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Farmer experimentation for climate adaptation with triadic comparisons of technologies (tricot)

A methodological guide

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Farming under a changing climate requires creative problem solving

All over the world, the climate is changing. Weather is becoming more and more unpredictable and variable. Many places are now drier than years ago, and others have become rainier. Households depending on small-scale agriculture are particularly affected, and need to adapt to the changing conditions. An effective strategy for climate adaptation can consist in identifying the most suitable varieties for their main crops and discovering new production practices.

Access to new crop varieties, and new agricultural inputs and knowledge is vital for many rural households worldwide. But often there are obstacles to discovering new technologies: For example, access may be hindered by the inaccessibility of some remote rural areas, by the absence of developed markets for seed and crop inputs, or by the lack of information about new varieties or crop inputs. That is why, in many cases, the same varieties are being grown year after year, with inadequate inputs.

Over the last decades, agricultural researchers and organizations committed to development have been supporting farm households by introducing new varieties and other agricultural technologies in many parts of the world. But often these varieties were not adopted by the farmers over time. Sometimes, what works on a research station will not work well under the management constraints of a small farm. At different locations, environmental conditions differ, for example the distribution of rainfall, or pest and disease pressures. As a consequence, no single crop variety can be used everywhere, and it is difficult to foresee which varieties will be successful at which locations.

So why not place the research where it faces real-life conditions, directly on the farm? And why not involve the experts for every-day farming, the farmers?

With a new approach to technology dissemination and evaluation, called Triadic Comparisons of Technologies (tricot), crop varieties and other technologies can be tested on-farm, under realistic conditions. Through simple and hands-on experimentation, the participating farmers may identify innovations which will be of real benefit to them. Tricot is a ready-made methodology, serving both research, and the dissemination of varieties and other technologies and practices in highly variable areas. It provides a means to link technology development of research institutes to real-life experiences of farmers.

If you are a researcher, extension agent or NGO actor working with agricultural development, this guide is for you. In ten steps, you will learn how to establish and carry out a tricot project, involving many farmers as on-farm researchers and as beneficiaries of the new technologies. Although every tricot project will be different, this guide contains all the information you need to know to be able to design one of your own!

Identifying farm-specific solutions with tricot

Triadic comparison of technologies can help to introduce new varieties, inputs and practices to rural areas, because it empowers farmers to identify the most suitable technologies for the local conditions of their own farm. Tricot is a research methodology that involves many farmers in the testing and/or validation of new and promising technologies, like crop varieties, as 'farmer researchers'.

This means: Large numbers of farmers carry out many small and easy trials, instead of a few big trials realized at research stations. The participants provide the observations from their trials to the agricultural research centers, where the data from all mini-trials is merged and analyzed. The research centers then feedback the findings to all participants.

With a tricot approach, research centers get the opportunity to validate and disseminate new technologies 'massively' and in a participatory way, collaborating with a large number of participants under diverse conditions. Valid results about the qualities of different technologies (e.g. various varieties of one crop) can be generated from a big number of trials in different environments. Important criteria for adoption into practice, which are easily overlooked at researcher-managed trials, are accounted for by the participants. Therefore, higher technology adoption rates and a stronger impact of the research on farming can be expected.

On the other side, the rural households benefit from discovering new technologies that are suited to their environmental and socio-economic conditions, and have a high probability of improving their yields. Especially in regions where environmental conditions or socio-cultural preferences to crops vary strongly in the landscape, tricot can help farming households to identify the technology that satisfies their needs best. Tricot is a strategy to overcome the "bottleneck" of technology dissemination to users that many research institutes face.

This methodological guide focuses on variety innovation, but the principles of tricot can be applied equally to other agricultural technologies, like fertilizers, biofertilizers and other inputs, or post-harvest technologies. Tricot with crop varieties may be most useful when it is applied together with other interventions directed at strengthening the local seed system: For example, training for farmers in quality seed production, or the establishment of local seed banks.

In the case of crop varieties, participating farmers receive a package with small quantities of seed of three varieties, from a pool of up to 20 varieties. These seeds need to be cultivated along with the farmers' regular cultivation. Each variety is grown in a very small part of their land, and the farmers observe their development. The participants report their observations in a simple format to a local tricot facilitator, who is a contact person between the researchers and the participants. After the harvest, the information from all participants is analyzed, and the farmers receive farm-specific information and recommendations.

Strengths of the tricot methodology	*Limitations of the tricot methodology*
✓ Quick dissemination of various new and even unreleased varieties.	✗ Farmers may initially need training and assistance, which requires an investment.
✓ Participants can identify a variety they like and that fits to the conditions on their farm.	✗ There is a risk that some or all participants will find none of the tested varieties better than their own varieties.
✓ A large number of farm households can be involved in the approach.	✗ Tricot requires many participants to work well.
✓ Local seed systems are strengthened, because more choices are available to adapt to the changing climate.	✗ If the number of farmers reporting back data is too low, the project may yield results that are not useful for the researchers (although the trials can still be useful to farmers).
✓ New varieties can be tested in many different environments, under real-life farming conditions.	
✓ Unreleased varieties can be matched to the environment where they are best adapted.	

Overview of a tricot project: ten steps

Each project consists of ten steps, which are summarized below.

In this methodological guide, each step will be explained in detail.

1 The researchers define a total set of 8 to 12 promising crop varieties that they want to evaluate, and provide seed to the project implementers.

2 The implementing organization (NGO, a governmental extension service, etc.) design the tricot project, using the free online software ClimMob (www.climmob.net).

3 The implementers recruit a number of dedicated farmers who are interested in improving their farming by getting to know new varieties.

4 The implementers prepare the trial packages, each of which includes seed samples of three varieties in a randomized order, as well as an observation card, and disseminate them to the participating households.

5 The participants receive the trial packages with a random combination of three varieties, and plant all three spearatey, but next to each other in a mini-trial on a part of their farm.

6 Every participant is responsible for their trial, and makes various easy observations during growth and after harvest. For example: Which variety had highest yield? And which one had lowest yield? The participants mark these observations in the observation card.

