Testing climate-smart agricultural technologies and practices in South-east Asia: a manual for priority setting

Working Paper No. 133

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Ronnie Vernooy, Arma Bertuso, Bui Vinh Le, Huong Pham, Louis Parker, Yumiko Kura

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

Working Paper

Testing climate-smart agricultural technologies and practices in South-east Asia: a manual for priority setting

Working Paper No. 133

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Ronnie Vernooy
Arma Bertuso
Bui Vinh Le
Huong Pham
Louis Parker
Yumiko Kura

Correct citation:

Vernooy, R., Bertuso, A., Bui Vinh Le, Huong Pham, Parker, L., Kura, Y. 2015. Testing climate-smart technologies and practices in South-east Asia: a manual for priority setting. CCAFS Working Paper no. 133. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available online at: www.ccafs.cgiar.org

Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is a strategic partnership of CGIAR and Future Earth, led by the International Center for Tropical Agriculture (CIAT). The Program is carried out with funding by CGIAR Fund Donors, the Danish International Development Agency (DANIDA), Australian Government (ACIAR), Irish Aid, Environment Canada, Ministry of Foreign Affairs for the Netherlands, Swiss Agency for Development and Cooperation (SDC), Instituto de Investigação Científica Tropical (IICT), UK Aid, Government of Russia, the European Union (EU), New Zealand Ministry of Foreign Affairs and Trade, with technical support from the International Fund for Agricultural Development (IFAD).

Contact:

CCAFS Coordinating Unit - Faculty of Science, Department of Plant and Environmental Sciences, University of Copenhagen, Rolighedsvej 21, DK-1958 Frederiksberg C, Denmark. Tel: +45 35331046; Email: ccafs@cgiar.org

Photos: Bui Vinh Le (CIAT) and Ronnie Vernooy (Bioversity International)

Abstract

The project Integrated agricultural technologies for enhanced adaptive capacity and resilient livelihoods in climate-smart villages (CSVs) of Southeast Asia aims to provide climate-smart agriculture options to enhance adaptive capacity among CSV farmers and stakeholders, and contribute to more climate-resilient livelihoods, in selected sites in Cambodia, Lao PDR and Vietnam. In order to facilitate a participatory process leading to the selection of the most effective technologies and practices, a team of CCAFS researchers worked on the development of a priority-setting manual. This manual includes a number of principles and a sequence of six steps which were developed based on a critical review of past and ongoing participatory climate-smart technology selection experiences carried out as part of CCAFS in Africa and Asia, the experiences of the research team with similar processes and activities and were complemented by insights from the literature. A draft of the manual was put to test by the CIAT-Asia coordinated project research team in Ma village in the north of Vietnam in July 2015.

Keywords

Adaptation; Climate-smart agriculture; Priority setting; Technology assessment.

About the authors

Ronnie Vernooy is a genetic resource policy specialist at Bioversity International, Rome, Italy. Email: r.vernooy@cgiar.org

Arma Bertuso is a senior research associate at the International Potato Center in Los Baños, Laguna, the Philippines. Email: a.bertuso@cgiar.org

Bui Vinh Le is a soil scientist and research coordinator at the International Center for Tropical Agriculture, Asia office, Hanoi, Vietnam. Email: v.bui@cgiar.org

Huong Pham is a research associate economics and marketing at the International Center for Tropical Agriculture, Asia office, Hanoi, Vietnam. Email: p.huong@cgiar.org

Louis Parker is a geo-spatial analyst at the International Center for Tropical Agriculture, Asia office, Hanoi, Vietnam. Email: l.parker@cgiar.org

Yumiko Kura is the regional program manager – Greater Mekong Region at WorldFish, Phnom Penh, Cambodia. Email: y.kura@cgiar.org

Acknowledgements

The research for this paper was made possible thanks to the technical and financial support of the CGIAR Research Programme on Climate Change, Agriculture and Food Security (CCAFS). We thank the villagers of Ma village, Yen Binh district, Yen Bai province, in north Vietnam for their willingness to try out the methodology described in this paper and for their frank feedback. We thank CCAFS colleagues working in Cambodia, Lao PDR and Vietnam for their comments on the methodology trial experience in Ma village and suggestions made to improve the process. CCAFS colleagues working in Colombia, Costa Rica, East Africa and India provided useful resources and references for which we are grateful. We thank Arwen Bailey (Bioversity International) for the text editing and useful suggestions to improve the document.

