millet malting quality



Millet maturity



Millet overall



Millet panicle length



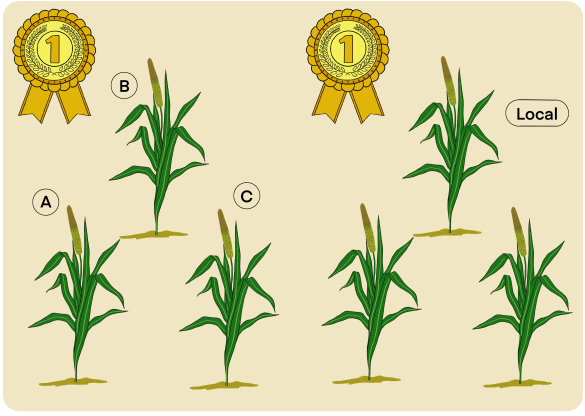
Millet stover yield



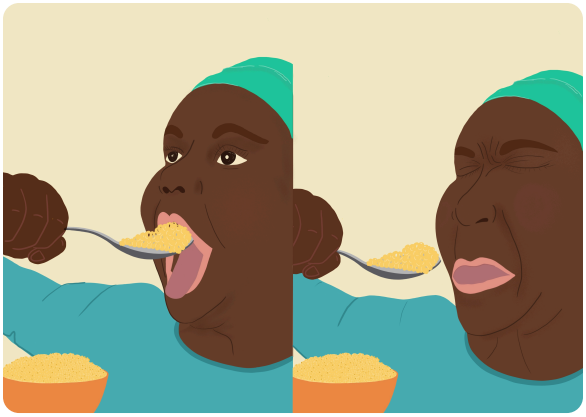
Millet disease



Millet marketability



Millet overall vs local



Millet taste



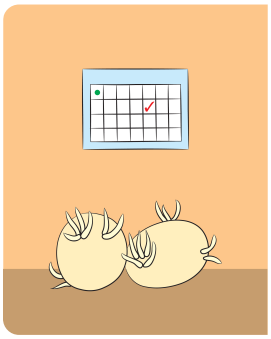
Millet threshability

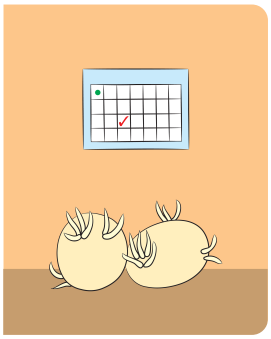
Potato





Potato disease



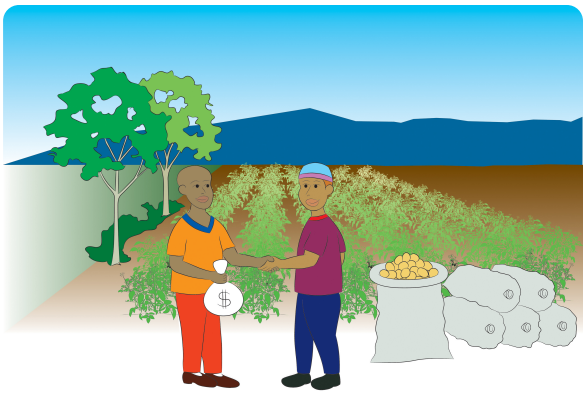


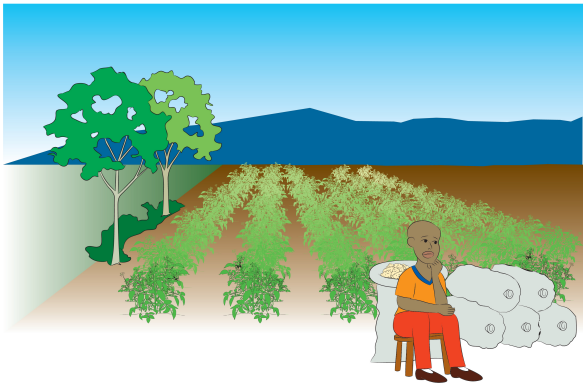
Potato dormancy



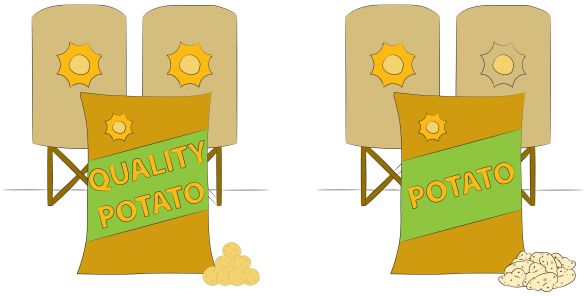


Potato early

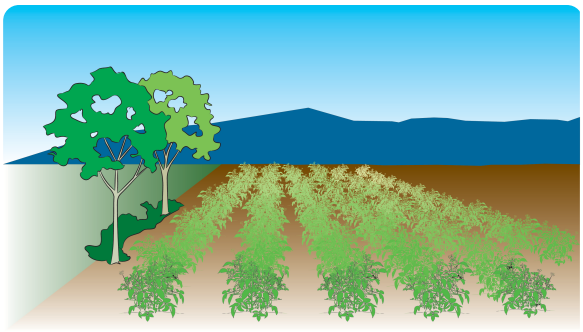


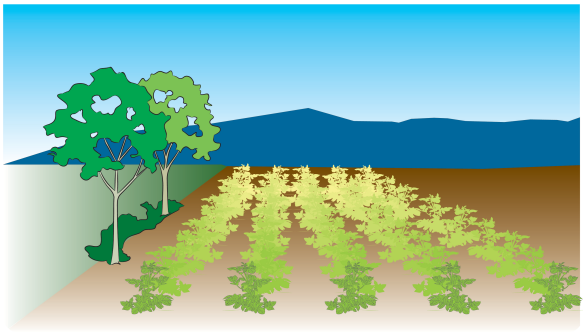


Potato market harvest



Potato market storage





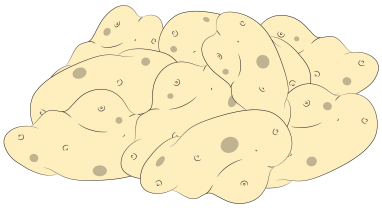
Potato maturity



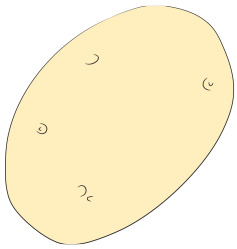


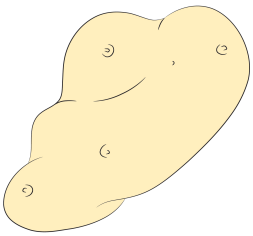
Potato pest



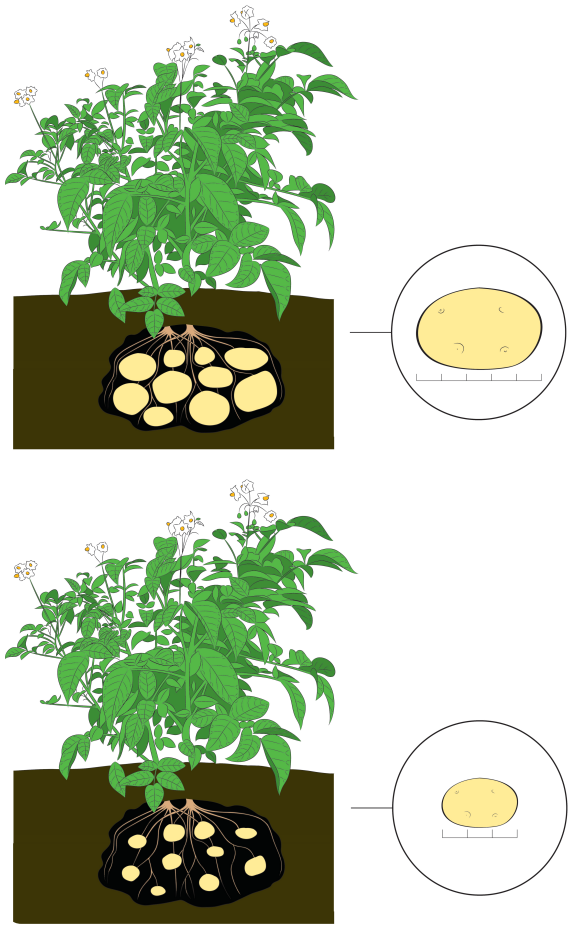


Potato quality

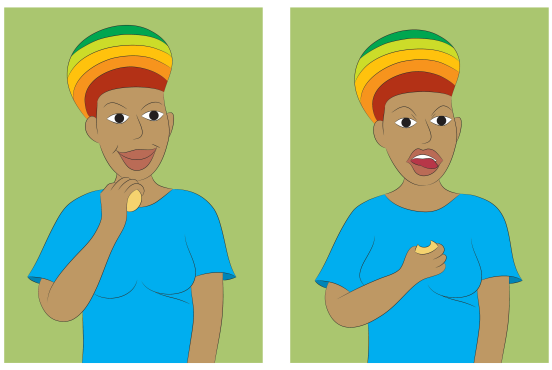




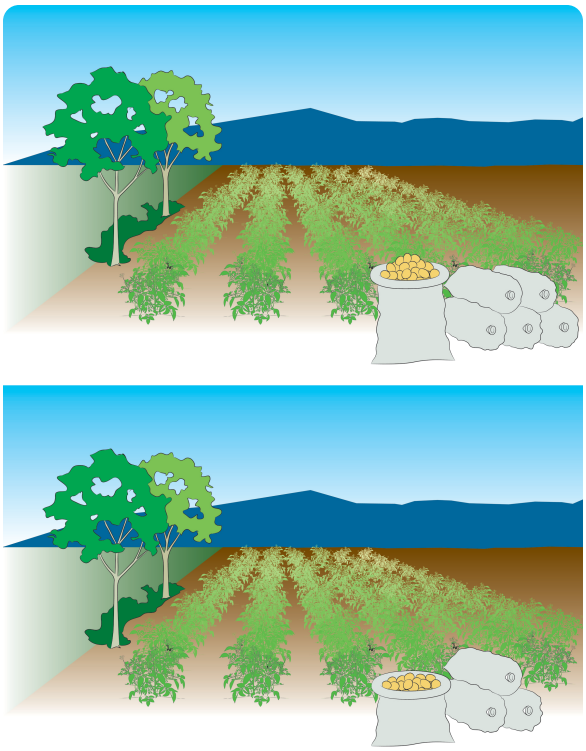
Potato shape



Potato size

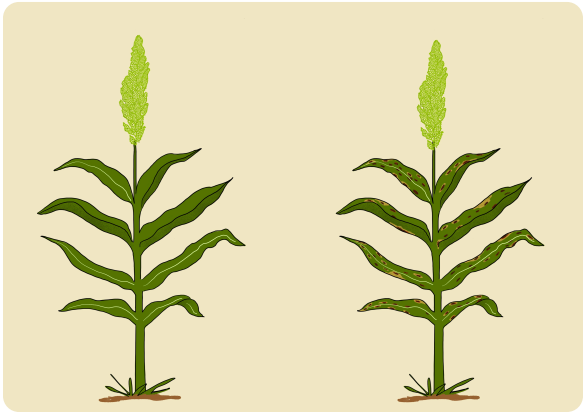


Potato taste



Potato yield

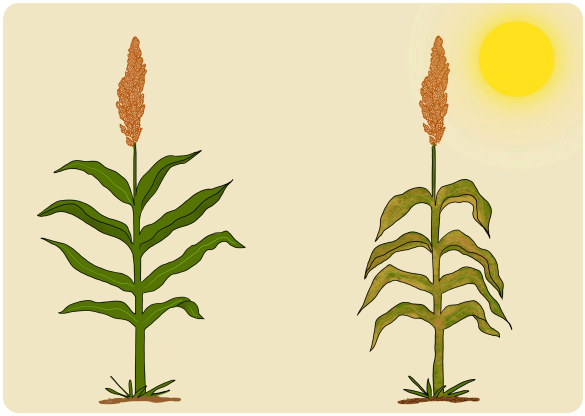
Sorghum



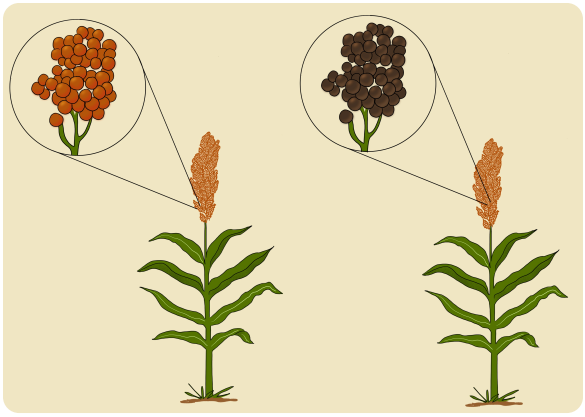
Sorghum antracnosis resistance



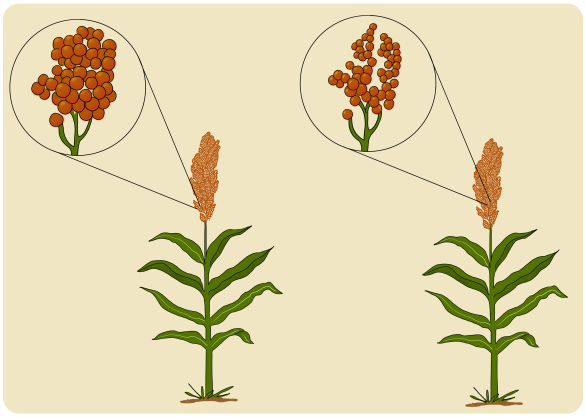
Sorghum disease tolerance



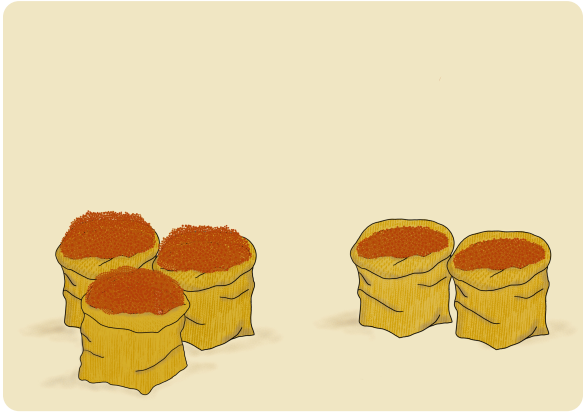
Sorghum drought tolerance



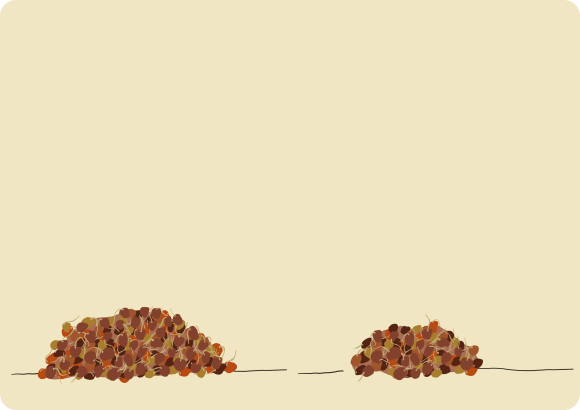
Sorghum grain color



Sorghum grain size



Sorghum grain yield



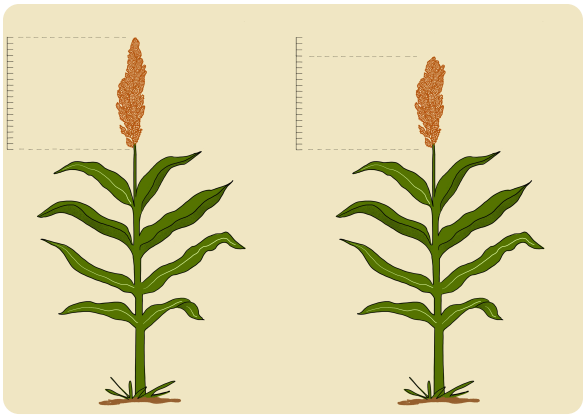
Sorghum malting quality



Sorghum marketability



Sorghum maturity



Sorghum panicle length

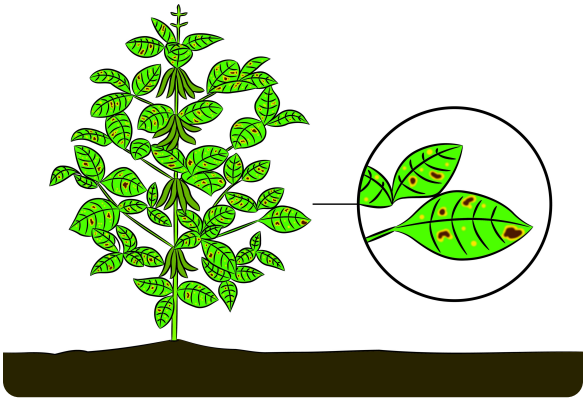


Sorghum stover yield

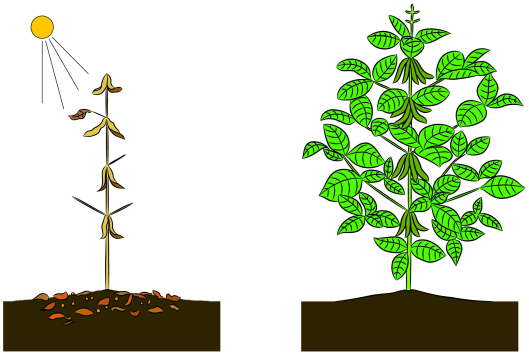


Sorghum striga

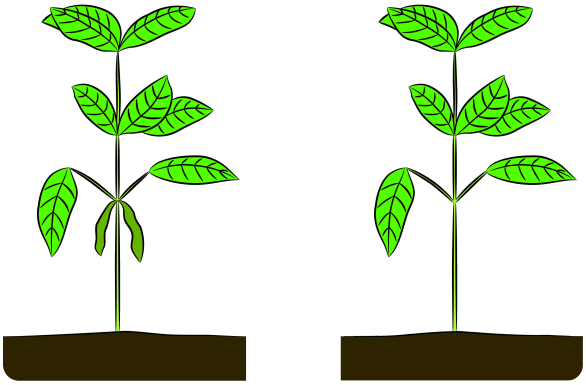
Soybean



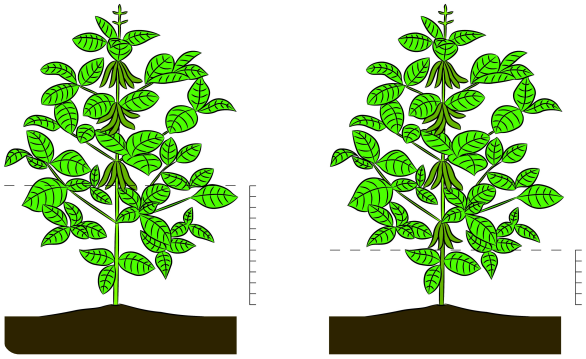
Soybean disease



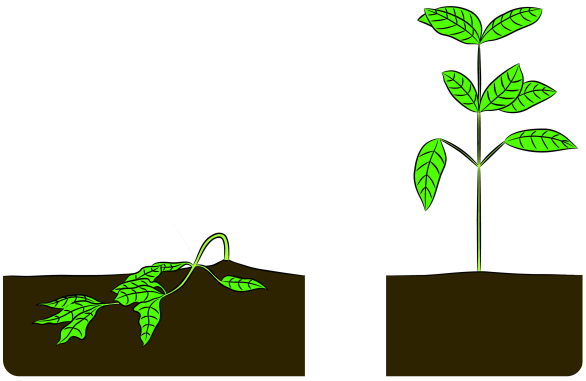
Soybean drought



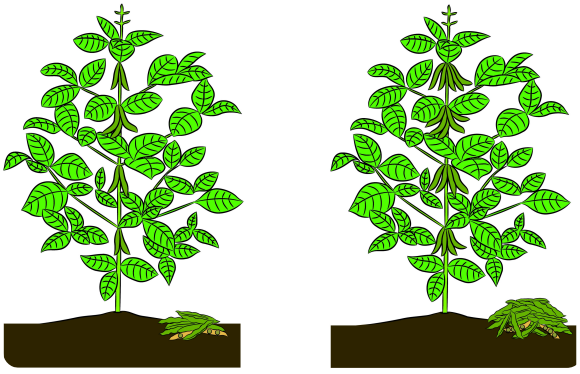
Soybean early



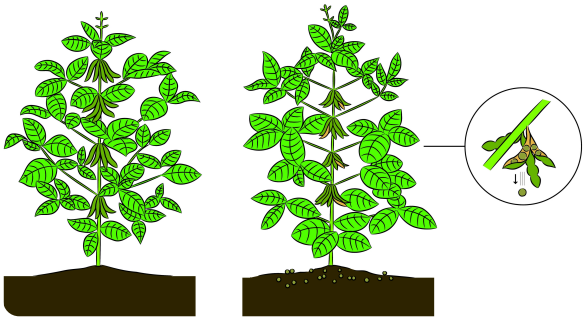
Soybean height



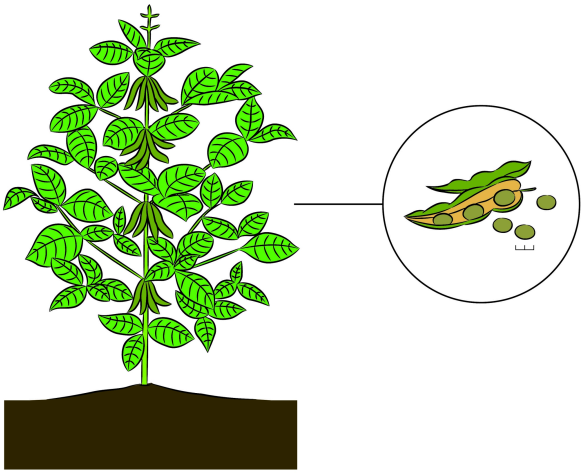
Soybean lodging

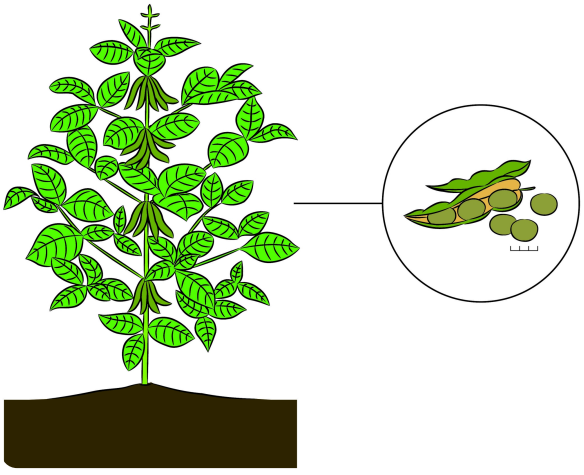


Soybean pods per plant

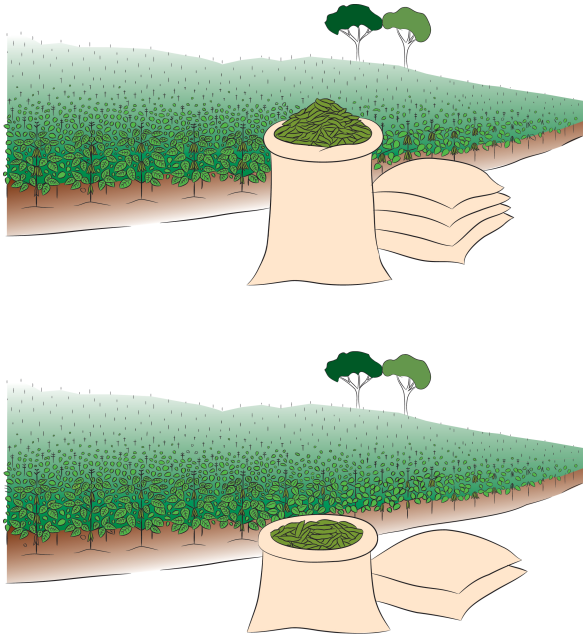


Soybean shatter





Soybean size



Soybean yield

Tricot guidance for farmers

This sheet can be distributed to participating farmers to explain the tricot methodology.

📄 Tricot guidance sheet for farmers (English)

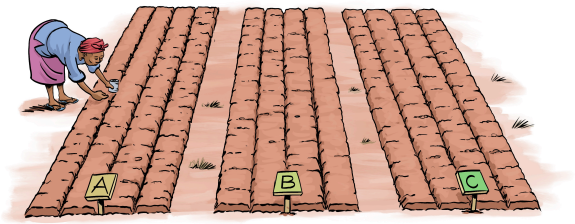
Tricot guidance images



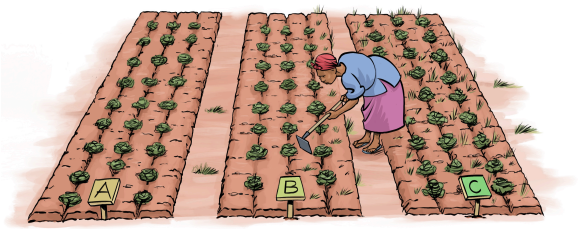
Preparation



Meeting



Planting



Management



Observation



Communication



Results

Spousal Information Letter

The Spousal Information Letter is used to inform and introduce spouses of