7 The local facilitators collect this data from the participants, and pass it on to the implementing organization.

8 The implementers compile and analyze the data from all trials, using ClimMob.

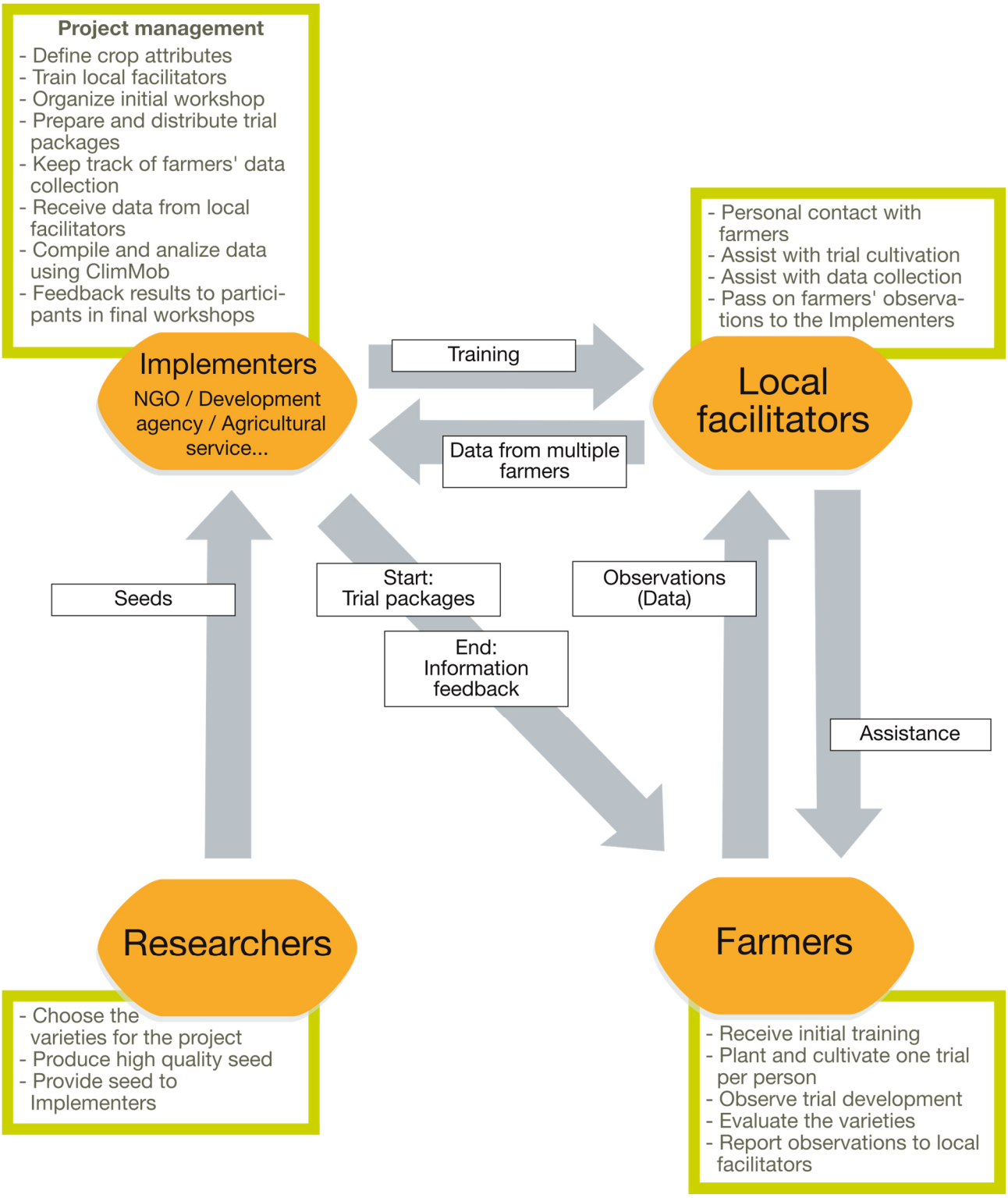
9 The implementers feed back the information to every participant: the names of their three varieties, which variety is most suited for their farm, and where to get more seed.

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

Feliciano Castellanos, of El Barro, Comayagua, Honduras, carrying out observations in his tricot trial. Photo: Roberto González

The stakeholders in tricot and their responsibilities

Who participates in which way?



Step 1. Before the project: Preparations

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

Is tricot the right method to use?

Whether to use the tricot method should be based on knowledge of the local farming. Tricot is a methodology for introducing agronomic innovation, such as new varieties of common crops. It is most useful in situations where farmers are experiencing agronomic challenges, like droughts, pest and disease attacks, or where they are insatisfied with product quality. Of course, tricot should only be used when agronomic innovation can be part of the solution!

Pablo Mejía is an agricultural promoter with the NGO "Rural Reconstruction Program" in Honduras. He is leading a tricot project with 200 farmers.

"The farmers in the Yojoa Area of Honduras experience strongly varying yields of common bean. The varieties they have been cultivating for many years are not fit anymore to the prolonged droughts and new diseases.

To improve the farmers' yields, my NGO collaborates with a university research programme, which provided seed of eight new bean varieties with improved drought and disease tolerance.

Now, I and five field facilitators from the local communities work with about 200 farmers in various villages of the Yojoa area. Together, we determined the eight characteristics that will be evaluated: plant vigour, pest resistance, disease resistance, drought resistance, yield, market value, taste, and overall performance.

With this, my team could create the observation card and prepare the 200 individual trial packages for all participants."

A thorough problem analysis must come first. By discussing with experienced field agents and members of your target group about their needs and aspirations, you may decide: Is there a pressing problem that can be solved by agronomic innovation? If yes, which technology should be considered (crop varieties, irrigation technologies, fertilizer dosage, tillage systems)? If you go for a variety introduction project, you need to decide: which crop currently presents most difficulties to the local farmers?

When the above questions have been answered, you know whether tricot is suitable. Tricot can be used for many different technologies, but this methodological guide focuses on crop varieties.

Which crop varieties will be tested?

Researchers should have some varieties in mind, which may solve local problems and be adopted by the farmers. These can be released varieties, unreleased stable lines, local traditional landraces, or just any variety that seems to deserve more attention. The more you know about the agronomic problems which are commonly experienced by the farmers, the more precisely you can select the pool of

varieties. As a start, a total number of 8 to 12 varieties is recommended. A good way to select these from an even larger pool of materials is by doing "Participatory Variety Selection" with a core group of local farmers.

In which area will the project work?

For practical reasons, it is best to work in a defined region. If the project is spread across an entire country, it can be hard to stay in touch with the local facilitators and to assemble the farmers for the initial and final workshops. Nonetheless, it is important to include different climatic zones, so the area should not be chosen too small, either.

How many households will participate?

It advisable to involve as many participants as possible. The more trials are evaluated, the more useful the information about the varieties becomes. But keep in mind that involving more participants will also take more work to assist farmers in completing the process. Avoid including more farmers than the local facilitators can assist. When starting a project and gaining first experiences with the methodology, it is advisable to include around 100 to 200 participants, which is enough to get good results in most situations. In a recent study, good experiences were made with 100 observers and 12 varieties. In following growing cycles, the number of participants may be increased, to involve more farm households in getting to know new varieties and improving their farming. Also, the number of varieties can be increased in subsequent rounds or they can be kept at the same number to see if different varieties are preferred by different farmers in different areas.

Which variety characteristics will be evaluated?