Contents

Acronyms

CSA	Climate-smart agriculture
CSV	Climate-smart village

Introduction

The project 'Integrated agricultural technologies for enhanced adaptive capacity and resilient livelihoods in climate-smart villages (CSVs) of Southeast Asia' aims to provide climate-smart agriculture (CSA) options to enhance adaptive capacity among CSV farmers and stakeholders, and contribute to more climate-resilient livelihoods, in selected sites in Cambodia, Lao PDR and Vietnam. Research focuses on integrated CSA technologies and practices which: apply across crops or farming systems; create synergy with parallel research interventions for farm productivity, food security or income generation; demonstrate potential outcomes within a farm-to-landscape setting; and are available for immediate field-testing as derived from earlier research by CGIAR centres and research programs. One of the expected outputs of the research is location-specific, integrated technologies and practices with potential for adaptation and upscaling beyond CSVs.

In order to facilitate a participatory process leading to the most effective technologies and practices, a team of CCAFS researchers worked on the development of a priority-setting manual for the selection of a small number of promising technologies and practices. This manual includes a number of principles and a sequence of six steps. These principles and steps were developed based on a critical review of past and ongoing participatory climate-smart technology selection experiences carried out as part of CCAFS in Africa and Asia (Mwongera 2015, Shikuku et al. 2015, Taneja et al. 2013), the experiences of the research team with similar processes and activities (e.g. UNU-IAS, Bioversity International, IGES and UNDP, 2014; Vernooy, 2003) and were complemented by insights from a number of articles about CSA, resilience

(frameworks and indicators), and participatory technology selection (e.g. FAO 2013, Herrero et al. 2014, Reed et al. 2013, Ribot 2014, Sumberg et al. 2003). A draft of the manual was put to test by the CIAT-Asia coordinated research team implementing the project 'Integrated agricultural technologies for enhanced adaptive capacity and resilient livelihoods in climate-smart villages (CSVs) of Southeast Asia' in Ma village in the north of Vietnam in July 2015 (see Smith 2015 for an impression of the village). Lessons learned from the pilot testing of the manual were subsequently used to revise the draft manual.

Apart from this Introduction, the manual has three sections (Principles, Process, Conclusion), two annexes and a short reference list.

Principles

- Lessons learned from past technology interventions (failures and successes) will be taken into consideration and built upon.

- Promising technologies to be introduced for testing can come from many sources including farmers' own practices.

- Promising technologies will be described in detail with the help of (audio)visuals considering that many farmers have weak reading skills. Apart from technical descriptions, aspects that require attention include: costs (in terms of labour and other inputs required), time horizon (e.g. number of years before fruit trees bear the first fruits), and risks (e.g. price volatility, pest and disease susceptibility).

- Technologies developed or under development by CGIAR centres are not prioritized *per se*.

- The priority-setting process is conducted stepwise and farmers are given enough time to reflect on and discuss among themselves the options presented.

- More than one technology can be tested at a time—assuming sufficient resources are available—in particular to respond to possible different interests and needs in the village, e.g. of landless villagers, less resource endowed households, women and men farmers.

- The interests and needs of women, given their key roles in agriculture, receive special attention during the process of priority setting.

- Given the permanent or temporary outmigration of youth that is occurring in many rural areas, age is another social variable of importance requiring special attention.

- The results of the *ex ante* characterization and assessment of the proposed basket of technologies are used for the final selection of technologies proposed for testing.