participating farmers to the tricot project, fostering a mutual understanding of its objectives and highlighting how it encourages men’s support of women’s participation. This helps effectively reach and access women participants in dual-adult households, avoid unintended household-level consequences and enhance data collection. Prepared by Emily Amondo.

📄 Spousal Information Guidelines for farmers (English)

📄 Spousal Information Letter (English)

Farmer Feedback Package

Introduction

The Farmer Feedback Package contains documents designed to support the feedback of tricot trial results back to the participants. It includes the minimum elements needed to deliver useful and clear information about farmer participation and trial results.

Why farmer feedback matters

Providing feedback to farmers is essential because they are active partners in the tricot process. As citizen scientists, they deserve to know the results of the trials in which they participated.

What the Farmer Feedback Package contains the following documents:

- Feedback workshop manual: A document that explains how to carry out a feedback workshop, including the activities to be conducted and the resources needed.

Feedback sheet documents:

- Feedback sheet manual: A document that explains how to create the feedback sheet.
- Farmer feedback sheet data frame: An Excel file structured with the required information to populate the feedback sheet.
- Farmer feedback sheet template: A Powerpoint template to create the farmer feedback sheet.
- Icons for the feedback sheet: These icons are used to created the feedback sheet.

Farmer certificate documents:

- Certificate manual: A document that explains how to create a certificate of participation.
- Certificate data frame: An Excel file structured with the required information to populate the certificate.
- Certificate template: A PowerPoint file containing the basic certificate design, linked to an Excel dataset.

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1000FARMS Community of Practice

What is the 1000FARMS Community of Practice?

> Rachel Chase

1000FARMS is a project that aims to implement an Africa-wide, digitally supported network for on-farm variety testing using tricot. The intended outcome is that breeding programs and partners can access critical performance data plus direct farmer feedback and use it to make better “what to advance/where to recommend” decisions.

On-farm testing at scale is hard for predictable reasons: logistics, consistency, data quality, staff turnover, varying local realities, and the constant evolution of tools and methods. A Community of Practice helps turn those challenges into shared knowledge. The 1000FARMS Community of Practice is therefore a place to find on-farm testing and tricot resources, connect with the community to share experiences and ask questions to 1000FARMS team members.