Maybe one variety has highest yield, but another variety grows fastest. Both characteristics can be important, and there may be many more characteristics that matter. You will need to define the variety characteristics that will be evaluated. The characteristic that is always included is crop yield. Also, participants should be asked to give their "final judgement" about the varieties' overall performance. All other characteristics can be defined by consultation with experienced facilitators and local farmers of both genders. Many vegetative and post-harvest characteristics can be evaluated, but it is recommended to pick no more than ten characteristics. With more variety characteristics, participants may be discouraged by the complexity of observation. These are some

Avoid unclear wording

When creating visual materials, or explaining the process to farmers, it is important to choose words carefully. Use words that are clear to all farmers and that refer to the characteristic they need to evaluate. How farmers talk about their crops changes from one area to another. For example, the most "vigorous" variety may be the tallest in one region, but may refer to the thickest shoot in another place. Or, the "fastest development" can relate to either vegetative growth, or fruit maturation. Find out how farmers talk about the variety characteristics, and choose the words that farmers will understand.

examples: Plant vigor, Length of growing period, Drought resistance, Pest resistance, Yield, or Market value of produce. The key question must be: *What really matters to the farmers?*

What do you need to know about the environments and participants?

With the analysis in tricot, it is possible to see if variety preferences are different in different areas or climatic conditions. Or if women and men like different varieties better. Other factors of influence on variety preference can be, for example, household wealth or agronomic management practices. The project implementers need to decide which questions they will ask farmers, to make it possible to give very specific advice about which variety is best for which situation.

Should participation be rewarded?

This question requires careful thought. Providing a reward to motivate farmers could increase participation. But some types of rewards can undermine enthusiasm, curiosity and the desire to learn, and these are often the most important reasons to participate. In several tricot projects, farmers receive some extra seed of the variety they prefer at the end. This reward is closely tied to the goal of the project and motivates participants not only to contribute, but also to pay attention to the process, to be able to pick a good variety.

How much high-quality seed is needed for the project?

In the tricot project, every farmer is given a small quantity of seed of three varieties. The trial package includes three small bags of seed. Each bag should allow for a small plot of several rows, each a few meters length. For example, in a project on common bean, the local team decided that six rows of eight meters length should be planted per variety. With typical sowing distances and agronomic practice, this means about 600 plants in total. One bean seed weighs about 0.2 g. So in this case, 0.2 g x 600 = 120 g of seed were needed for each variety, per trial. In other trials, other seed quantities were given.

The project implementers need to define the size of the trial plots, taking into account the typical size of a farming plot the farmers usually have. The trial plots are the same size on all farms. Once the size of the trial plots is defined, the quantity of seed required for every trial can be calculated as shown below.

To know how much high quality seed of each variety is needed for the whole project, first calculate the total number of small seed bags that will be needed. We always give three bags per participant. On the next page, we present how to calculate the seed quantity required for every variety.

(1) Total number of bags = Participants × 3

Then, calculate how many bags per variety are needed with the following two steps.

(2) Bags per variety = Total number of bags / Number of varieties included in the project

(3) Round up the result from (2) to know how many bags per variety are needed.

The total seed quantity needed per variety is obtained in the last step:

(4) Total seed quantity per variety = Bags per variety × Seed quantity per bag

Calculation example

Imagine a tricot project has:

- ***1000 participants***
- ***14 varieties***
- ***3 varieties (bags) per package***
- ***120 g of seed per bag (about 600 seeds)***

(1) 1000 participants × 3 bags per package = 3000 bags in total

(2) 3000 bags / 14 varieties = 214.3

(3) Round up 214.3 → 215 bags per variety are needed

(4) 215 bags per variety × 120 g = 25,800 g =

25.8 kg of seed is needed for each of the 14 varieties

Which visual materials are needed?

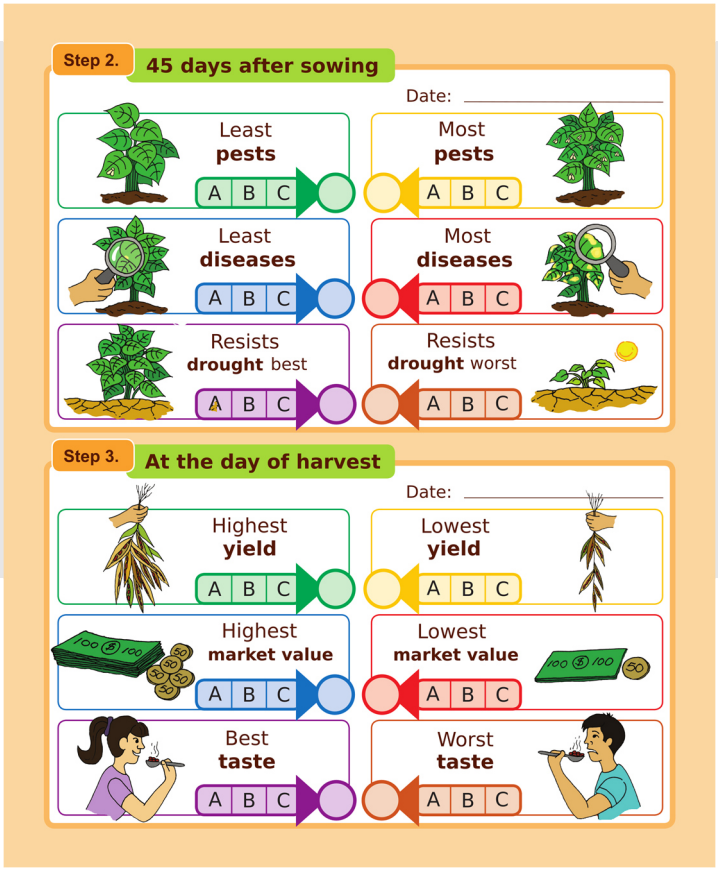
At www.climmob.net you will find examples and illustrations to generate your own visual material. In order to explain the process and to facilitate the data collection, the following materials are needed:

- Informative leaflet or poster: As an aid to explain the research process to the participants
- Observation card: For the participants to collect their observations on the field. It is designed to include participants with a minimal level of literacy.

Observation card (example)

This is an excerpt of the observation card, which is included in the trial package. The participant fills it with her or his observations about the varieties. This example is about bean, using the characteristics selected in a tricot project in Honduras.