- Use is made of a conceptual framework that puts livelihoods at the centre of the analysis. In this framework, developed for the project by the project research team, livelihoods are shaped by macro level factors such as the history, political economy and agro-ecological characteristics of the country, by climate (change) dynamics (including longer term changes of key climate variables and changes in the nature and frequency of extreme weather events), and by micro level factors such as access to natural resources, information, services and markets; natural resource management knowledge and skills; and kinship and social relationships. The degree of capacity to adapt to climate change and/or mitigate climate change impacts is the (emerging) result of the interplay of the factors mentioned.

Process

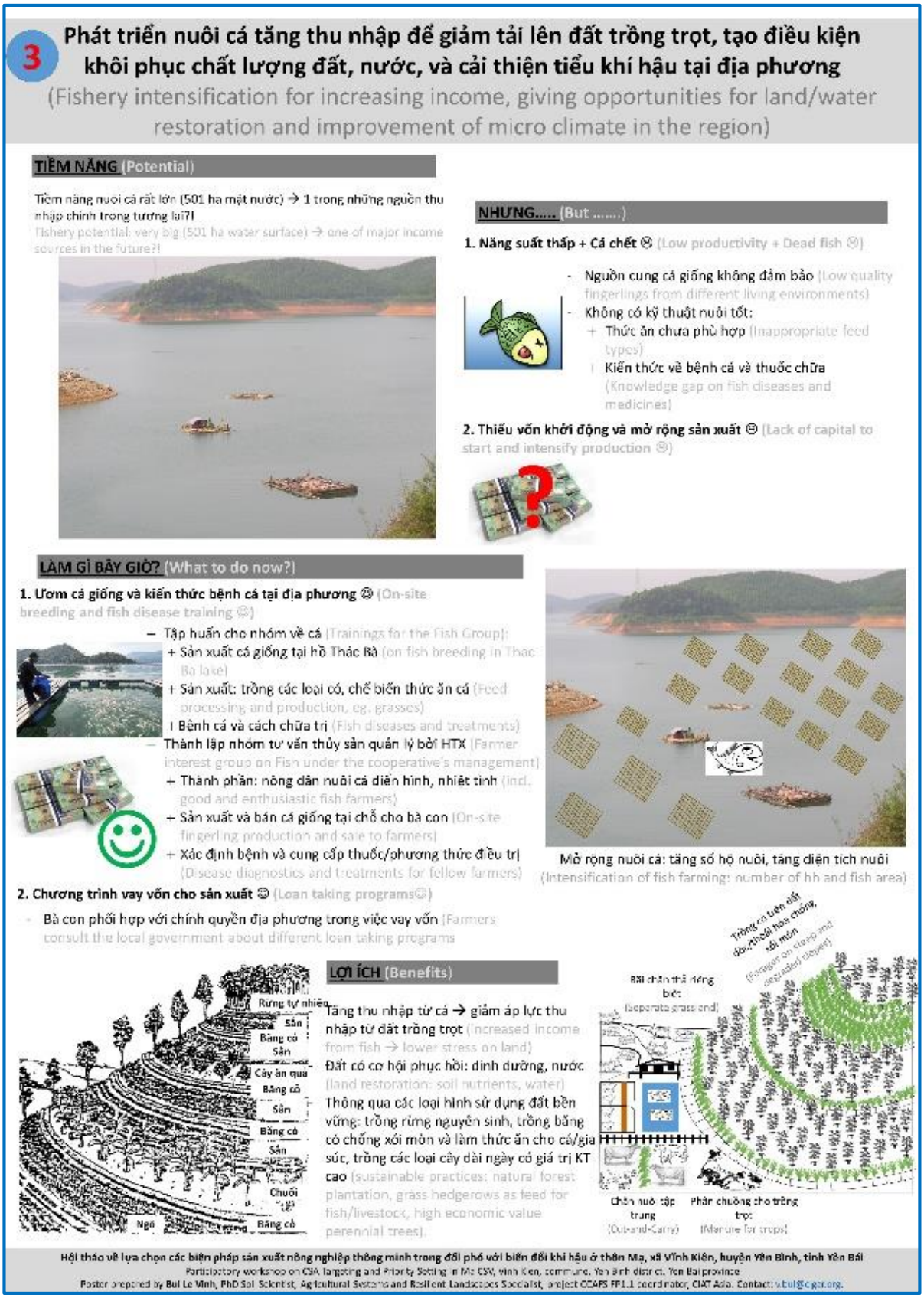
Taking into account the principles described above, a six-step priority-setting process is proposed:

1. Selection of initial basket of promising technologies
2. Participatory *ex ante* assessment of the initial basket of promising technologies (technology fair)
3. Discussion with farmers of shortlisted promising technologies
4. Interactive technology event
5. Scoring and final ranking of promising technologies by farmers
6. Selection of one or more promising technologies for testing

Each of the six steps is described in the following paragraphs.