Anyone can become a member of the Community of Practice.

What you’ll find inside the Community of Practice website

The site is organized like a modern forum (powered by Discourse), with

categories that map to the real needs of practitioners:

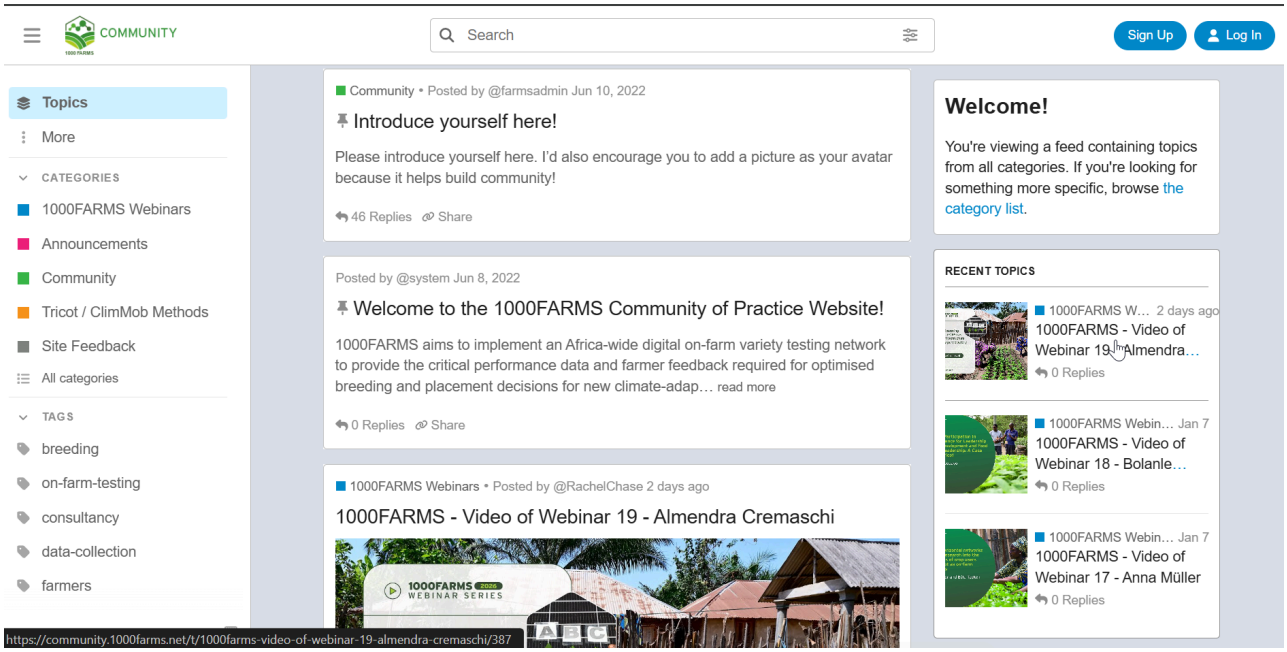
1000FARMS Webinars – A library of webinar recordings. The category description emphasizes that webinars are archived with transcribed Q&A, and sometimes extra context is added—so learning doesn't disappear after the live session ends.

Community – A default home for introductions, cross-topic questions, and connection-building. There's even a dedicated "Introduce yourself" thread that nudges people to add avatars—small touches that help a network feel human.

Announcements – Where updates land: new ClimMob features, training courses, country activities, and other important information meant for everyone.

Tricot / ClimMob Methods – A space for the real nuts-and-bolts: trial methodology discussions, implementation questions, and open exchange on what to do in tricky scenarios.'

The Community of Website is found at https://community.1000farms.net



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Frequently Asked Questions

Tricot FAQs | ClimMob FAQs

Tricot FAQs

What is the incentive for growers to participate?

Through participation in a tricot experiment, growers 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 growers can learn about new options to improve their farming and might discover useful innovation under realistic conditions. Many growers are also motivated by being part of a research project, interacting with researchers and contributing to knowledge generation.

Even when a grower does not immediately identify a suitable option among the three tested technologies, participation can be useful: growers often discuss results with their neighbors, exchange seeds, and subsequently try out options that were successful on other participants' farms.

Do the growers need a smartphone to participate?

No. They note down all 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.

How do the growers record their field observations?

At the beginning of the tricot experiment, growers 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, growers 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.

Should growers 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 growers control conditions, for example, by applying mineral fertilizer, they might end up selecting a variety that will not fare well on a larger scale, without fertilizer.

How should a grower rank the varieties if there are no evident differences?