A full four-page template is available for free download at www.climmob.net



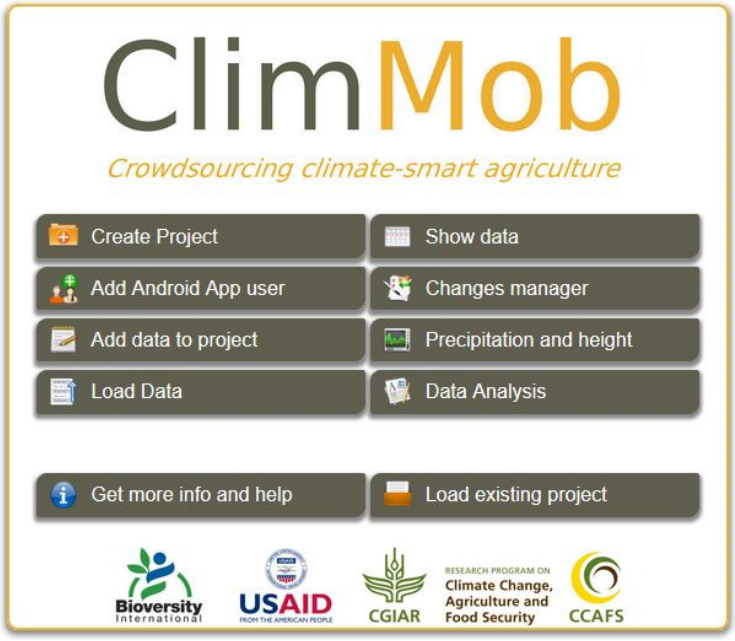
Step 2. Designing the project

Once you have chosen which varieties will be evaluated, and you have identified which crop characteristics are most important to the farmers, your project can start!

Video No. 5

Tricot uses ClimMob, an online platform specially created for tricot projects. ClimMob is the vital tool for any tricot project, and is used for the following activities:

- Designing the study
- Generating the randomized list of combinations of three varieties for the individual trial packages
- Project management, data overview
- Input of the participants' observation data
- Data analysis and automatic generation of the information sheets for the participants



The ClimMob.Manager at www.climmob.net

To start a new tricot project, visit www.climmob.net, go to "tools", and sign up for the ClimMob.Manager. Use your email address as account name, and define a password. You will get an email for the activation of your account, which you can now use at every future login to the ClimMob.Manager.

You can then create a new crowdsourcing project, following the 12 steps explained in the following table.

Step	Activity	Comment
1	***Register yourself***	Do not forget to pin your geographic location on the map.
2	***"Identifier of the project"***	Give the project a name, for example: "Rice_Honduras_ 2016 _season1" It is highly recommended to include the crop, the year or time, and the location, to be able to distinguish the project from others, when you manage multiple projects.
3	***"We request the following information of the farmer"***	These options cannot be changed. They are important for the unique identification of the participant. In a large project, there can be various farmers with the same name.
4	***"Number of observers (farmers)"***	Number of participants in the whole project, for example: 200 When you are not sure, better choose a number too high than too low.
5	***"Number of items each observer compares"***	The number of varieties that each farmer will receive with their trial. We always use 3 options.
6	***"Names of the varieties"***	List here the names of all varieties or technologies included in the project. Type the name of each variety and hit ENTER.
7	***Overall performance*** ***"We suggest these optional characteristics:"***	The participants will be asked to compare the three varieties for their 'Overall performance', that means, which one was *generally* the best variety. These are the crop characteristics that will be evaluated. You can check the characteristic you want to evaluate, and add other characteristics of your own in the next step. The total number of characteristics should not exceed 10 for reasons of simplicity. If you do not check any characteristics, the participants will only evaluate the varieties' 'Overall performance'.

Step	Activity	Comment
8	***"Do you want to include the comparison between the Overall Performance of the project varieties with the observer's local variety?"***	Check the box so participants will be asked to compare the overall performance of the trial varieties with their local variety. Leave unchecked if there are no local varieties.
9	***"Want to add some extra characteristics?"***	Add any other crop characteristic you want to evaluate. You can also leave this space blank.
10	***Explanatory variables***	Including explanatory variables improves the analysis, and may increase the project's benefit for the participants. Check any variable that might influence variety performance. The participants will need to give this information later on.
11	***"Do you want to add extra explanatory variables?"***	Add any other variables that might lead to different variety performance, for example 'Wind barriers'. Write all answer options in the box below, one option per line. You can also leave both spaces blank.
12	***Evaluation***	This last question is included in the project to be able to evaluate its overall success. After collecting all data, assign the correct number to each trial, according to the result you have observed: (1) Success, the trial and data collection were completed successfully. The participant has carried out the trial correctly. (2) Failure due to a natural cause (flooding, drought, etc.) (3) Failure due to missing response by the participant. (4) Failure due to improper execution of the trial by the participant (misunderstanding at collecting data, mistake with the trial code, etc.)

Your project is now created and will always be accessible online! From now on, you can manage your project via your account at www.climmob.net. Only few people, that is, only the project implementers, should know the password and have access to the project data.

Now, a window will show up, offering the download of a "zip" folder including two files. Download the folder, and save it on your computer. Right-click and 'extract' the folder using a free program like *winZip*, *winRar* or *7zip*.

The first file in the folder (for example "rice_honduras_2016_season1") is a complete spreadsheet for all project data. Use this file to collect the participants' observation data. The spreadsheet is an important backup to the online data entry! Also, the data spreadsheet can be used by the local facilitators for the on-site collection and storage of data from participants.

The second file (for example "package_rice_honduras_2016_season1") is the **randomization** - the complete list of variety combinations for the preparation of the trial packages. This list is important: It defines the random combinations of three varieties per trial. Use it when preparing the packages for the participants.

The randomization

ClimMob generates a sophisticated randomization of three varieties for each trial package. In this randomization, all pairwise comparisons of two varieties are included with the same frequency. This balance in the trials is important for useful results. Therefore, it is recommended to strictly adhere to the order given in the second file when preparing the variety packages. If the number of participants is lower than the number of combinations generated in your file, use the first combinations, and leave the ones at the end of the list.

Step 3: Finding the participants

Anybody who wishes to participate can get involved in tricot. Many motivated participants are key to the project's success! The local facilitators are able to identify farmers in their communities, who can contribute to tricot.

Participants should be:

- Volunteers who are ready to commit time and effort to participation.
- Farmers who enjoy experimenting and trying out new things.
- Both women and men, preferably at an even ratio.

The local facilitators, your persons of trust, may recruit participants in the farming communities. Also, hanging posters in agricultural shops, village halls or corner shops may help to attract attention. You do not need to know the farmers already before they participate.

Azucena Fajardo, from La Majada village in the Yojoa area, participates in the tricot project with bean.

"I was asked by a friend, Serapio Orellana, if I wanted to participate.

I am always curious to learn new things about farming. And I want to improve my production of bean. I know it will take work, but I think it will be worth the effort. So I said yes."

Tricot is an iterative process, and farmers can participate many times

When a tricot project has started and farmers participate for the first time, some investments are required. The local facilitators must be trained, and setting up the initial workshops for the participants takes time. During their first cycle, farmers may have many questions and need assistance from the local facilitators. Because the participants will learn many things during the process, and because they get to know only three randomly chosen varieties per cycle, it is encouraged that farmers participate again and again. This way, first-time participants can ask their more experienced colleagues when they have doubts, and the farmers get the chance to experiment with new sets of varieties with every cycle.

Local groups can carry out a trial together!