Step 1: The research team in each CSV site puts together an **initial basket of promising technologies** based on suggestions from women and men farmers, extension agents, national and international researchers and others with sound knowledge of the issues at stake, the local history and context, the experiences with past technology interventions, and the scientific knowledge available of the technologies proposed. The number of technologies in the basket should be kept to a workable amount to allow for enough time to assess each technology (see next steps). From the experience in Ma village in Vietnam, no more than ten is suggested.
The research team collects relevant information about the technologies in this initial basket and summarizes the key features **in a way that farmers can easily understand** (e.g. poster format using drawings and/or photos, short audiovisuals; see Image 1 for an example of a poster used in Ma village, north Vietnam.
There is no precise format suggested to describe each of the technologies, but a general rule is that the more detailed information the better. Annex 1 offers a guideline with a series of detailed questions that could orient the preparation of the posters and/or audiovisuals.

Image 1. Poster for the technology fair in Ma village, north Vietnam (poster design: Bui Vinh Le, CIAT).



This initial basket should have a balanced mix of technologies of two kinds: 1) those that farmers can apply 'individually' (at the household or farm level) and 2) those that are applied at a landscape level (thus requiring collective action by a group of farmers or all the farmers in the site). The basket should have a good number of technologies that address two or more dimensions of climate smartness as defined by CCAFS. The dimensions are: weather, water, soil, seeds and breeds, energy and markets.

Technologies should be titled by using a few clear key words and described as precisely as possible including a reference to the envisioned users. Apart from technical descriptions, aspects that require attention include: costs (in terms of labour and other inputs required), time horizon (e.g. number of years before fruit trees bear the first fruits), and risks (e.g. price volatility, pest and disease susceptibility).

Step 2: The research team facilitates a **participatory *ex ante* assessment (known as a technology fair) of the initial basket of promising technologies** in the research site. Depending on the size of the village or site, either all farmers or a carefully selected smaller number of farmers and local extension agents are invited to visit the technology fair. Experience suggest that one can work well with a group of up to 40 farmers. The selection of a small number of farmers should take into consideration the composition of the CSV in terms of sex, age, ethnicity and social class (in terms of wealth).

This exercise has the following sequence:

i) Preparation by the research team of brief presentations of each of the technologies in the basket (use of audio-visuals is recommended).

ii) Brief presentations of the technologies in the basket to all or selected farmers and extension agents.

iii) Farmers go around the technology fair (posters). Posters could be grouped by type, for example, technologies that require collective action and technologies that can be applied at the individual farm level. Each poster should be given enough space for viewing. All posters should be easily visible and reachable. Researchers can be on standby to answer questions farmers may have, but they should limit themselves to offering factual

answers and not opinions about the suitability of the technologies. In Ma village the posters were displayed outside; see Image 2.

Image 2: Poster display in Ma village, north Vietnam (photo: Bui Vinh Le, CIAT).

iv) Farmers and researchers regroup in plenary for a brief exchange of impressions and observations about the technologies at display/showcased. Questions to guide the exchange could be: What do you think about the poster/audiovisual presentation of the technologies? Were the posters/audiovisual presentations clear and providing useful information? Was any information that you were looking for not included? Were you familiar with the technologies presented or were they new? Which ones were new? What was the most interesting technology presented and why? Would you be interested in testing it and why?

It is recommended that a "roaming rapporteur" be selected from among the research team to capture comments and suggestions made by farmers at the poster display and while looking at the audiovisuals.