That’s a tough question. As tricot relies on comparison data, all data must be entered in that format. That means, growers have to decide which variety grows best, which grows worst. They cannot record their observations saying ‘all varieties performed equally well’. We generally advise everybody to just take another look – surely, there is some small difference.

The growers work in different environments. How can their observations be merged?

Growers provide rankings based on what they observe in their fields. Under different environmental conditions, such as different climate, these observations may vary. The ClimMob process allows for geospatial disaggregation of results by registering growers' 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 variety had highest yield in lowlands, while another variety had highest yield in higher altitudes. If the observations did differ significantly between environments, ClimMob will automatically provide location-specific results. You may need to use our R package ClimMobTools for this analysis.

Does every grower compare their three options with a local control?

Every grower receives and compares three technology options, for example three different crop varieties. If you want to compare these new varieties with the local one, you can do that but it's not a must. There are two ways to do so. First, you can include the variety that growers usually grow (their 'local control') to the comparison as an additional question at the end of the experiment (e.g. Does variety A performed better or worse than the local variety).

Secondly, local varieties can also be included in the pool of test varieties. Some growers will then "blindly" receive a local variety as one of their three options for evaluation. At the end of the trial and once the data from all growers is analyzed, every grower will receive an individual evaluation of which variety has performed best under their local conditions. Perhaps in the next

year, they want to grow a different variety, as it outperformed their local variety!

What agricultural technologies can I innovate using tricot?

So far, tricot has mostly been used to evaluate annual crop varieties (e.g. beans, rice, wheat, chickpeas). 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.

Please send us an email if you are thinking about testing another technology, and are unsure about how to proceed. We think the tricot method is powerful, and together with the ClimMob software can easily be applied to a range of agronomic technologies.

I understand that I design the tricot experiment, and participating growers run the trials on their farms. But who are these field agents?

The field agents act as intermediaries between you and the growers.

Let’s say you are designing a tricot experiment that involves 300 growers. All these growers will need to receive initial training; seeds or fertilizer regimes they are about to compare; and in general a person to contact if they have any questions. So the field agents take care of all these tasks, each field agent might care for a group of 10 to 20 growers. Often, they might themselves be a local grower who knows the area and other growers well.

You as administrator of the tricot experiment could also be a field agent.

How long does it take to run a tricot experiment?

The duration of a tricot experiment depends on the technology you want to test, and on how many cycles you run. For example, if you test different varieties of annual crops, first results can be available after just one cropping season. You can use these results to narrow down the number of varieties for testing in the following season, adjust your tricot experiment and so improve your selection over time.

You should allow enough time before and after the tricot experiment for organizational tasks, to recruit and train field agents and growers, and afterwards to communicate the results of the experiment to the growers.

How many field agents and farmers are required to run a successful tricot experiment?

This depends on the number of technology options that you want to test. And also on the resources you have available. However, the ClimMob software will help you plan all those steps, and tailor your tricot experiment to your needs and resources. You can calculate the number of farmers required by using the sample size calculator.

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 get evaluated by growers, on their own fields, and for traits that are of direct interest to them. The unique idea behind tricot consists in “crowdsourcing” the data. This makes tricot experiments more flexible, less resource-consuming and easier to scale up to very high numbers of contributors, representing more diverse environments.

For example, comparing a PVS and a tricot experiment on common bean selection in Central America (Occelli et al., 2024) showed us that the tricot approach was about a quarter cheaper compared to the PVS experiment. Tricot was shown to reach nearly twice as many farmers with the same resources and was easier to scale across larger geographic areas. Data management and publication was also better with tricot due to more complete and accurate data.

How much does it cost to run a tricot experiment?

There is no one fixed answer, but a tricot experiment can be tailored to the resources you have available. As a starting point, here are some of the items you will need to budget for:

- a computer with internet connection to run the ClimMob software
- enough experimental packages of seeds/fertilizer treatments etc. (the technology you want to compare) to distribute among the growers
- training events for recruiting and training field agents
- training events for recruiting and training growers
- time and cost involved for field agents to go out and collect data from the growers
- possibly smartphones / tablets to collect data (field agents might already have phones, and the ODK Collect app is a compatible Android app)

To help estimate tricot trial costs, we have developed guidelines and templates that can be filled in. Click here to go to the costing templates.

Is there a cost for any of the software that I need for running a tricot experiment (ClimMob, ODK Collect)?

Both ClimMob and ODK Collect are free for CGIAR and NARES plant breeding programs. 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 growers in the field, without the need for internet connectivity. A fee will be charged for private companies.

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

You can include more than three technology options in your tricot experiment.

Every grower will receive a personal trial package which contains only three technology options, but these come out of a larger pool. For example, every grower receives seeds of three different crop varieties. It’s important to know that each grower receives “their” specific three varieties based on a strict randomization scheme. The ClimMob software takes care of organizing which three varieties go to which grower. The grower will plant the three options in 'incomplete blocks' (see definition in glossary)

ClimMob FAQs

Who created ClimMob?

ClimMob and the tricot methodology were initiated by Jacob van Etten, PhD, and developed by a team of researchers and programmers at the Alliance of Bioversity International and CIAT (CGIAR), now led by Kauê de Sousa.

Learn more about the development process through these publications:

- van Etten et al., 2019. First experiences with a novel farmer citizen science approach: Crowdsourcing participatory variety selection through on-farm triadic comparisons of technologies (tricot). Experimental Agriculture, 55(S1). https://doi.org/10.1017/S0014479716000739.

- van Etten et al., 2022. Redesigning farmer-participatory on-farm trials from a citizen science perspective: The tricot experience. In: Véronique Bellon Maurel, Nicolas Tremblay, Simon Cook, Myrtille Lacoste, James Taylor, et al.. Proceedings of the 1st International Conference on Farmer-Centric On-Farm Experimentation (OFE2021): Digital tools for a scalable transformative pathway. 1st International Conference Farmer-Centric On-Farm Experimentation (OFE2021), Oct 2021, Montpellier, France. https://hdl.handle.net/10568/121924

Do I need to be a programmer to use ClimMob?

No, ClimMob is designed to be user-friendly and accessible, even for users without technical backgrounds.

Can ClimMob be used without internet access in the field?

Yes, data can be collected offline with ODK Collect and uploaded once the device has internet access.

How is ClimMob different from other agricultural data platforms?

ClimMob is designed specifically for participatory testing using the tricot method. It is open-source, modular, and tailored to multi-actor agricultural innovation.

What crops or technologies can I test with ClimMob?

Any agricultural technology that can be compared in sets of three—e.g., crop varieties, fertilizers, planting methods—can be tested with ClimMob.

Is ClimMob free to use?

Yes, ClimMob is open-source and free for anyone to use.

Can I merge data from two different tricot projects?

You can merge the data if both projects are testing the same technology and you have at least one technology option (e.g. the same crop variety) in both projects. The merger can be done, for example, in the R package using ClimMob R Tools and your API key. You find your API key in the ClimMob software, by clicking on your name >>> Profile.

Does the ODK Collect app work on iOS smartphones?

As of today, there is no ODK Collect app for iOS. You need an Android phone to run ODK Collect.

Do field agents need constant internet connection while collecting trial data with ODK Collect?

No. The field agents can input the data they collect from the observers even while they are not connected to the internet. Field agents can later upload the data to ClimMob, at the first opportunity to connect to the internet again.

References

Occelli, M., Sellare, J., Sousa, K. D., Dell'Acqua, M., Mercado, L., Paredes, S., Robalino, J., Rosas, J. C., & van Etten, J. (2024). Group-based and citizen science on-farm variety selection approaches for bean growers in Central America. *Agricultural Economics*, *55*(2), 270–295. https://doi.org/10.1111/

agec.12819

Version: current

📄 Download the Case studies chapter as a PDF

African crop case studies

> Happy Daudi, Elysé Tuyishime, Edith Kadege, Jamlick Mwathi, Reuban Ssali, Richard Oteng-Frimpong, Patrick Ongom, Mohammed Hassena

The links below are interviews with breeders and trial managers that have employed the tricot approach for crop evaluations.

🥜 Groundnut (Kenya & Tanzania) 🌽 Maize (Rwanda)
🫘 Common bean (Tanzania) 🌽 Maize (Kenya) 🍠 Sweet potato (Uganda)
🥜 Groundnut (Ghana) 🫘 Cowpea (Nigeria) 🌱 Seed systems (Ethiopia)

Putting farmers at the center: Testing groundnut varieties with the tricot approach in Kenya and Tanzania - Happy Daudi



Associated paper: Daudi, H., A. M.Bujiku, R.Oteng-Frimpong, et al. 2026. Analysis of Genotype-by-Environment Interaction, Farmers' Preferences, and Gender Response in Groundnut Breeding in Tanzania Using Triadic Comparison of Technologies. Food and Energy Security15, no. 2: e70228. https://doi.org/10.1002/fes3.70228.

As a groundnut breeder at CIMMYT, Dr. Happy Daudi was looking for a better way to test new varieties on farmers' fields—one that would give her robust data, real farmer feedback, and still be affordable. That's when she turned to the tricot approach.

"Tricot gives us quality and robust data and is more cost effective than other methods for on-farm testing," Happy explains. "Tricot also involves more farmers for better results."

By design, tricot spreads trials across many farmers' fields, rather than concentrating them in a few locations. This opens the door to more diverse conditions, more perspectives, and ultimately, better decisions.

What tricot taught them

Happy and her team quickly learned that farmers' willingness to participate is one of the most important ingredients for success. "When you come with a new and effective approach, they are more willing to participate," she says.But involving many farmers also brings practical challenges. One major limitation is seed availability. To run tricot trials at scale, you need enough seed to supply all participating farmers. "If you want to involve many farmers, you need a lot of seed, and that can be a limitation, especially for crops with low multiplication rates."

There were also language and cost issues. The ClimMob software platform used with tricot is only available in English, meaning that the agricultural extension

officers had to work with farmers to translate it in local languages. Even so, the benefits to relationships with farmers are clear.“Tricot helps improve our engagement with the network of farmers and extension officers that participate,” she notes. Over time, that network becomes a strong foundation for future research and testing.

From farmer feedback to varietal release

One of the biggest impacts of tricot in Happy’s work has been on variety evaluation and release. “Tricot data helped us write a proposal for a varietal release,” she says. “Normally the farmer’s perspective is not well represented, but by collecting feedback from farmers via tricot we were able to develop a good product profile for groundnut.”

Instead of relying mainly on data from research stations, the team can now include what farmers actually prefer and experience in their own fields. That makes release proposals more relevant and more likely to lead to varieties that farmers will truly adopt.

New insights: Genetic gain and market segments

Tricot has also opened the door to new kinds of analysis.“With tricot, we can estimate on-farm genetic gain, which is important for research and breeding, and before tricot we could only do this with on-station data which was very different.” Testing varieties under real farm conditions helps reveal how they perform in the complexity of everyday agriculture—not just under controlled station environments.

