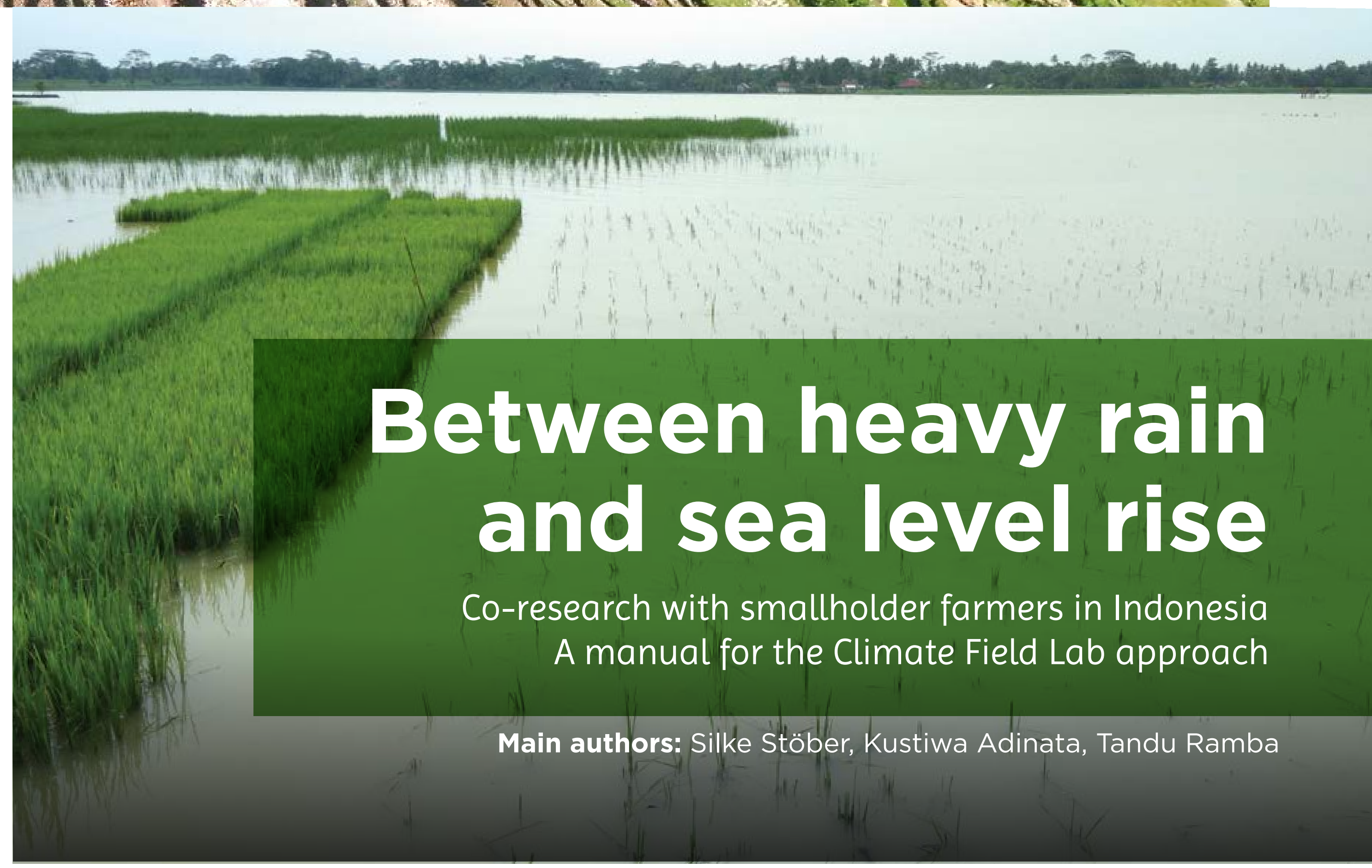


Between heavy rain and sea level rise

Co-research with smallholder farmers in Indonesia
A manual for the Climate Field Lab approach

Main authors: Silke Stöber, Kustiwa Adinata, Tandu Ramba

Supported and funded by:

Brot für die Welt

Diakonie Katastrophenhilfe

SLE Manual 2022

Published by: Centre for Rural Development (SLE)

Humboldt-Universität zu Berlin
Lebenswissenschaftliche Fakultät
Albrecht Daniel Thaer-Institut für Agrar- und Gartenbauwissenschaften
Seminar für Ländliche Entwicklung (SLE)
Hessische Str. 1-2
10115 Berlin
Telephone: 030-2093-46890
Fax: 030-2093-46891
E-mail: sle@agrar.hu-berlin.de
Website: www.sle-berlin.de