In order to capture the likely different opinions in the group, it is important to use techniques that allow women and men, younger and older, less and more experienced farmers to express themselves freely without feeling like

they are contradicting more powerful people. This might not so easy given that in a plenary setting usually the leaders tend to dominate the conversation.

The plenary exchange offers some initial feedback on the technologies displayed. Based on the results of the plenary discussion, the next step is to give every single participant a chance to provide her or his feedback on each of the technologies. This will be facilitated by means of a **technology characterization and scoring card**. The card can be found in Annex 2. Farmers receive one card for each technology presented. It is recommended that the technologies be numbered and the scoring cards accordingly. If the wish is to trace the scoring to the individual farmer, then farmers should be asked if they agree to write their name on each of the scoring cards. However, this practice might not always be acceptable in some contexts and cultures. See Image 3 for an impression of farmers trying out the draft scoring card in Ma village, north Vietnam.

Image 3: Farmers from Ma village scoring the technologies displayed at the technology fair (photo: Ronnie Vernooy, Bioversity International).

v) There are two options for filling out the characterization and scoring card: 1) Prior to the technology fair, done by the research team; 2) During the technology fair done together with the farmers. The first option saves time but does not allow for further interaction with farmers, while the second option takes time but allows for interaction with farmers. From the pilot

experience in Ma village in north Vietnam where 10 technologies were introduced it emerged that the second option proved very time consuming. If the number of technologies is ten or more, it is likely more efficient to fill in the cards beforehand.

vi) Scoring of the input and output indicators by each one of the farmers, facilitated by one of the members of the site research team. To keep things simple for the farmers, three scores are used only:  . The happy face means "I happily accept/I am very willing to accept this". The sad face means "It is hard for me to accept this/I am reluctant to do this. The neutral face means "I am not so sure about it". These scores can be translated into points: 1 for the sad face, 3 for the netral face, 5 for the happy face respectively (1-3-5 are suggested to capture relative differences more easily). The characterization and scoring card could be enlarged by one more column to record farmer's observations about his/her own scoring. Although this will likely provide useful information, it will slow down the scoring process.

vii) Comparison of the technology characterization scores, facilitated by one of the members of the site research team. Scores can be compared according to one or more of the variables of sex, age, ethnicity and social class. It is recommended that results be shared with the farmers the same day of the technology fair or during the days immediately following the technology fair so that this step can be concluded properly and in a timely fashion.

viii) Ranking of the technologies based on the comparison, facilitated by one of the members of the site research team.

Step 3: Based on the results of step 2 and taking into consideration the resources available for testing in the CSV site, the research team puts together **a second and reduced version of the basket of promising technologies to be discussed with farmers in an interactive way**.

Optional: At this stage, the CSV team could prepare additional information to be communicated to farmers. A number of tools are available that might be useful including:

- Land-use planning analysis, developed by CIAT
- Climate modelling, using WorldClim data. WorldClim is a set of global climate layers that can be downloaded for free via http://www.worldclim.org. These layers cover all global land areas except Antarctica and consist of 19 bioclimatic variables derived from monthly temperature and precipitation values. Bioclimatic variables represent annual trends, seasonality, and extremes. They are in the latitude/longitude coordinate reference system.
- Crop suitability analysis (EcoCrop), developed by CIAT with support from Bioversity International and the International Potato Center. http://gisweb.ciat.cgiar.org/ClimateChange/EcoCropFB/
- Social and gender analysis tools (available from various sources).
- Ex-ante cost and benefit analysis (available from various sources).

For each of the technologies, the most appropriate form of actual showcasing is prepared, to display or try out the technology during the interactive event to be organized in the CSV site (step 4). Showcasing tools can include actual examples of technologies, posters, photo show or video, accompanied by an explanation by a farmer, extension agent or researcher who has a sound knowledge, and preferably some hands-on experience, of using the technology. The completed characterization cards (without the scores) are multiplied, one copy for each of the farmers expected to take part in the event (step 4).