Tricot also helps breeders understand market segments more clearly.“Tricot helped us group varieties according to market segment; for example, in Tanzania, farmers’ selection traits are different from zone to zone.” That means breeders can better match varieties to specific regions and farmer preferences, rather than assuming that one variety fits all.

Advice for others who want to use tricot

If you’re considering tricot, Happy has some practical advice:

- Plan and organize carefully.“People must organize and plan well,” she says.
- Don’t be intimidated by the software.“Don’t worry about the software – it is easy to learn it.”
- Make sure you have enough seed.You need to know how many farmers you can realistically involve with the seed you have. “You need to multiply enough seeds for the trials so it is important to see how many farmers you can give seeds to with what you have.”
- Align trials with the growing season.Many farmers do not have irrigation, so timing is critical. “Keep in mind the trial needs to be according to the growing season as many farmers do not have irrigation.”

Is tricot the right tool for variety evaluation?

For breeders, Happy’s answer is yes.“It is especially useful for breeders,” she says. “They can get more preference information than other approaches because tricot involves many farmers, who are the ones who would adopt the released varieties.” Tricot doesn’t just help estimate genetic gain—it also supports grouping varieties according to market segment and understanding who each variety is really for.

There are still challenges. Happy points out that the current methodology and software are stronger on qualitative data (like farmers’ rankings) than on quantitative data (like yield), and breeders need both. Improving how quantitative data are handled will make tricot even more powerful.Even so, her experience shows that tricot is a major step toward farmer-centered breeding—where farmers’ voices, preferences, and fields are at the heart of variety testing and release.

From trials to scale: How tricot guides maize variety choices at One Acre Fund - Elysé Tuyishime



For Elysé Tuyishime and his team at One Acre Fund in Rwanda, the goal was clear: identify maize varieties with real potential to scale to farmers. With limited time and many candidate varieties, they needed an approach that could move quickly, involve farmers directly, and still generate reliable insights. They turned to the tricot approach.

Why tricot?

Elysé and his colleagues chose tricot for three main reasons. First, it allowed them to test many varieties in a single season—up to 15 different maize varieties at once. This breadth is crucial when an organization wants to quickly pinpoint which options are worth investing in.

Second, by testing so many varieties at once, tricot helped them identify high-performing varieties faster and move more quickly toward scaling out the best options to farmers.

Third, tricot required less follow-up than other approaches. Compared to more traditional methods, it meant fewer visits to farmers and less time required to complete the trials, a major advantage for a field-based organization working

across many communities.

What they learned from using tricot

As they implemented tricot, Elysé's team uncovered several important lessons. One of the most striking was the value of blind testing. When farmers did not know which variety was which, it reduced bias and sparked more curiosity about the results. Farmers were genuinely interested in seeing which varieties would come out on top.

They also discovered how reliable ranking data can be. The rankings farmers provided highlighted traits that drive real-world preferences—for example, maize grain size, which might be overlooked if the focus stayed only on yield. Farmers themselves appreciated how simple the tricot trials were. Many found the approach easy to follow and, as a result, were willing to participate in more than one tricot trial.

At the same time, the team realized that tricot is better suited to testing crop varieties than farming practices. When they tried to use tricot to test practices, such as different management techniques, the training required for farmers became more complicated, and the approach was less straightforward.

Supporting better decisions

Tricot has directly shaped decision making at One Acre Fund. Elysé notes that the approach has helped breeders refine their variety catalogues, because it highlights the traits that actually drive farmer preferences—again, grain size being a clear example.

Tricot also enabled the team to produce maps showing variety prioritization by zone. These maps indicate which varieties perform best and are most preferred in specific areas, making it much easier to target variety recommendations and support adoption in a more precise, zone-by-zone way.

Finally, tricot helped them filter down their options. Instead of being overwhelmed by many similar-looking varieties, they were able to narrow the list to one to three strong candidates with real potential to scale out to farmers.

Advice for those considering tricot

Elysé recognizes that many people used to traditional approaches don’t immediately trust tricot. Ranking data can look less precise than standard measurements, and some teams are unfamiliar with how to analyze it. His message to them is clear: think of tricot as capturing farmers’ best choices.He points out that ranking data often reveals differences that traditional methods miss, and that farmers are capable of evaluating any trait, no matter how complex, if trials are designed well.

Tricot, he argues, can help breeders:

- Determine which traits are truly worth improving
- See whether new varieties are actually better than existing ones from the farmers’ point of view

In this way, tricot becomes a powerful bridge between breeding decisions and farmer realities.

A tool for evaluation and marketing

Elysé also sees tricot as valuable beyond breeding trials—it is helpful for variety evaluation and marketing. Because it consolidates feedback from many farmers, tricot offers a breadth of perspective that is difficult to achieve with more traditional approaches. It also shows which traits farmers are already aware of and which traits may require more marketing and awareness-raising.

For organizations like One Acre Fund, this insight is essential, not only for choosing which varieties to promote, but also for shaping the messages and

training that accompany them.

Challenges and requirements

Tricot is not without its challenges. Elysé notes that the approach involves a series of sequential steps that cannot be skipped. This structure ensures the quality of the data but can sometimes make implementation feel complicated. In addition, tricot requires a dedicated field-based team to engage with farmers, manage trials, and support data collection.

Despite these demands, his experience in Rwanda shows that tricot can be a highly effective way to find the right maize varieties quickly, understand what farmers truly value, and support smarter, more targeted scaling decisions—all while keeping farmers' voices at the center of the process.

Using tricot to hear farmers' voices in bean breeding - Edith Kadege



Associated paper: Kadege E. et al., (2026). Tanzanian farmers' preferred traits for common bean varieties: breeding insights from the tricot approach. Front. Sustain. Food Syst. 9:1639680. doi:10.3389/fsufs.2025.1639680

When Edith Kadege began her PhD research on common beans in Tanzania, she wanted to go beyond on on-station trials and really understand what farmers value in their bean varieties. Working with the Tanzania Research Institute (TARI), she chose the tricot approach as her main tool.

There were other participatory methods available, such as participatory varietal selection, but tricot offered clear advantages. It is simple for farmers to use and can involve large numbers of farmers across diverse environments. That wide involvement leads to more accurate, more representative assessments. Because tricot is based on ranking a small set of varieties, it can generate meaningful insights from relatively few trials. It also requires less time and effort from farmers, which has translated into higher participation and lower dropout rates in Edith's work. On top of that, it is cost-effective, using fewer resources—time, materials and personnel—than many traditional methods.

Edith also appreciates that tricot reduces bias. In conventional group evaluations, farmers may be influenced by each other's opinions and some traits may be overlooked. With tricot, farmers evaluate varieties in their own fields, leading to more honest and nuanced feedback.

What she learned from using tricot

Through her tricot trials, Edith gained both practical and strategic lessons. First, she saw the value of instant data. Using tools like ODK, she could receive data as trials were ongoing, allowing her to detect errors and fix problems during the season instead of after it was over.

Second, she noticed that because tricot is inclusive, many farmers are already familiar with the varieties by the time they are released. This early exposure helps boost adoption rates, since farmers have already tested the varieties themselves.

New insights on beans, disease and preferences

The tricot trials delivered several important insights about common beans and the people who grow them. Edith and her colleagues realized the significance of anthracnose disease in common bean and observed that infection levels varied across agroecological zones. This highlighted a clear need for targeted disease management and resistant varieties.

In terms of traits, farmers consistently prioritized:

- High yield
- Market acceptance
- Disease resistance

However, tricot also surfaced other considerations that might not appear in standard trials. Farmers discussed cooking beans with banana and intercropping beans with other crops, underlining the importance of integrating cultural practices and farming systems into breeding priorities.

The approach also helped identify gender- and age-specific preferences:

- Women tended to focus on post-harvest traits such as storage and cooking qualities.
- Men emphasized agronomic traits, including field performance and plant characteristics.
- Youth often prioritized marketability and income potential.

For Edith, this showed that breeders shouldn’t treat “farmers” as a single, uniform group. Instead, they should first identify **who the end users are—by gender, age and cultural context** to design varieties that will truly be adopted.

Why she recommends tricot

From Edith’s experience, tricot is:

- Simple and practical
- Low-cost
- Able to involve many farmers across different environments

Because so many farmers test the varieties themselves, post-trial adoption rates tend to be higher—people already know how the varieties perform in their own fields.She believes tricot is very appropriate for variety evaluation and release. It generates enough data to show when a particular variety is high-performing and suitable for a range of conditions.Looking ahead, Edith argues that future research in Africa and beyond should use tricot more widely to promote new varieties and improve crop productivity, nutrition and income.

Challenges and room for improvement

Despite the benefits, there are challenges that Edith would like to see addressed, especially in the ClimMob platform that supports tricot. She and her team found it harder to collect and manage quantitative data, such as disease infection levels, and to integrate supplementary data. At present, the system is stronger on qualitative rankings than on numeric traits. But breeders also want to know: How much is “high yield”? How severe is disease infection? For Edith, improving the handling of quantitative data would make tricot even more powerful for breeding programs.

Even with these challenges, her experience with tricot shows how the approach can bring farmers’ voices and realities to the center of bean breeding—helping shape varieties that work not just in trials, but in the everyday lives and fields of Tanzanian farmers.

Letting farmers lead: How tricot Is shaping

maize breeding at Bayer - Jamlick Mwathi

For Jamlick Mwathi and his team at Bayer Crop Science in Kenya, understanding farmers isn't a "nice to have" – it's central to how they design their maize breeding strategies. That's why they turned to the tricot approach. "We use tricot because of the benefits you get from understanding your customer (farmer)," Jamlick explains. The insights they gain feed directly into breeding strategies and help identify gaps that need to be addressed in future products.

Lessons from using tricot

Working with tricot quickly challenged some long-held assumptions.Jamlick's team had always placed yield at the top of their priority list. But the tricot trials revealed that farmers cared deeply about other traits too—especially grain size and grain colour. "Tricot gives insights on important traits, e.g. maize grain size and colour," he says. "We always considered yield to be more important, so we were surprised at the results and have since integrated these attributes into our breeding program." Tricot didn't just confirm what breeders already thought; it reframed what "important traits" mean from the farmer's perspective, and the breeding program was adjusted accordingly.

New insights on maize preferences and performance

The trials also brought some surprises when it came to variety choice. Jamlick and his colleagues were "amazed" to see farmers consistently choose a hybrid that the breeding team had not considered the best by their own internal criteria. Farmer rankings convinced them to bring that hybrid into the breeding program, rather than dismissing it. They also appreciated how tricot helped profile varieties with a micro-environmental focus. Two areas that the company had long treated as similar turned out to be quite different in terms of hybrid

performance. “In this way, tricot helps you showcase your product in the best area for it,” Jamlick notes. Instead of assuming uniform performance across regions, they can now match hybrids to the environments where they truly excel.