Printing
Druckerei der Humboldt-Universität zu Berlin
Dorotheenstraße 26
10117 Berlin

Distribution
Seminar für Ländliche Entwicklung (SLE)
Hessische Str. 1-2
10115 Berlin

Layout
Design for Development D4D

Editing
Carmen Aspinall

Suggested citation
Stöber, Silke; Adinata, Kustiwa; Ramba, Tandu 2022: Between heavy rain and sea level rise. Co-research with smallholder farmers in Indonesia. A manual for the Climate Field Lab approach. Humboldt-Universität zu Berlin, Centre for Rural Development (SLE), Berlin, JAMTANI, Pangandaran and MPM Toraja, Kondoran.

ISBN: 978-3-947621-35-4

SLE manuals are created from the practical experience of several years of research and development work. Over the entire period, lessons learnt and good practices are compiled. In the manuals, we present instruments and procedures that are explained clearly, step by step, and with the help of practical examples. With its manuals, SLE aims to support researchers and practitioners who are active in solution-oriented and transformative international development work by providing replicable methods in a structured manner, so that the wheel does not always have to be reinvented.

The Centre for Rural Development (SLE) affiliates with the Albrecht Daniel Thaer-Institute for Agricultural and Horticultural Sciences in the Faculty of Life Sciences at the Humboldt-Universität zu Berlin. Its work concentrates on four strands: international cooperation for sustainable development as a Post-Master degree course, training courses for international leaders and experts in the field of international cooperation, research on sustainability issues, and advisory services for universities and organisations.

The views and opinions expressed in this manual are those of the authors and do not necessarily reflect the official position of Brot für die Welt.

Dr Silke Stöber
E-Mail: silke.stoeber@agrar.hu-berlin.de

Kustiwa Adinata
E-Mail: kustiwa.adinata@gmail.com

Tandu Ramba
E-Mail: mtvkondoran@gmail.com

Co-authored by:
Rahmansyah Dermawan UNHAS
David Harris MPM
Dr Hari Iswoyo UNHAS
Prof. Dr Kaimuddin Mole UNHAS
Dr Muhamad Khais Prayoga UNPAD
Feri Rianto JAMTANI
Ai Rinawati JAMTANI
Asroni JAMTANI
Dr Mieke Setiawati UNPAD
Prof. Dr Tualar Simarmata UNPAD
Nedim Sulejmanoviç FU Berlin
Martin Ihm SLE

Acknowledgements

We are extremely grateful for the funding support offered by Brot für die Welt and for the tremendous efforts of all people from JAMTANI, Motivator Pembangan Masyarakat (MPM), Hasanuddin University (UNHAS), and Padjajaran University (UNPAD) involved in this co-research. For her encouraging interest and support, a special credit is given to Iris Bauermeister from Bread for the World. A junior research team did a six-month study to design and test some of the survey instruments presented in this manual. The four young scholars from Germany and Indonesia, namely Max Hollburg, Muhamad Khais Prayoga, Simon Schöll, and Theresa Landwehr, did a great effort in testing some of the assessment instruments which are presented in this manual. Their research was supported by Engagement Global, the ASA Hochschule Programme 2018. We are equally grateful for the insights and local wisdom provided by more than 100 co-research farmers from Ciganjeng and Rawaapu villages in Java and BatuSura', Bua'tarrung, Buntu Datu, TallangSura', and To'pao villages in Toraja.

This manual is dedicated to the memory of the late Dr Neni Rostini, a senior scientist and lecturer at Universitas Padjadjaran (UNPAD), in recognition of her valuable contributions and strong drive to support smallholder farmers and young scholars in solution-oriented research. She contributed and published remarkable research, particularly on participatory plant breeding. We miss her very much, will never forget her enthusiasm, and will always remain impressed by the simplicity of her solutions.

We will keep her commitment, her spirit, and farmer-friendly principles in science, alive.

Dr. Neni Rostini on her trip to University of Warsaw for the 3rd Symposium on "Universities and Climate Change" under the auspices of the International Climate Change Information and Research Programme (ICCIRP) (4 July 2019).