Carrying out a trial together makes the learning process easier, and participation is more fun. Any existing group, like farmers' committees, credit cooperatives, or a religious group, can receive a trial and participate together. In this case, a 'host' farm is needed, where the varieties can be planted. The host farmer will be the contact person for the local facilitator. All activities can be performed jointly by the group, from planting, to evaluating the trials, to harvesting the crop. Then, in the following season, group members may want to plant a trial for themselves, building on the experiences they gained in the group. To enhance the participation of women farmers, it can be useful to establish 'women's research groups', which are in charge of one tricot trial.

In Siguatepeque, a small town in Honduras, local farmers were invited to an open and free **agrobiodiversity fair**. At this event, researchers and NGOs presented new crops and varieties. The Rural Reconstruction Program also had a stand, where the field promoters explained tricot, registered interested participants and distributed trial packages to many interested farmers.

This way, the tricot project also reached communities where the NGO did not work before. Although not all of them reported back the information, the event was very important to engage new participants. (Photo: Jacob van Etten)

Step 4. Initial workshop and distribution of trial packages

The tricot process starts with an initial workshop. Here, the participants receive the trial packages, and they learn about the process. For a successful project, it is vital that the participants get a good understanding of the methodology.

Video No. 3

Required material and logistics:

- Meeting place for about 20 persons
- Snack
- Projector to show tutorial videos about tricot (these can be found online at www.climmob.net)
- Trial packages. Every trial package contains the following three elements:
  (1) Three bags with equal quantities of seed of three different varieties, according to the randomization that was generated by ClimMob
  (2) The observation card
  (3) A brochure that explains the process to the participant

Each tricot trial package must include these elements:
(1) seed bags, (2) observation card, and (3) brochure.

At the initial workshop:

- Farmers learn about the tricot methodology.
- Participants are registered.
- The trial packages are distributed to the participants.
- The farmers learn how to plant the trial and how to fill the observation card.
- Some agronomic lesson is offered as an incentive for assistance, for example about pest control.
- The incentives and benefits of participation are explained, like receiving seed of the most preferred variety, which the participants will identify via the experiment (seed is distributed before the next growing cycle).

The inception workshop should take place about four weeks before the sowing period, so farmers can adapt their own farm planning. It is most effective to invite not more than 20 farmers at a time. Women and men should be invited at an even ratio.

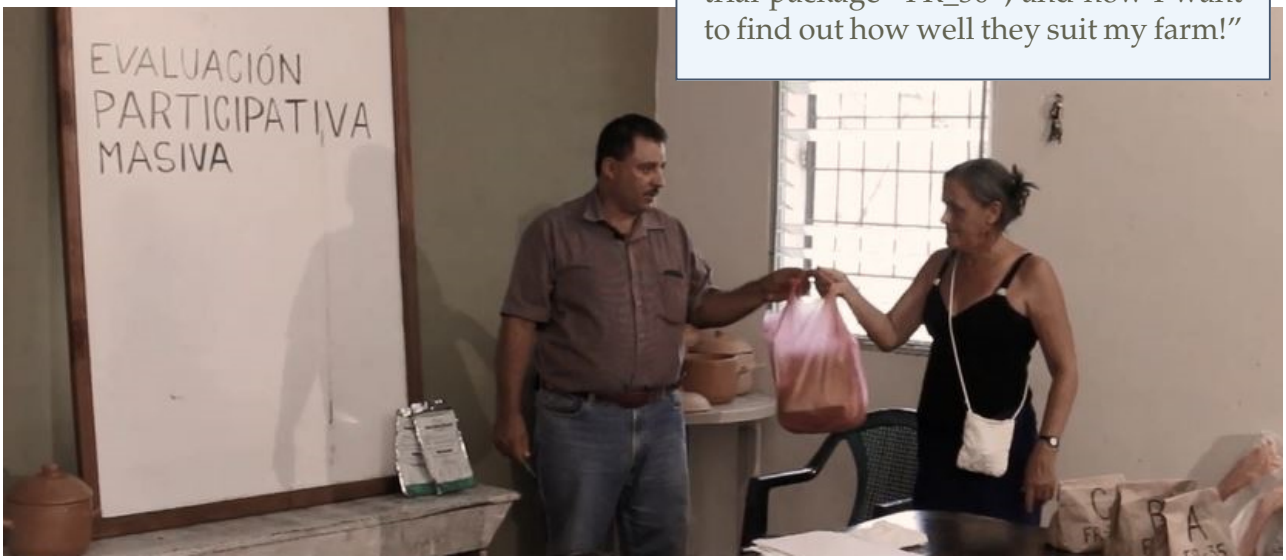
Getting to know tricot

The project implementers, together with the local facilitators, invite the interested farmers to a central installation. This can be a village meeting hall or an NGO office, for example. They explain the tricot methodology, its purpose, its benefits, and the responsibilities the participants have. It is important to visualize what a tricot trial looks like, so farmers can see what is expected from them. If possible, you can

Azucena Fajardo receives a trial package with 120 grams of seed of three varieties, without knowing their names.

"The initial workshop was a good experience. We were about 15 farmers, some I knew, and others I didn't know. The research is really new to us, but Don Pablo explained everything and answered all our questions.

I received three kinds of seed with my trial package "FR_30", and now I want to find out how well they suit my farm!"



Azucena Fajardo, from La Majada, Honduras, receives her trial package at the initial workshop. Photo: Roberto González

plant an example trial nearby beforehand. Otherwise, the trials can be visualized with a video (video 1; available at www.climmob.net).

Registration of participants

For the registration, the application "ClimMob.App" is used on any Android device, like a smartphone or a tablet. When the participants receive their personal packages, they are registered by the project implementers. These base data are required:

- Seed code (trial package code)
- Name of the participant
- Community of residence
- Telephone number with which the participant can be reached
- GPS coordinates of the place of package distribution
- GPS coordinates of the plot where the trial will be sown (this is determined using a map)

Practicing the observation

At the workshop, every farmer receives one observation card just for immediate exercise. It is important to explain the design very well and fill out one card for practice with the participants.

Farmer research group in Honduras.

Step 5. Planting of trials

The participants plant and manage the trials under their responsibility. Every farmer is responsible for his or her own plot.

Two messages are key here:

1. Planting a trial is simple. No special skills are required. Everyone can participate.

2. Participants are farming experts. Participants deserve full respect as generators of new knowledge.

At the initial workshop (step 4 of this guide), the participants have received their packages and have already seen a trial. Now they need to choose a part of their land for planting their own trial. It is important to keep in mind that the trials must represent regular farming practice for the results to be useful.