Step 4: **Interactive technology event in the CSV site.** This is an *in situ* showcasing of promising technologies, facilitated by the CSV research team in close collaboration with farmers and extension agents. A half-day event is suggested, during which CSV women and men farmers have a chance to become informed about the selected technologies, ask questions about their use and expected results and, if possible, try them out. During the event, farmers should be invited to comment on the quantitative aspects of the proposed technologies such as labour and investment costs. Participants in the technology fair could be invited once more to guarantee consistency.

Step 5: **Scoring and final ranking of promising technologies by farmers**. The scoring will be done individually differentiated by sex. The technologies are grouped by technology type in terms of individual versus collective action based technologies.

For each type of technology, farmers (and extension agents), receive the amount of 100 ‘points’ (representing a wallet with money, e.g. in Vietnam it could be the equivalent of 100 million Vietnamese Dong or VND), which they can assign to their technologies of choice. Scoring is done as discreetly as possible to avoid being influenced by others.

The 100 ‘points’ can be assigned to any number of technologies (from 1 to the maximum number). Women farmers will give red ‘points,’ men farmers blue ‘points’. Extension agents will give yellow ‘points’.

For each technology, total scores are counted for the red, blue and yellow ‘points’, and for all three colours together. Technologies are ranked for the red, blue and yellow ‘points’, and for all three colours together. The results are presented in plenary by one of the members of the CSV research team.

Step 6: **Selection of one or more promising technologies** for testing based on step 5. One of the members of the research team facilitates a discussion about the scoring and ranking results for each of the two types of technologies with the aim of seeing if an agreement can be reached to move to the next step of the actual introduction and testing of **at least one of the top ranked technologies in each category** in the near future according to the appropriate season.

In the discussion it might be good to consider the feasibility of organizing a field visit to a site where the selected technology or technologies can be seen in practice.

Conclusion

This manual presents a series of principles and a six process steps to facilitate a carefully planned and implemented participatory process leading to the selection of a small number of promising climate-smart agricultural technologies and practices. The principles and process aim to avoid a top-down and hurried technology selection approach. Instead, they provide farmers ample space and time for discussion and reflection about presented technology options. The scoring technique included in the methodology includes both input and outcome variables. A draft of the manual was put to test by the CIAT-Asia coordinated research team implementing the project 'Integrated agricultural technologies for enhanced adaptive capacity and resilient livelihoods in climate-smart villages (CSVs) of Southeast Asia' in Ma village in the north of Vietnam in July 2015. Lessons learned from the pilot testing of the manual were subsequently used to revise the draft manual. It is expected that research teams in other CSVs in Cambodia, Lao PDR and Vietnam make use of the manual and further improve it.

Appendix 1. Checklist to assess the feasibility of promising climate-smart technologies and practices

In order to increase the effectiveness of the priority-setting process, a careful evaluation of each of the proposed interventions is warranted in terms of feasibility and appropriateness in the context of each research site (climate-smart village). If needed, research teams should carry out additional research **before** presenting the options to the community for their assessment and decision-making. This will minimize the confusion and the time required by the communities to clearly understand the pros, cons and risks of each intervention. The following are the suggested items to consider.

Input criteria: related to the conditions that are necessary for the intervention to have a good chance of success in generating expected benefits in the context of the climate-smart village (CSV).

History

Is this intervention new to the village? Have some other projects previously tested this intervention in the same village or in the same district or province?

If the intervention is not new to the village, has it worked before and why? Has it not worked before and why?

Are there any historical constraints for this technology to be tested in this village and what could be done to overcome the constraints?

Resources/assets

Under what biophysical conditions will the intervention be effective? What are the other resource needs in terms of capital investment, operational costs and human resources?

Are there any constraints for this technology to be tested in the village because of resource/asset access? if so, what could be done to overcome these constraint?

Social and gender relations and differentiation

Does this intervention require the participation of men or women in particular? If so, why and in what ways?

What is the level of inputs required by women and men, and what are the implications for their time, labour, capacity, skill investments?

Are there powerful individuals in the village who may influence the intervention in one way or another? How will this affect different households, women and men?

Are there any constraints for this technology to be adopted in this village because of social and gender relationships? What could be done to overcome these constraints?