Source: Mieke Setiawati

Foreword of Bread for the World

Dear readers and users of the manual,

Climate change is presenting communities around the world with new complex challenges on many levels. People are increasingly exposed to the negative impacts of climate change, and smallholder farmers need to continuously adapt their agricultural practice to extreme weather conditions like rising sea levels, higher temperatures, and changes in precipitation. There is a high need to increase their adaptive capacities.

The overall aim of Brot für die Welt is to contribute to increase the resilience to climate change of communities all over the world. Therefore, 13 years ago, Diakonie Katastrophenhilfe and Brot für die Welt launched special climate change pilot projects with the three components, namely adaptation, mitigation and disaster risk reduction. We support to bring local partner organisations together with international experts and academic institutions. The aim is to try something different, and to develop innovative approaches together with the partner organisations, with the communities and with researchers. The Indonesian "climate lighthouse projects" of the partner organisations Jaringan Masyarakat Tani Indonesia (JAMTANI), Java and Motivator Pembangan Masyarakat (MPM), Sulawesi became a place of learning for other organisations.

In 2015, MPM and JAMTANI together with Brot für die Welt realised, that it is not enough to teach farmers new methods how to adapt to climate change. What is really needed is to enable farmers to continuously find new solutions how to adapt to the changing climate by themselves. Thus, the research farmer component was born with the focus of increasing the adaptive capacity of smallholder farmers through co-creation of knowledge, combining local wisdom and academic research.

Our partner organsations JAMTANI and MPM together with the Indonesian Universities Hasanuddin University (UNHAS), Sulawesi and Padjajaran University (UNPAD), Java and the Centre for Rural Development (SLE) of the Humboldt University, Germany implemented a Climate Field Lab approach combining climate-friendly farming, climate adaptation co-research and climate field schools. The Climate Field Lab enables farmers, non-governmental organisations and researchers to go new paths of adapting to changing climate together. It puts the smallholder farmer's needs into the center of research and enables to implement joint academic experiments. This manual documents some of their experiences, practical examples, lessons learnt and good practices on how to increase adaptive capacities. The manual shall be a tool to enable the lighthouse projects to shine.

During an exhibition of newly tested innovative agricultural approaches, a farmer in Java explained to me the impact of changing weather conditions, soil fertility and diseases to his rice plants, and that up until now he was not aware about what he could do to mitigate the threats. He said: *"Before, I did agriculture like a blind man. Now I can see and understand."* The farmer explained many different challenges as well as his self-tested solutions to improve the health conditions of his plants from the roots up to the fruits. We hope that this manual will also enable you to go new paths and enrich your work.

Bauermeister

Iris Bauermeister

Brot für die Welt

Diakonie Katastrophenhilfe

Foreword of academic partners

In the presence of global warming, the challenges facing agriculture are intensified. Farmers, especially smallholders, are the most susceptible. Successful responses through climate-adaptive farming practices are possible when many stakeholders work together. Academics and scientists from universities are expected to play a role in bringing science to the field and supporting farmers in applying technologies and practices that have been tested in joint studies, including those related to climate change adaptation strategies.

Scientists from the Universitas Hasanuddin (UNHAS) and Universitas Padjadjaran (UNPAD) in Indonesia have been working together with farmers in a project named the 'Climate Resilient Agriculture Investigation and Innovation Project' (CRAIIP). Their collaboration has generated significant benefits for both farmers and universities. The direct involvement of farmers in scientific experiments in their own fields has empowered farmers to see themselves as researchers capable of setting up and managing their on-farm experiments and performing observations of variables that are manageable for scientific data processing, with supportive guidance from scientists and professors from the universities. This created a great atmosphere where farmers' confidence was boosted significantly, encouraging them to perform their own trials under their own control to find farming practices better adapted to climate change.

After about five years of collaboration, there are many lessons learned from various activities. Among the most important and significant ones are: (1) researchers and academics from universities can work together very well with farmers, extension officers, and NGOs; (2) farmers' experience has more influence on their understanding of introduced technologies (they say, that the farmers' brain is in their eyes); (3) farmers are very good learners and co-researchers; (4) simple scientifically designed research can be carried out by farmers with some support; (5) research activities are particularly effective when university students and farmers are paired.