Keep in mind:

- The trial should be located right next to, or even within the production plot.
- Farmers should neither select the best nor the worst spot, but an average, representative location.
- All varieties must be planted on the same day, together with the production plot, and always receive the same agronomic management.
- The three varieties are planted right next to each other, in the exact same way.
- Each variety covers the same defined number and length of rows, for example: Six rows of five meters length each, or four rows of eight meters length.
- Variety A is planted to the left, B in the middle, C to the right. The borders between the varieties may be marked with sticks or a plastic cord.
- Each trial is planted and managed by the participant in just the same way they always manage their crop. For example: If the participants usually intercrop with another crop, they may also do intercropping with the trial varieties.
- Special attention for the trial, but also negligence will distort the results. For example, if the farmers do not irrigate their production plot, they should not irrigate the trial either.

Apart from the small plot size, there is really nothing new or special about planting the trials! The participants should be confident in their own skills as farmers, and treat the new varieties in their normal way.

Top: Azucena Fajardo has planted the bean varieties of her trial just within the production plot.

Each variety covers 4 rows of 8 meters length.

Left: The varieties were planted in the order of A – B – C.

Step 6. Observation

During the the trials' growing period, the farmers observe the varieties and record their observations on the observation card.

Video No. 2

The questions made in tricot are a new way of looking at things for many participants. Most farmers can tell which of the three varieties they generally like best. But it is not always easy to decide which one has the best growth form, for example. Still, the participants are able to make very accurate observations!

The participants observe the varieties in their trials and always focus on only one crop characteristic at a time. The observations they make always follow the same structure: The 'best' and the 'worst' among the three trial varieties needs to be identified. The participants mark their choices on the observation card. There, the question is put in as few words as possible to make it easier for participants who read slowly. For example, instead of asking "Which of the three varieties has developed the best foliage?" the observation card just asks "Best foliage".

Focus on one crop characteristic at a time

Sometimes it is hard to see that a variety looks rather bad, but still performed best in one certain characteristic. For example in pest resistance: Imagine a variety that was heavily affected by drought and diseases and hardly produced yield, but which was spared out completely by insects. For good results, it is crucial to really focus only on the crop characteristic under evaluation, and ignore all others!

Choose the right dates for evaluation

Appropriate timing is important, and the participants should be told at what day from planting each crop characteristic needs to be evaluated. It is common to evaluate the trial in three stages: earlier-developing characteris-tics (for example, foliage development), later-developing characteristics (for example, disease resistance) and post-harvest characteristics (for example, yield, market value). The project implementers should suggest the evaluation steps and dates to the participants.

Serapio Orellana, from El Barro village in the Yojoa area, is a field facilitator for the tricot project. But he also participates as a farmer and grows three bean varieties in his own trial.

"Of course, we farmers always have an eye on our plots. And every farmer can tell you if the crop looks good or bad.

But for us, the observation in tricot was a new thing to learn: To look very closely only at single aspects, like the pest resistance.

Also, I have never compared the taste of three varieties like this. They really taste differently!

As a field facilitator, I help other farmers with the observations on their trials. Sometimes, variety A has the best vigour of all, but then the fruit gets attacked by diseases. You never know what the varieties are like before the end of the season!"

Provide follow-up assistance

Many farmers have a busy life, and tricot will be one activity among many others. By telephone calls, the project implementers or the local facilitators may keep track of their evaluation and remind them of upcoming observation steps. The telephone calls will also help to clarify open questions, and they let farmers know that their contribution is important and valuable. Within their own capacities, the local facilitators may also support farmers directly in the evaluation at the plot.

Over the course of the whole growing season, Azucena Fajardo duly filled this observation card with her observations:

Step 7. Data compilation

The farmers cultivate the three varieties and evaluate their trials. The local facilitators collect these observations from them, and pass them on to the implementing organization.

Every participant (or group of participants) observes one trial. They mark their personal observations on the observation card. The local facilitators then collect these observation data from all participants. Each local facilitator may be responsible for up to 25 participants.

The local facilitators have different options for collecting the data from the farmers.

Local facilitators have different options for collecting data. For example, they may use the ClimMob.App on a tablet computer or a smartphone running under Android. Alternatively, they can also collect all farmer observations using a printed spreadsheet. The project implementer can prepare the spreadsheet: It is a printout of the relevant lines for each local facilitator, from the complete project spreadsheet (file 1) generated in step 2 of this guide.

The local facilitators then pass on the data to the project implementers. These integrate the data from the whole project, and update the project's online database at www.climmob.net

Only the project implementers should know the password and have online access to the project!

Different ways of data collection and compilation are possible. It is important to take the different paths into account when planning the project. Local facilitators may choose the most convenient option for them.

Pablo Mejía had the experience that different strategies for data collection work best, depending on the individual participant:

"We always use a mix of the different ways we have available for collecting the data from the participants.

For example, my colleague, field facilitator Serapio Orellana, visits some farmers and collects their observation sheets after the harvest. Then he hands them to me, and I add the data to the project via the ClimMob.Manager on my computer.

With some farmers who live very far away, we arranged that I call them from time to time. This works fine, because we trust each other.

Serapio, myself, and the other field facilitators all have smartphones, where we have installed the ClimMob application. This is how we collect most farmer observations.

When we I am out in the communities for other lines of my NGO's work, or when Serapio visits the participants, we ask for their observations. Wherever we are, we can then directly save them on our phones. "

Options for data collection:

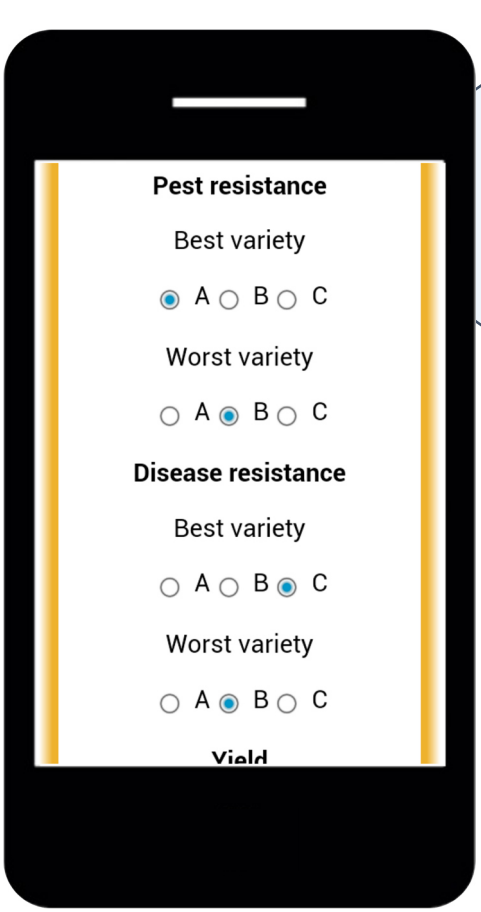
- Collect observation cards and copy participants' observations to a printed spreadsheet.
- Take photos of the observation cards to copy the data later, directly into your database with the ClimMob.Manager. Remember to write down the participants' name with the number of each photo.
- Add data directly to your database using the ClimMob.App in your mobile device. A telephone network is not required while inserting the data.
- Call the participants on their own or their neighbour's telephone.