Market, value chain/extension services

Does this intervention concern one or more products that have market demand?

Are viable input and output value chains established to support the intervention?

Are there technical services available to support farmers to implement this intervention, e.g. CSV team, local line agencies, private sector, other CGIAR centres?

Policy/law

Are there government policies and regulations that promote or constrain the intervention?

If there are such constraints, what could be done to overcome the constraints?

Climate smartness criteria

What climate smartness dimensions does the intervention address, e.g. water, soil , pests and diseases, seeds and breeds, information, markets?

What specific climate-related challenges or opportunities does this intervention respond to in terms of mitigation and/or adaptation?

Financial resources and capacity of CSV team to support this intervention

Are sufficient funds, staff capacity and time available to implement the intervention?

What are the guestimates of the total cost of the intervention?

What resources might be available from the project, the community or elsewhere?

How do available resources compare to estimated costs?

Outcome criteria: related to the expected results and changes brought about by the technology.

Sustainable resource use/conservation

How does the intervention affect the environment and natural resource base?

What could be done to maximize positive impact?

What could be done to minimize or avoid negative impact?

Women empowerment/equity

How might the intervention affect women's empowerment and equity within the village?

What could be done to maximize the positive impact?

What could be done to minimize or avoid negative impact?

Poverty reduction

How does the intervention affect income generation and household asset accumulation?

How does it affect household labour allocation?

What could be done to maximize the positive impact?

What could be done to minimize or avoid negative impact?

Food security

How does the intervention affect household food security?

What could be done to maximize the positive impact?

What could be done to minimize or avoid negative impact?

Overall assessment

How many output goals does the intervention contribute positively to? How?

How many output goals does the intervention contribute negatively to? How?

What could be done to maximize positive results?

Should the intervention be proposed for the community evaluation given the pros and cons and possible future risks?

Is additional research warranted to provide more information to the community to discuss all the pros and cons and the risks?

Appendix 2. Climate-smart technology/practice characterization and scoring card

INPUTS: ***having the capacity to test***						
The average investment costs per household*	Lower than X amount of money	Between X and Y amount of money	Higher than Y amount of money			
The amount of labour per household*	Lower than X hours per week	Between X and Y hours per week	More than Y hours per week			
Degree of dependency on female labour	It does not necessarily require female labour	Requires some female labour alongside male labour	Highly dependent on female labour			
Outside technical support needed	Farmers do not need training	Some training needed	Regular training needed			
Amount of cooperation needed among villagers	None	Now and then	Continuous cooperation			
SUBTOTAL SCORE						
OUTCOMES: ***livelihood improvement***						
Natural resources conservation (water, soil, air, crops, trees, livestock, fish)	One natural resource better managed/ conserved	Two natural resources better managed/conserved	Three or more natural resources better managed/conserved			
Food security	No direct contribution	Food shortages reduced	Food shortages eliminated			
Income generation	No new source of income	A new source of irregular income	A new source of reliable income			
Benefits for women	Women will not benefit	Women will benefit a little	Women will greatly benefit			
Community development	No benefits to the community	Some households benefit	The whole community benefits			
Response to climate changes	No direct response	It will take time	Direct response			
SUBTOTAL SCORE						
TOTAL SCORE: likelihood of success						

*Best guestimates to be prepared by the research team based on local context

References

Food and Agriculture Organization of the United Nations. 2013. Climate-smart agriculture sourcebook. FAO, Rome. Available at: http://www.fao.org/3/a-i3325e.pdf

Herrero, M., Notenbaert, A., Thornton, P., Pfeifer, C., Silvestri, C., Omolo, A., Quiros, C. 2014. A framework for targeting and scaling-out interventions in agricultural systems. CCAFS Working paper No. 62. Copenhagen, Denmark: CGIAR Research Programme on Climate Change, Agriculture and Food Security. Available at: https://cgspace.cgiar.org/rest/bitstreams/29043/retrieve