Why he recommends tricot

For Jamlick, the value of tricot is clear: “With tricot you will get benefits that you cannot get with other methods.” In breeding, he stresses, companies need to appeal to the customer—the farmer. Tricot helps:

- Profile farmers’ needs and gaps
- Identify key challenges
- Point to what breeders can do to address those challenges

He believes tricot is not only useful for public breeding programs, but “very useful for seed companies” as well, because it aligns product development more closely with what the market actually wants. Jamlick also sees tricot as highly appropriate for variety evaluation and release. The information they obtained on grain size and colour “could not have come easily without tricot,” yet it significantly influenced how they modulated their maize breeding strategy. In his view, tricot “really informs breeders about the gaps that are not obvious.”

Challenges and the way forward

While his overall experience with tricot has been positive, Jamlick does see room for improvement—particularly on the software side. He notes that there were some technical issues when using the platform. However, these were resolved with the help of technical support and did not overshadow the broader value of the approach. For Jamlick and Bayer Crop Science in Kenya, tricot has become much more than a trial design—it’s a listening tool. By bringing farmer preferences and real-world performance to the center of maize

breeding, it is helping shape products that fit farmers' needs, fields, and markets far better than traditional, breeder-only approaches.

Reaching more farmers with less effort: How tricot supports sweetpotato research at CIP - Reuben Ssali

Associated paper: Moyo et al., (2021). Consumer Preference Testing of Boiled Sweetpotato Using Crowdsourced Citizen Science in Ghana and Uganda. Frontiers in Sustainable Food Systems. DOI=10.3389/fsufs.2021.620363

For Reuben Ssali at the International Potato Center (CIP), the appeal of the tricot approach was immediate. He saw in it a way to reach many more farmers than traditional trials usually allow—and to do so in a way that was simple and inclusive, regardless of farmers' education levels or resources. "I realized I would be able to reach many more farmers," he explains, "and it is very easy to involve farmers regardless of their education level or resources." With tricot, smallholder farmers take a central role in testing varieties on their own fields, ranking them according to their preferences and experiences. For Reuben, that meant more participation, more diversity of environments, and richer data for sweetpotato breeding.

Lessons from using tricot

Implementing tricot taught Reuben and his team some important practical lessons. The first was the critical importance of multiplication rate. If a promising variety doesn't have enough planting material multiplied before the trial begins, it is very difficult to fix this problem later. "Multiplication rate of varieties is very important," he notes. "If you start a trial and a variety is not well multiplied it is not easy to resolve." Tricot also opened doors to new collaborations. It created opportunities to engage with researchers they did not

usually work with—such as those responsible for seed multiplication—as well as agricultural extension officers, who were involved throughout the trial. On the digital side, the ClimMob software provided a strong backbone for the work, supporting everything from farmer registration to data collection.

However, one challenge remained: when farmers provided rankings, it was not always clear which trade-offs they were making. Understanding why a farmer preferred one variety over another—what traits they were prioritizing or overlooking—was not always straightforward. “When farmers made the ranking it was difficult to know what trade-offs they are making,” Reuben explains, “in other words what traits they accept in the ranking.”

New insights on sweetpotato traits

Before using tricot, the CIP team had already conducted surveys to understand which traits farmers wanted in sweetpotato varieties. They had a rough idea of priorities, but tricot allowed them to validate and refine that picture. “Implementing tricot allowed us to validate some traits,” Reuben says. “Trait preferences are more pronounced when farmers provide information about their rankings.” By looking at how farmers ranked varieties under real field conditions, preferences became clearer and more concrete. The trials also revealed an interesting nuance: some farmers were willing to ignore certain negative traits—such as mealiness in some varieties—if other qualities were strong enough. This kind of insight helps breeders understand not just which traits are important, but which trade-offs farmers are willing to accept.

Why he recommends tricot

Reuben describes the tricot approach as very practical for both farmers and researchers. He highlights how the ClimMob system supports the entire process, making it easier to implement the research and to give feedback to farmers at the end of the trial. That feedback loop strengthens trust and keeps farmers engaged in the research process. For Reuben, tricot is clearly

appropriate for variety evaluation and release. Even simple rankings can quickly show the best and worst varieties, and the approach provides a valuable feedback loop for breeders:

- It can reveal why a released variety is being rejected in the field.
- It offers robust statistics that variety release committees appreciate.

In other words, tricot doesn't just identify winners and losers; it helps explain them.

Challenges and questions still to answer

Despite its strengths, Reuben sees one main challenge: understanding trade-offs more clearly. The rankings show which varieties farmers prefer, but not always exactly why—especially when a variety is liked despite some obvious negative traits.“Only challenge is not being able to quickly distinguish the trade-offs of good vs bad traits,” he says. “We would like to know why farmers appreciated varieties despite some bad traits.” Addressing this challenge—by combining ranking data with more detailed trait information and farmer feedback—could make tricot even more powerful for sweetpotato breeding and beyond. For now, Reuben's experience at CIP shows that tricot is a highly practical, farmer-centered approach that expands reach, deepens collaboration, and offers breeders clearer signals about which varieties truly work for farmers and why.

Scaling farmer reach and market insight: How tricot supports groundnut breeding in Ghana - Richard Oteng-Frimpong

For Richard Oteng-Frimpong at the Savanna Agricultural Research Institute in Ghana, one of the biggest challenges in breeding is simple but stubborn: how

do you get new breeding lines into the hands of enough farmers, in enough places, to really understand their value? The tricot approach offered a powerful answer. Richard was drawn to tricot because it allowed him to reach a larger number of participants and to distribute breeding lines to farmers who were previously inaccessible. Instead of testing a few lines in a small number of locations, he could involve many farmers directly in evaluating new material. The digital support behind tricot also mattered. With the ClimMob platform handling trial design and analysis, he found the process easy and simple to use, reducing the workload on the research team.

What he learned from using tricot

Once implemented, tricot changed how Richard and his team worked.First, it expanded the scope of their trials. “Tricot allowed me to test more lines,” he notes—his current trial includes 15 different lines, far more than many conventional on-farm trials would handle. They also found that most participants were genuinely happy to test the material. Farmers appreciated having access to new lines and being part of the evaluation process. On the data side, using ODK for collection brought a major advantage: the data came in quickly and online, speeding up analysis and decision making. They no longer had to wait months for data entry and cleaning before seeing results. Tricot also encouraged new partnerships. Working closely with seed companies helped them see which varieties were accepted by the wider community, bridging the gap between experimental lines and market realities.

Logistics,languages and local needs

Along the way, Richard’s team learned a lot about logistics and collaboration. Because trials took place across areas with multiple local languages, they needed field agents to translate and support data collection. These local partners played an essential role in ensuring that farmers could participate fully and that their feedback was accurately captured. The trials also confirmed

that trait requirements vary between users. For example, they found that early-maturing varieties were especially preferred by female farmers, who often balance production needs with household responsibilities and risk management.

Shaping decisions in the breeding program

The insights from tricot have fed directly into decision making in Richard's breeding program. The results help shape target product profiles, clarifying which traits should be prioritized. Among the key findings were the importance of seed size and colour, as well as fast maturity—the latter being crucial to help crops escape environmental stresses. By disaggregating the data, they could see which traits mattered most to which groups, such as the stronger emphasis on early maturity from female farmers. That level of detail makes product profiles more accurate and more responsive to real farmer needs.

Why he recommends tricot

For researchers considering tricot, Richard's advice is straightforward. He describes the approach as very simple and cheaper than many other methods. With ClimMob assisting in trial design and ODK enabling real-time data collection, tricot saves scientists a lot of time. It also makes it possible to work with large numbers of farmers, which in turn supports more robust decisions than those based on smaller, more controlled trials alone. Because tricot allows researchers to reach many people with a large number of breeding lines, Richard sees it as an excellent source of market intelligence. It helps breeding programs design varieties that are better tailored to the market, increasing the likelihood of wide adoption. In his view, every breeding program should consider using tricot, because it provides feedback that helps ensure new varieties don't just perform well in trials—they are also wanted and used by farmers.

Challenges and how to address them

Richard’s experience also highlights some challenges that come with the approach. Working on groundnuts, one major issue was seed requirements. Running large tricot trials meant they needed a lot of seed, forcing the team to multiply seed during the off-season to be ready. Language diversity posed another challenge. With multiple languages spoken across the study area, they relied on field agents to translate farmers’ feedback. Richard notes that if more farmers could use the ODK app themselves, they could send data directly, reducing the need for translation and speeding up the process even further. Despite these hurdles, his experience shows that tricot is a practical, scalable, and farmer-centered approach—one that not only broadens participation in groundnut breeding, but also sharpens understanding of what the market really wants, and why.

Aligning breeding with farmer demand: How tricot is reshaping cowpea work at IITA - Patrick Ongom

For Patrick Ongom at the International Institute of Tropical Agriculture (IITA) Nigeria, it became clear that traditional approaches to on-farm testing weren’t giving the full picture. They were limited in scale, slow in delivering results, and often difficult to integrate smoothly into the breeding pipeline. That’s when his team decided to adopt the tricot approach. Tricot appealed to Patrick because it mimics normal experimental design in research, making it easier to fit into the existing breeding process. With tricot, decisions can still be made on the basis of solid statistics, but the approach also allows trials to cover large numbers of farmers for more representative data on varietal performance. He also appreciated how data is captured, summarized and stored. Compared to some traditional methods, tricot’s digital tools made the whole process more efficient and easier to manage.

Lessons from getting started

As they rolled out tricot, Patrick and his team learned that the method itself is not complicated—once people understand it. “We learned that once you understand the process it is simple, and it was successful,” he notes. However, they also discovered that field agents play a critical role. When agents were not well trained, technical issues could arise, especially around the use of software and data capture. This led to a key lesson: at the beginning, there needs to be strong supervision and monitoring of field agents to make sure they are comfortable with the tools and protocols. A bit more support early on helps avoid bigger problems later.

Building partnerships on the ground

Using tricot also helped Patrick’s team strengthen logistics and partnerships in cowpea-growing areas. They built important connections with farmer groups, field extension agents, and local government officials—all of whom are crucial for promoting cowpea and taking new varieties to both farmers and consumers. These partnerships go beyond a single trial season. They create a supportive network that can help move improved varieties from experimental plots into real-world use.