To upload the new data to your database, there are three possibilities:

(1) "Send data" with the ClimMob.App on a device running under Android

(2) "Add data to project" in the ClimMob.Manager

(3) "Load existing project" in the ClimMob.Manager to replace the whole data spreadsheet by an updated one



ClimMob.App

This is just an excerpt of what data collection with the ClimMob.app looks like. After you select the participant by village and name, you can easily enter all of her or his observations in your hand-held device.

Missing data?

Before moving to the next step, be sure all available data from all farmer trials has been entered to your database.

Press the button "Show data" in the ClimMob.Manager anytime to see which data are still missing!

Step 8. Data analysis

When all your data is inserted to your ClimMob database, the analysis can start!

Video No. 7

The analysis will give you two useful results:

- A rating of how well each variety performed for each crop characteristic
- Information on differing performances depending on the growing conditions or characteristics of the participants (For example, the highest yielding variety with irrigation, and the highest yielding variety without irrigation; variety preferred by women, variety preferred by men)

The analysis is conducted using just a few steps:

(1) Press the button "Data Analysis" in the main menu of the ClimMob.Manager.

(2) Select the project you will analyze.

In some cases, you may implement various projects at the same time, for example for different crops or in different regions.

As an exercise, you can try out the procedure with the 'example' project, which is offered as an option in ClimMob.

(3) Select the explanatory variables you want to include.

Explanatory variables can lead to a better understanding of different observations about the varieties, and to more useful results. For example, one variety may perform best under irrigation, but in drought conditions, a different variety may give best results. It is best to include every explanatory variable one by one. If all variables are included at the same time, the analysis can take a very long time, and the results will be difficult to interpret.

Pablo Mejía of the "Rural Reconstruction Program" kept an overview of the data that was supplied by the farmers, and carried out the analysis.

"Not all of our participants could finish their trial. So for some trials, we only have the observations on the first attributes.

In a few cases, we also lost contact to the farmer. Maybe they changed their telephone number, for example.

But all in all, I could still compile data from more than a hundred trials, and produce the information sheets for all participants.

I ran the analysis for all crop attributes. For the explanatory variables, what mattered most was altitude and irrigation, because these are factors with strong variation between the villages and farms.

The results were quite suprising! We saw that many participants really liked the variety "Chepe" in the lowlands. But in the higher areas, it was susceptible to diseases, so farmers preferred another variety there.

The results are also interesting for the university researchers, who gave us the seeds"

(4) Select all crop characteristics you want to analyze.

You can select all characteristics at once, or just the ones you are interested in right now.

(5) Select the documents you want to generate. Two types of outputs are possible:

- ***Analysis report***

Directed to the implementing organization and the researchers. It is a report presenting all results: It tells you which varieties performed best for every crop characteristic, and whether there are any differences due to explanatory variables, for example irrigation.

- ***Information sheets***

A document will be created, including a personal information sheet for every participating farmer. These sheets contain:

  - The names of their three specific trial varieties
  - The name of the most recommended varieties for the participant's own farm

(6) Press OK.

Depending on the number of observers, the analysis can take a long time. In some cases, it may take up to half an hour to generate all the info sheets.

The information sheet

Thank you for your participation!

Community: **La Majada**
Name: **Azucena Fajardo**
Package code: **FR_30**

In the following, please find the results of the research you have participated in:

You had received the following varieties for evaluation:

Variety	Name
Variety A	Vaina Morada
Variety B	Jamapa
Variety C	Bayo

You have ranked these varieties in the following order:

Crop attribute	Best	Second	Worst
Plant vigor	Jamapa	Bayo	Vaina Morada
Pest resistance	Jamapa	Bayo	Vaina Morada
Disease resistance	Vaina Morada	Jamapa	Bayo
Drought resistance	Bayo	Jamapa	Vaina Morada
Yield	Bayo	Vaina Morada	Jamapa
Market value	Jamapa	Bayo	Vaina Morada
Taste	Jamapa	Bayo	Vaina Morada
Overall performance	Jamapa	Bayo	Vaina Mora

These are the best and worst varieties which you and other similar observers (Region, Irrigation, Altitude) received:

Position	Variety
Position 1	Jamapa
Position 2	Bayo
Position 3	Talete
Position 4	Negro Criollo
Position 5	Nayait
Position 6	Michigan
Position 7	Vaina Morada
Position 8	Vaina Blanca

This is the information sheet for Doña Azucena.

With her information sheet, Azucena Fajardo now learns the results of her trial:

The first table tells her that her three varieties A, B and C are called “Vaina Morada”, “Jamapa”, and “Bayo”.

The second table repeats her own evaluation. For example, for Overall Performance, she had ranked the variety “Jamapa” as best.

The third table presents the full ranking of all eight varieties in the project, based on the observations of all farmers within the same group as Doña Azucena.

This group is defined by the three explanatory variables “region”, “irrigation”, and “altitude”.

The results show that “Jamapa” really is the best available variety for the conditions at Azucena’s farm!

Step 9. Final workshop

You have run the analysis. Now the participants are eager for the results of their trials! All participants get invited to a final workshop to receive and discuss the results.

Soon after all data is collected and the analysis is done, all participants are invited to final workshops where they receive their info sheets and get the chance to discuss the results. The participants have made many different experiences with their trials, and sharing these among the participants is very important for the learning process. Plan at least half a day for each workshop.

Preparations for the final workshops:

- Like for the initial workshops, invite about 20 participants per event to some central place that is accessible for all.
- Ask all participants to bring some samples of the harvest from their trials.
- Have the information sheets for all participants prepared and printed out.

The workshop consists of three parts:

(1) The project implementers or the local facilitators present the overall results of the variety evaluation.

(2) The participants receive their personal info sheets and have time to discuss the results. It is recommended to form groups of five persons for this activity.

(3) Participants then receive a practical agronomic lesson as an incentive for participation. For example, you may introduce important knowledge about seed storage or seed selection.

These are points that facilitators need to take into account:

- Discussion among the participants is important: Everyone can learn from another!
- It is crucial to make clear that there is no single best variety. In fact, for every farm, a different variety can be the most suitable!
- Seed exchange should be fostered. At the workshop, the farmers can exchange, deal, or share the new seed among themselves.

Don Pablo, who led the tricot project on bean, is satisfied with the feedback:

"The final workshops are perhaps the most important days of the tricot project! It was a pleasure to see how the participants vividly discussed their experiences with the different varieties!

But also we from the Rural Reconstruction Program learned a lot from the participants:

For example, at the workshops, many farmers expressed that they wanted to learn more about pests and diseases. So we will put these issues in focus at the initial workshops of the next cycle.

Hopefully, with many of the current participants, again!"