Dr Meddy Rachmadi
Dean of Faculty of Agriculture of UNPAD

Prof. Dr Salengke
Dean of Faculty of Agriculture of UNHAS

Abstract

This manual is a product of the Climate Resilient Agriculture Investigation and Innovation project (CRAIIP). It presents the Climate Field Lab approach and provides tools for climate change adaptation by smallholder farmers in two rural regions in Indonesia. The Climate Field Lab adheres to transdisciplinary adaptation co-research through a science-practice partnership on agro-ecological farming. Co-research implies that farmers are local experts in cooperating actively with nature and its weather variability. Alas, the impacts of climate change aggravate farming through the increased frequency and magnitude of climate-related extremes. As a consequence, farmers are faced with the continuous need to build their adaptive capacities through co-creation of knowledge in a dialogue with their communities, with scientists and with climate change experts.

Between 2016 and 2019, the Indonesian-German CRAIIP team consisting of co-research farmers, two farmers' organisations/NGOs, as well as scientists of three universities, applied various co-creation tools for building the adaptive capacity in Climate Field Labs in two regions. An estimated 100 smallholder farmers, women and men, from West and Central Java and South Sulawesi took part in the solution-oriented research. This manual is directed towards scholars, students, trainers and development experts. It offers a set of instruments that aim at broadening their spectrum for approaches, methods and tools of participatory adaptation co-research, directed towards their own research and development work. All tools presented in this handbook were tested in farmer-led research processes, which included demonstrations on stress-resilient rice varieties, improved agro-ecological soil fertility strategies in rice, and the organic cultivation of local chilli pepper varieties.

The manual starts with the climate change situation in Indonesia (part 2). The concept for co-creation of knowledge in the Climate Field Lab is explained in part 3. Part 4 presents the 18 tools used in the Climate Field Lab illustrated by examples, useful materials and numerous practical tips applicable for own adaptation co-research. Part 5 includes the annexes, provides an overview of all information and training materials, as well as including scientific articles produced throughout the course of the project CRAIIP.

The CRAIIP partners wish to get in touch with other science-practice networks to help to build climate resilience of smallholder farmers through co-creation of knowledge, agro-ecological approaches and to advocate and spread the use of adaptation co-research as a research method.

Keywords

Climate change, climate resilience, climate change adaptation, co-research, agricultural extension, farmer field school, field lab, practice research, field trials, farmer-led research, smallholder farmer, Indonesia, rice, chilli

Contents

Tables

Figures

Information boxes and infographics

List of acronyms

AR	Assessment Report
BAPPEDA	Regional Development Planning Body
BAU	business as usual
BMKG	Badan Meteorologi, Klimatologi, dan Geofisika
BPH	brown plant hopper
CRAIIP	Climate Resilient Agriculture Investigation and Innovation Project
DAP	Days after planting
ENSO	El Niño Southern Oscillation
GFRAS	Global Forum for Rural Advisory Services
GHG	greenhouse gas
HLPE	FAO High Level Panel of Experts on Food Security and Nutrition
IPCC	Intergovernmental Panel on Climate Change
IDR	Indonesian Rupiah
JAMTANI	Jaringan Masyarakat Tani Indonesia (Farmer Community Network)
LULUCF	land use, land use change, and forestry
MPM	Motivator Pembangan Masyarakat (Motivator Community Development Foundation)
NDC	Nationally Determined Contribution
PLA	Participatory Learning and Action
RAN API	National Climate Change Adaptation
SLE	Centre for Rural Development (Seminar für Ländliche Entwicklung)
SRI	System of Rice Intensification
UNHAS	Universitas Hasanuddin
UNPAD	Universitas Padjadjaran
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

1. Introduction

1.1 Background

Farmers are local experts in cooperating actively with nature and its weather variability. Therefore, farming as such, particularly rainfed agriculture, has been shaped over time to adapt to adverse weather conditions such as temperature extremes, strong winds, and variable rainfall. However, climate change aggravates farming as climate-related extremes occur more frequently and with greater severity. Farmers directly encounter the impacts of climate change daily. Some of their adaptation strategies are not sustainable or effective climate-resilient strategies. Applying more chemicals to address increasing pests and diseases pressure as a result of higher humidity or temperatures is not ecologically sustainable. In a similar way, increasing their use of synthetic fertilisers to compensate for nutrient leaching caused by heavy rainfall or flooding, falls within the spectrum of maladaptation. Maladaptation leads to environmental degradation, displacement of pressures to surrounding environments, and socio-economic dependencies, such as greater reliance on purchased external inputs and disregard of local knowledge (Frison et al., 2011; Magnan, 2014).