Mwongera, C. 2015. Farmers single out indicators for adopting climate-smart agriculture. Climate & Agriculture Network for Africa. Available at: http://canafrica.com/caina_blog/farmers-single-out-indicators-for-adopting-climate-smart-agriculture/

Reed, M.S., Podesta, G., Fazey, I., Geeson, N., Hessel, R., Hubacek, K., Letson, D., Nainggolan, D., Prell, C., Rickenbach, M.G., Ritsema, C., Schwilch, G., Stringer, L.C., Thomas, A.D. 2013. Combining analytical frameworks to assess livelihood vulnerability to climate change and analyse adaptation options. *Ecological Economics* 94: 66-77. Available at: http://dx.doi.org/10.1016/j.ecolecon.2013.07.007

Ribot, J. 2014. Cause and response: vulnerability and climate in the Anthropocene. *Journal of Peasant Studies* 41(5): 667-705. Available at: http://dx.doi.org/10.1080/03066150.2014.894911

Shikuku, K.M., Okolo, W., Mwongera, C., Benjamin, T., Winowiecki, L., Twyman, J., Ampaire, E., Acosta, M., Läderach, P., Eitzinger, A. 2015. Climate-smart agriculture prioritization manual. Copenhagen, Denmark: CGIAR Research Programme on Climate Change, Agriculture and Food Security. [Not available on-line.]

Smith, G. 2015. Farmers debate their options in a changing climate. CIAT Blog. Available at: http://www.ciatnews.cgiar.org/2015/07/31/farmers-debate-climate-risk-and-their-options/

Sumberg, J., Okali, C., Reece, D. 2003. Agricultural research in the face of diversity, local knowledge and the participation imperative: Theoretical considerations.

Agricultural Systems, 76(2): 739-753. Available at: https://entwicklungspolitik.uni-hohenheim.de/uploads/media/Day_4_-_Reading_text_1.pdf

Taneja, M., Pal, B.D., Joshi, P.K., Aggarwal, P.K., Tyagi, N.K. 2014. Farmers' preferences for climate-smart agriculture: an assessment in the Indo-Gangetic Plan. IFPRI discussion paper 01337. Washington D.C., USA: International Food Policy Research Institute, and Copenhagen, Denmark: CGIAR Research Programme on Climate Change, Agriculture and Food Security. Available at: http://cdm15738.contentdm.oclc.org/utils/getfile/collection/p15738coll2/id/128116/filename/128327.pdf

UNU-IAS, Bioversity International, IGES and UNDP. 2014. Toolkit for the indicators of resilience in socio-ecological production landscapes and seascapes (SEPLS). Available at: https://www.bioversityinternational.org/e-library/publications/detail/toolkit-for-the-indicators-of-resilience-in-socio-ecological-production-landscapes-and-seascapes/

Vernooy, R. 2003. *Seeds that give: participatory plant breeding.* Ottawa, Canada: International Development Research Centre. Available at: http://www.idrc.ca/EN/Resources/Publications/openebooks/014-4/index.html

RESEARCH PROGRAM ON
Climate Change, Agriculture and Food Security

CGIAR

CCAFS

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is a strategic initiative of CGIAR and Future Earth, led by the International Center for Tropical Agriculture (CIAT). CCAFS is the world's most comprehensive global research program to examine and address the critical interactions between climate change, agriculture and food security.

For more information, visit www.ccafs.cgiar.org

Titles in this Working Paper series aim to disseminate interim climate change, agriculture and food security research and practices and stimulate feedback from the scientific community.

CCAFS is led by:

CIAT

Strategic partner:

futureearth
research for global sustainability

Research supported by:

CGIAR Fund

Danida

European Commission

IFAD

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Agency for Development and Cooperation SDC

IICT

UKaid from the British people

Australian Government
Australian Centre for International Agricultural Research

Irish Aid
Government of Ireland
Rialtas na hÉireann
Ireland's commitment to a world without poverty and hunger

Ministry of Foreign Affairs of the Netherlands

Government of Canada
Gouvernement du Canada

NEW ZEALAND MINISTRY OF FOREIGN AFFAIRS & TRADE
MANATŪ AORERE