Step 10. Evaluating the project

The first tricot cycle has finished. Now it is time to ask: What can be improved?

Countries, crops and people are diverse, so every tricot project is different. This booklet can only be a guide to assist you in designing your own local project. Tricot is an iterative process, and the last step in a project cycle is the evaluation of the project. This way, the procedure can be adapted flexibly to local conditions, so the next cycle will be even more effective.

Listening to the participants' experiences is most important. It is crucial that the participants perceive tricot as both simple and beneficial. You should try to identify possible improvements in these aspects.

At the final workshops, participants can express their experiences, recommendations and complaints about the process. Moreover, the local facilitators can make many valuable comments and recommendations, because they have constantly been in touch with the farmers.

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

Also, with the results of every cycle, you may identify one or two varieties which were not well accepted by the farmers. Then, for the next cycle, you can discard those varieties that were ranked lowest by the participants, and replace them with new material. This way, there is constant, 'refreshed' input to the seed system, and the farmers' chances of discovering a useful variety remain high.

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

Indicator 1: The rate of completed trials

Count the trials that were fully completed, as well as the trials where data is missing. You evaluate whether the loss of information is due to natural causes (drought, etc.) or to the management of the trial by the participant (for example, a mistake with the package code, lack of interest in finishing the observations, etc). This way, important knowledge about the specific difficulties can be generated, which will help you to find strategies to avoid those.

Indicator 2: The gender ratio of participants

Women tend to have less access to the profits of agricultural production, and other resources generated by such work. Participaton in a tricot project can open doors for the empowerment of women. It is recommended that every tricot project strive towards a balanced gender ratio among participants by specially encouraging the participation of women.

Indicator 3: The rate of farmers who participate again, after the first cycle

This is a clear indicator of the participants' motivation. If many persons do not want to participate a second time, something needs to be changed about the tricot process design.

Indicator 4: Changes in the seed choice

On the observation card, the farmers write whether they will continue planting any of the new varieties from their trial. If they choose to plant at least one of the three varieties, this shows the impact of the trials on the local seed diversity. If no or very few farmers want to keep planting the varieties, then the initial selection of varieties may have been inadequate.

Indicator 5: Changes in seed and information exchange

Because of their joint experience in the tricot trial, farmers may become more active in experimenting with seeds and exchanging seeds and information within their communities. This can be checked a year after the tricot trial by talking to the participants as well as to other farmers in the communities.

Glossary

Analysis report	Summary of the results of the tricot project. It is generated automatically using the ClimMob.Manager and is directed to project implementers and researchers.
Android	Operating system of the majority of smartphones and tablet computers (Samsung, BLU, Huawei, and more). ClimMob.App, the ClimMob application, will not work on any device by the brands Apple or BlackBerry.
ClimMob	Software and online platform for the design and management of any tricot project. The database of all projects is saved here. (www.climmob.net)
ClimMob.App	Application for the use of ClimMob on mobile devices running under Android. It can be used offline and without telephone network. The participants' data is saved on the device and can be sent to the database at a later moment.
ClimMob.Manager	Online tool for project implementers within ClimMob, for setting up and managing a tricot project. Also used for the analysis of results and the generation of information outputs at the end of the project.
Crop characteristics, Evaluative characteristics	The 5 to 10 crop characteristics that will be evaluated within the tricot project. The most important crop characteristics for the participants should be chosen in consultation with all actors. For example: Foliage, disease resistance, yield, and others.
Crop varieties	Between 5 and 20 varieties of one same crop, which may be suited to the climate of the research region and accepted by the participants. For example, it can be unreleased varieties, local releases or traditional landraces, or varieties from other regions with similar climatic conditions. The researchers select the varieties, and it is recommended to begin a first project with a number of 8 to 12 varieties.
Explanatory variables	Information about meteorology and agronomic management of the trials, serves to improve the analysis. The explanatory variables refine the results and help to identify the most suitable variety for the local conditions of every participant. Examples:

	Use of irrigation, use of fertilization, season was rainier or drier than usual, etc.
Identifier of the project	Individual name of the tricot project. It is recommended to include the crop, the year, the season, and the region. Example: Wh_2016_Sp_Nor (= Wheat, Year 2016, Spring season, Northern region)
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. The implementers have the major responsibilities in the project, for example: • Train the facilitators and participants, • Distribute the trial packages, • Carry out the data analysis once all data is collected and compiled, • Feedback the information to the participants via the facilitators.
Info sheets	Personalized information output for every participant. It is generated automatically using the ClimMob.Manager and includes: (1) The names of the three varieties which the participant received, (2) The names of the most recommended varieties for their farm, (3) Information about how to access more seed.
Local facilitators	Lead farmers of rural communities, who are trained and remunerated by the implementing organization to assist the participants with the cultivation and evaluation of their trials. They collect the data from the participants and pass it on to the project implementers.
Observation card	Pictorial form printed on thick paper, which the participants use to mark their evaluation of the varieties at the trial plot. A generic design can be found for download at www.climmob.net, and needs to be adapted to the local requirements by a graphic design studio.
Participants, Observers	Farmers of both genders, who commit to sowing a trial, carrying out the observations, marking the observations on the observation card at the appropriate dates, and eventually reporting the observations to the local facilitators.

Personal information

In step 3 of creating a tricot project with the ClimMob.Manager, you will see a list of the personal information which the participants will be asked to provide. This data is needed to identify the individual participants from within a large number of participants, and to be able to contact them in case of a question. It includes: Name, village, name of spouse or parent, telephone number.

Randomization

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

Researchers

Experts for the crop under evaluation. They select the varieties to be included in the project and supply quality seed to the implementing organization.

Seed code, Package code, Trial package code

Unique ID specifying a participant's combination of varieties in the specific trial package. It should contain the crop, the growing season, the region, and the package number. Example:

Wh_2016_Sp_Nor_100 (= Wheat, Year 2016, Spring season, Northern region, trial number 100)

A complete list of all seed codes and variety combinations (the randomization) is provided by ClimMob when the project is created.

Technologies

With tricot, many different kinds of farm innovation can be tested. Crop varieties can be one kind of technology, but also different irrigation systems, fertilizers, or cropping styles are "technologies" and can be tested by tricot.

Trial, Mini-trial

Cultivation and observation of three different varieties of one crop, by a farmer in a small area of her or his own farm.

Trial package

Bag given to every participant at the initial workshop. It contains:

(1) Three small bags with the same quantity of seed of three different varieties. They are marked with "A", "B", and "C", as well as the seed code.

(2) Observation card

(3) Explanatory brochure about the tricot process

Trial plot

A small area within or at the margin of the participant's production plot, with representative soil conditions. It is divided into three equal parts, for the varieties A, B, and C.

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PRUEBA3

Crowdsourcing crop improvement: Evidence base and outscaling model

Evaluación participativa masiva: Base evidencial y modelo de escalamiento

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