New insights on cowpea preferences

One of the most valuable outcomes of the tricot trials was a clearer view of which cowpea traits truly matter to farmers. Through the ranking data and feedback, Patrick and his team found that farmers placed particular importance on:

- Grain colour
- Seed size
- Resistance to pests and diseases

These insights allowed IITA to adjust product profiles and breeding priorities, ensuring that these traits are properly captured in new lines. Importantly, the results from tricot also fed directly into variety release decisions. The data helped identify which candidate varieties should be advanced and released, not just based on breeder criteria, but on the preferences and experiences of farmers themselves. Tricot has also guided IITA to restructure the cowpea breeding pipeline so that it aligns better with market classes. That shift is moving the program in the right direction—toward breeding for consumer- and farmer-demanded traits, rather than only researcher-defined targets.

Why he recommends tricot

For others considering the approach, Patrick describes tricot as a powerful and useful technology. From the farmers' perspective, it is easy to work with: they have only three varieties to score in each mini-trial, which keeps the task manageable and reduces fatigue. From the breeders' perspective, tricot is equally attractive:

- Data access is instant, thanks to digital tools,
- Results are easy to summarize using functions in the software,
- It is easier to scale out and work with large numbers of farmers,
- The approach is not constrained by small sample sizes.

Compared to traditional methods, tricot offers a way to combine experimental rigor with farmer reach and practicality.

A role across the breeding pipeline

Patrick is convinced that tricot is appropriate for variety evaluation and release—and not just at one point in the breeding cycle. "Tricot can be instrumental in several stages in the breeding program," he explains. For cowpea, IITA is using tricot at later stages, once materials have already been tested in more controlled environments. At that point, tricot provides farmers'

opinions on near-final varieties. At the same time, they have also used tricot in earlier development stages, showing that the approach can be flexible and integrated at multiple points to refine decisions.

Challenges and opportunities for improvement

Like any system, tricot comes with some challenges.On the user side, Patrick's team sometimes found that the data for one farmer was uploaded twice. Fortunately, there is an option in ClimMob to fix such errors, but it highlighted the need for better mechanisms to catch and correct common mistakes in the field. Patrick also notes that familiarity with the tools matters. The more comfortable field agents and researchers are with ClimMob and data collection apps, the better the quality of the results. Even with these issues, his experience suggests that the benefits far outweigh the challenges. Tricot has helped IITA engage more farmers, clarify trait priorities, guide variety release decisions, and align the cowpea breeding pipeline with real market demand. For Patrick Ongom, tricot isn't just another trial design—it's a way to bring farmers' voices and preferences directly into the heart of the breeding process.

Bringing new varieties to isolated farmers: How tricot supports seed sector development - Mohammed Hassena

For Mohammed Hassena, working with Integrated Seed Sector Development (ISSD), one challenge stood out: many farmers in isolated areas simply don't have access to the varieties promoted through formal extension programs. These farmers are often left behind when new varieties are introduced, even though they may need them the most. That's why Mohammed and his team decided to use the tricot approach. Tricot offered a way to reach farmers in remote locations and put new varieties directly into their hands. Instead of

expecting farmers to come to demonstration plots or rely solely on extension agents, tricot brings the trial to the farmer’s own field.

Learning that tricot is easier than it looks

At first, Mohammed and his team assumed tricot would be a complex process—especially when working across many communities and landscapes. But once they began, they discovered that it was more straightforward than expected, largely because they established partnerships with local people. By working closely with local partners, they were able to include many farmers across different areas and manage the logistics more easily than a centralized trial system would allow. There were some early struggles with data collection: staff initially had difficulty handling parts of the digital process. But these issues turned out to be manageable and were easily solved within the software, underscoring the importance of training and support rather than being a fundamental barrier to using tricot.

Farmers’ enthusiastic participation

One clear success of the tricot trials was the enthusiasm from farmers themselves. Mohammed notes that farmers were very interested in the trials, largely because of the range of different varieties they were able to evaluate. Having access to multiple options, some of which they had never seen before, generated curiosity and engagement. Farmers were happy to give their answers, share their rankings, and discuss what they liked and didn’t like. This willingness to participate is crucial—not only for collecting good data, but also for building familiarity and trust around new varieties.

Insights from on-farm trials in low-service areas

The on-site tricot trials provided especially valuable insights in areas where variety choice and extension services are limited. In such places, Mohammed found that tricot was an excellent and simple way to introduce new varieties,

while simultaneously seeing which ones farmers preferred. Instead of top-down recommendations, the process let farmers experience the varieties themselves and express their preferences through rankings. However, he also identified a potential tension when it comes to private companies testing existing varieties. If farmers' feedback is not favorable to varieties that are already released, companies might find it difficult to accept those results. This may lead to some reservation from private companies about using tricot, especially if it challenges their current product lineup.

Advice for companies wanting to use tricot

Despite these tensions, Mohammed sees strong reasons for seed companies and other actors to adopt tricot. For companies that want to target a specific area, tricot is, in his view, one of the best ways to identify new varieties that farmers truly like. It allows companies to see which varieties stand out in the eyes of local farmers and in real local conditions. For companies that are testing already released varieties, tricot also has clear benefits: it can help promote those varieties, increase awareness, and build farmer confidence in them. However, Mohammed highlights one important point of caution: naming varieties. During trials, farmers often give varieties their own names. If a company later releases the same variety under a completely different name, it can create confusion. Farmers may not realize that the variety they liked in the trial is the same one now being marketed under another name. His advice: companies should take care with naming, and where possible, build on the names farmers already know, or at least make the link clear.

Tricot as a tool for variety introduction

Mohammed is convinced that the tricot approach is well suited to variety introduction. "If you include a variety in tricot, farmers will already know it," he explains. When that variety is eventually released, adoption rates are likely to be higher, because farmers have already tested it in their own fields, seen how it performs, and formed an opinion about it. This familiarity reduces risk for farmers and speeds up the transition from trial to widespread use.

Challenges and how to overcome them

Tricot does come with some perceived challenges—especially at the planning stage. When someone first considers targeting a large number of farmers, the approach can feel logistically demanding and expensive. Mohammed’s experience, however, is that these worries are often greater in theory than in practice. By partnering with local people, they found that the process was actually manageable and efficient, even across remote areas. Local partners helped with coordination, communication, and farmer engagement. Another issue is what happens when farmers multiply the varieties themselves. Rather than seeing this as a problem, Mohammed views it as part of promoting the varieties. Farmer-led multiplication can help spread promising varieties more widely and quickly, as long as quality is monitored.

Overall, Mohammed's experience with tricot under Integrated Seed Sector Development shows how the approach can:

- Extend the reach of new varieties into isolated farming communities,
- Generate enthusiastic farmer participation,
- Provide honest feedback that both public and private actors can learn from, and
- Lay the groundwork for higher adoption rates when varieties are finally released.

For organizations serious about inclusive variety introduction and real farmer input, tricot offers not just a methodology, but a pathway to make sure no farmer is left out simply because of where they live.

Version: current

Coming soon

Here are some of the tools and features currently under development to support tricot users.

Online tricot course

This open-access multi-module online course will contribute to the creation of a pool of professionals skilled in implementing on-farm trials following the tricot approach, leading to high-quality data collection, analysis and increased understanding of variety performance in use environments. On completion of the course, participants will receive a certificate to demonstrate their newly acquired skills.

Sikia

Sikia, meaning "to listen" in Swahili, is an offline-first mobile and web platform designed to scale open-ended qualitative research in crop breeding. Developed under the Gates Foundation-funded NDIZI project, it uses automatic speech recognition (ASR) and vision-language models (VLMs) to convert enumerator-recorded farmer interviews and field images into structured, actionable insights.

Traditional methods constrain scale: in-depth household interviews are expensive (+/-170 USD/hh) and logistically challenging, sms-based surveys scale affordably (0.7 USD/respondent) but lack depth and nuance. Sikia complements typical ClimMob survey questions "Which variety do you prefer: A, B, or C?" by enabling richer, open-ended questions at scale—e.g., "What do you like about this product and why?" or "What qualities would you like in a

new variety to replace your current one?" Such questions capture nuance and unanticipated insights that predefined formats may overlook, from diverse farmer groups.

Sikia engages local enumerators living in villages so there is no field travel required. These trusted locals use dialects (Sikia-trained for transcription), minimizing bias for authentic responses. Enumerators conduct free-flowing interviews; on-device chatbots prompt for gaps (e.g., "What about variety X on taste?"), ensuring completeness with low training. Tanzania trials used M-Pesa payments to pay enumerators on distance. LLMs extract sentiments, traits, and emergent themes, mapping to breeder ontologies.

Sikia is designed to integrate seamlessly with ClimMob. Tested on 1000FARMS tricot trials, including Tanzania bean (n=480), Sikia quantified gendered preferences (women: taste; men: yield/climate). Swahili models are operational and offline expansion to other African languages is underway.

ClimMob Registration Application

ClimMob Registration App is a mobile-first Progressive Web App (PWA) for seed evaluation trials — runs in any browser on iOS/Android, no app store needed. It will serve as the data entry front-end for the ClimMob platform, feeding farmer observations into centralised analysis and reporting.

Core features:

- QR scanning — scan coded seed packages to load structured registration forms tied to specific trial projects
- Step-by-step forms — captures field conditions, plant performance, GPS location, and photos across three seed varieties per package
- Offline-first — fill, save, and submit without connectivity; data queues locally and syncs automatically when back online
- Multi-phase trials — re-scan the same package at sowing, mid-season, and

harvest to record stage-specific observations

- Draft management + submission history — review past entries and resume incomplete forms
- Light/dark themes, EN/NO language switching — simple UI built for low-tech users in the field

Version: current

Glossary of Terms

Administrator is the person or organization who coordinates the tricot project. It's the project manager. The administrator could be a scientist working at a research institute, or at an NGO, governmental extension service, etc. If the administrator is not a scientist, she or he might collaborate with scientists or a research institute to develop the tricot project, and obtain the tested technologies, such as seeds or fertilizer. The tasks of the administrator include:

- Designing the tricot project using ClimMob software
- Recruiting field agents and participants
- Training field agents
- Preparing trial packages
- Organizing initial workshops
- Keeping track of growers' data collection
- Analyzing data using the ClimMob software
- Communicating final results to participants in final workshops (together with field agents)

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.

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.

ClimMobTools is an open-source statistics toolkit available on the R platform. It enables administrators to further explore and analyze their tricot data. The 'ClimMobTools' R package supports more sophisticated data analysis than what is offered through the easy-to-handle ClimMob online software. R software (free): https://cran.r-project.org/ ClimMobTools: https://cran.r-project.org/web/packages/ClimMobTools/index.html

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 For on farm trials, 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 farm. Examples: Use of irrigation, use of fertilization, season was rainier or drier than usual, etc.

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.

Field agent is the extension worker, linking the implementer and the participants. A tricot project might employ 20 to 30 field agents. Each field agent can cover a different geographical region and can coordinate 10 to 20 participants. Field agents are vital to a tricot project, as they allow many small trials to take place in different regions at the same time. Field agents get trained by the implementer, and in turn pass their knowledge on to the

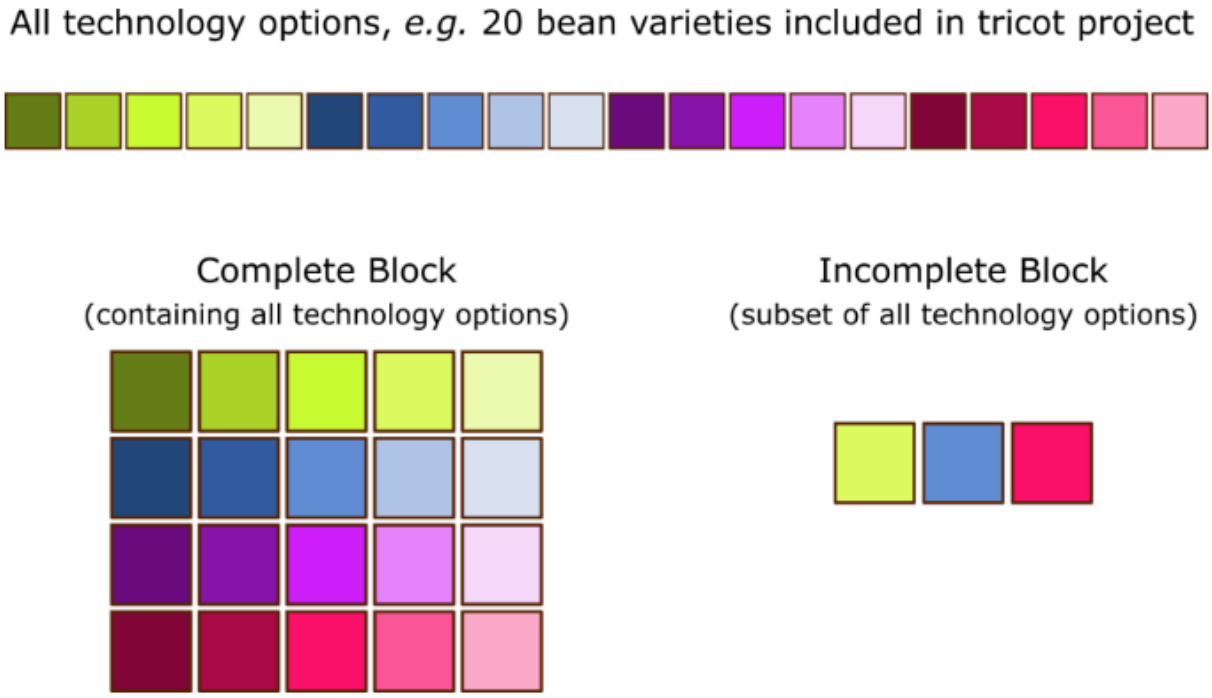
participants. The implementer can also be a field agent. Likewise, a field agent can also participate in the tricot project as an observer. *The tasks of field agents include:

- Staying in personal contact with participants
- Assisting participants with trial cultivation and data collection
- Collecting participants' observations at the end of the trial through personal visits or telephone calls
- Passing on participant data to the implementer, using the ODK Collect app

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 participants
- Distributing the trial packages
- Carrying out the data analysis once all data is collected and compiled
- Feeding back the information to the participants via the field agents.

Incomplete block design Incomplete block design refers to an experimental setup in which not all treatments occur in one block. In the case of tricot, this means that not all technology options (= treatments) occur in each individual trial (=block). Instead, each participant cultivates or tests just three technology options in her/his trial (for example, three randomly assigned bean varieties), instead of cultivating all technology options included in the tricot project (which could be up to 20 bean varieties). Because many participants each cultivate a trial with a subset of three different technology options, all these individual trials – taken together – cover the testing of all technology options.



Infosheet Personalized information output for every participant. It is generated automatically using ClimMob and includes:

- Names of the three technology options that the participant received and tested
- Names of the most recommended option for their farm (in the case of on-farm trials)
- Information about where to obtain more material of the preferred technology option (if applicable).

ODK Collect ODK stands for ‘Open Data Kit’. ODK Collect is a free app for Android devices that is used to collect and compile data. It completely replaces the need for paper forms, for example during a survey.

In a tricot project, the field agents use this app on a mobile devices (smartphone or tablet) to collect the field observation data from participants.

Each participant has written down their observations on their own observation card, and ODK Collect offers a simple way to digitize and compile the data from many growers.

The field agents do not need to be connected to the internet when entering data into ODK Collect, for example, when they are out in the field, visiting participants. When a participant observations are entered, ODK Collect will first store the data locally on the field agents' mobile device. The field agents can upload the data to ClimMob at later points in time, whenever the device can connect to the internet again. ODK Collect then uploads the individual data sets to the ClimMob online software.

The app can be downloaded for free from the Google Play Store. **Note that the app is available for Android only, not for iOS.**

Observation card Observation cards are used by the participants to record their field observations during different stages of the tricot trial. These paper cards are distributed by the field agents at the initial training event. Over the course of the trial period, the growers fill them out, using a pen.

Observation cards get designed by the project administrator, adapting a template that is available on ClimMob. Which observations participants need to make, and at what points in time – the observation card includes this information, to help participants collect their data alone. Observation cards require the observations to be entered as comparison data (ranking).

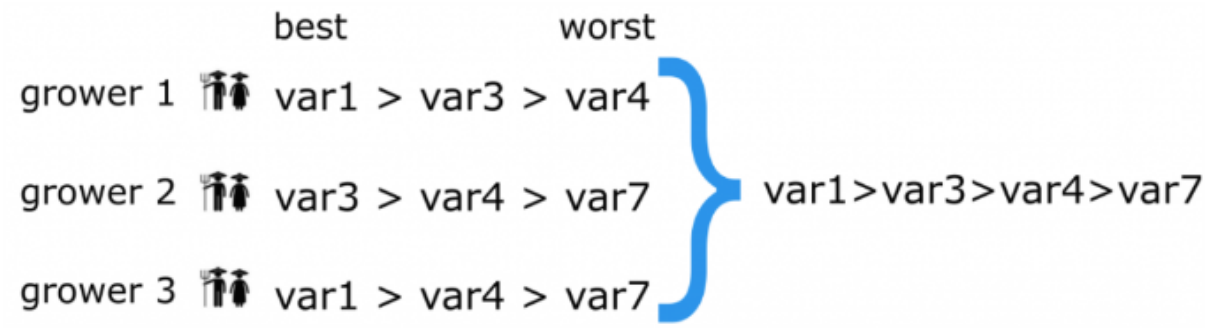
On-farm trial On-farm trails are tricot experiments conducted on the fields of participants. Participants in this case are farmers, and their role is to test throughout the growing season the three different technologies in their fields.

Plackett-Luce model In a tricot project, ranking data is collected on all participants (either farmers or consumers) with each one of them contributing one 'partial ranking'. The ClimMob software uses the statistical Plackett-Luce

model to combine all these partial rankings into a full picture.

The image below visualizes an example. Here, three growers each rank their individual set of three technology options (for example, crop varieties). Participant 1, for example, reported that var1 was the best technology option, while var4 was the worst, and var3 took a middle position.

The partial rankings from all participants are then combined, giving the overall ranking. When there are disagreements (for example, some participants find that var3 > var4, but others report that var4 > var3), the Plackett-Luce model determines the most likely overall



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.

Ranking Ranking is a way of describing the relationship between two items, for example, one being ‘bigger than’ the other. Ranking data is common, for example, in sports (‘Claire ran faster than Anna’), or in consumer studies (‘Consumers like apples better than pears, and pears better than strawberries’).

In tricot project, participants observe their technology options and rank these options by different aspects of their performance. Using ranking as a way to

collect field observations in on-farm trials has proven successful in a number of studies. There are multiple advantages in asking participants to rank, rather than take exact measurements or give subjective ratings:

Ranking avoids a drift in the point of reference during the evaluation process, it avoids different interpretations of the scoring scale between participants, and ranking is easy to explain and understand. A disadvantage of ranking is that it does not give an absolute zero, or an absolute scale.

In a race, two athletes might cross the finish line at the exact same time. In a tricot trial, a participant might observe two different bean varieties without noticing any difference in growth. However, the observation cards only allow field observations to be entered as ranks – ties are not possible. Even though it might be tough to spot the difference – we encourage participants to take another look. Surely, there is some small difference.

ClimMob analyzes ranking data using the statistical Plackett-Luce model.

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.

Sequentially balanced randomization ‘Random’ means that there is no obvious pattern or predictability in the way items are ordered. Simple randomization is the process of putting anything in a random order.

In a tricot experiment, growers receive trial packages that contain a random sub-set of three technology options. For example, if the tricot focus technology is ‘bean varieties’, every participating grower receives a set of three bean varieties, which are randomly picked from the total pool of bean varieties included in the project. Experience shows that a small share of growers tends to drop out of a tricot project, for different reasons. This is not a problem at the

level of the entire project. At the local level, however, this can lead to an imbalance. If technology options are distributed by simple randomization only, some technology options can be rare or absent in a certain community.

To address this issue, the tricot approach uses the ClimMob online software to assign technology options to participating growers using an advanced form of randomization: sequentially balanced randomization. This means that trial packages contain a balanced frequency of each technology option. For example, if we distribute packages 1–10 in the first local community, 11–30 in the second community and 31–40 in the third community, each individual variety will occur with nearly equal frequency within each community. If growers in the first community take only 9 trial packages instead of 10, distribution in the second community can simply start with trial package 10.

Technology Using the tricot approach, many agricultural technologies can be tested and innovated. For example: Crop varieties, Fertilizer regimes, Irrigation systems, Pest management strategies, soil management strategies, etc. Every tricot project focuses on one technology (for example, ‘fertilizer composition’), but tests a number of different technology options (fertilizer composition 1, fertilizer composition 2, etc.). In the past, for example, tricot has often been used to innovate a certain crop (technology) by testing new crop varieties (technology options). Experimental design terminology would refer to technology as ‘treatment’, and to technology options as ‘levels’. In the context of tricot, we chose to use ‘technology’ and ‘technology options’ for easier understanding.

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 participant 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.

Trial plot For on-farm trials, 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 The word ‘tricot’ is derived from three words: Triadic comparison of technology 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).

Tricot trial Test of different technological options, in sets of three, each observed and ranked by a participant. For an on-farm trial, the options are grown and observed in a small designated area of her/his own farm.

Tricot experiment A tricot experiment (or tricot project) refers to the whole process of putting the tricot approach into action. That is, engaging a large number of participants in testing a range of technology options in random sub-sets of three technology option per participant.

A tricot experiment, or tricot project consists of many small tricot trials.

Version: current

Contact

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