The growing move in agroecological and climate-resilient farming towards co-creating knowledge with farmers is also the move of the Climate Resilient Agriculture Investigation and Innovation project (CRAIIP). In fact, this manual captures the processes of co-creating knowledge in this Indonesian–German piloting phase between August 2017 and October 2019. The involved organisations are the Motivator Community Development Foundation (MPM) and the farmer-based Indonesian Farmers Community Network (JAMTANI). They partnered with three universities, which are the Universitas Padjadjaran (UNPAD), the Universitas Hassanudin (UNHAS), and the Centre for Rural Development (SLE) of Humboldt-Universität zu Berlin.

CRAIIP[1] was intended to create, analyse, summarise, and scale out knowledge about innovative learning for climate change adaptation. Its field operations took place in West and Central Java and South Sulawesi in its districts Cilacap, Pangandaran, and Tana Toraja (Figure 1).

"Sea level rise, salinisation, and flooding are climate-induced threats along the coastlines in Java, while increasingly irregular rainfall patterns and heavy rainfall events causing soil erosion and landslides occur more often in the mountainous area of Toraja."

~CRAIIP team

Figure 1 Project locations in Indonesia
Source: based on www.naturalearthdata.com, map author: SLE, M. Enzner (2018)

1. The project evolved from the *Climate Lighthouse* projects launched by Diakonie Katastrophenhilfe and Bread for the World (BfdW) in 2008. The *Climate Lighthouse* concept aims at "reducing the risks of climate change to particularly vulnerable target groups and offering them sustainable development prospects in a unified and systematic way."

CRAIIP project partners

Jaringan Masyarakat Tani Indonesia (JAMTANI) was founded in late 2018 when their 37,000 members from six Indonesian provinces splintered from the 2-million-member farmer association IPPHTI (Ikatan Petani Pengendalian Hama Terpadu Indonesia). JAMTANI and IPPHTI remain closely linked.

JAMTANI's mission is to develop agriculture through agroecological approaches, increase farmers' sovereignty over sustainable food, promote farmers' rights, and develop farmers' independence including gender equity. More information can be found at https://jamtani.or.id/public/

Established in 1983, the **Development and Training Centre of the Church of Toraja** is located in Kondoran in South Sulawesi. Their mission is to foster community development with a focus on peace-building, prosperity, and justice for all, through improving livelihoods, particularly income and health, environmental protection, agroecological farming, and gender equality. More information can be found at https://en.penamasmotivator.org/.

The Universitas Padjadjaran (UNPAD) in Bandung, West Java, founded in 1957, consists of 16 faculties. The Faculty of Agriculture (established 1959) is determined to contribute to agricultural sector development, such as: productivity increase, quality, efficiency, and promoting sustainable agriculture. It offers study programs from Bachelors to Doctorate degrees. Three lecturers and two postgraduate students have been involved in CRAIIP, with particular emphasis on organic soil fertility management in rice production. More information can be found at https://faperta.unpad.ac.id/

The Universitas Hasannudin (UNHAS) is located in Makassar in South Sulawesi and was founded in 1956. Today, it consists of 15 faculties. The Faculty of Agriculture was founded in 1962 and serves 2,000 Bachelors and Masters students. Four lecturers and four Bachelors and Masters students contributed their expertise, with a focus on organic chilli production and marketing, and sustainable rice production. More information can be found at *https://unhas.ac.id/en/page/faculty-of-agriculture1*

The Centre for Rural Development (SLE) at Humboldt-Universität zu Berlin, Germany has been engaged in international cooperation since 1962. It offers services that range from a postgraduate study programme and advanced training courses to practice-oriented research and advisory services with practice partners. In CRAIIP, SLE pulled together farmer-led research experiences and lessons learned. Several students were involved and their work is incorporated into this manual. More information can be found at www.sle-berlin.de.

All partners had previous experience in climate change adaptation in agriculture. They also supported agroecological principles. A range of solutions to adapt to climate change, such as floating rice fields to protect from floods, the use of biochar or green manure, and natural pest control had been tried out in the field. While some of these technologies were still in a testing stage, others were not yet scientifically verified or further optimised.

Small-scale farmers, particularly women, often lack opportunities to access information and training on innovative techniques that are urgently needed to adapt to climate change.

To address these two problems, CRAIIP aimed to position men and women farmers as self-determined agents of change through innovative co-research.

CRAIIP intended to contribute to bottom-up, diversified agricultural research and development landscapes: matching and merging technologies and ideas from both academia and farmers in collaborative research. The project placed farmers at the forefront of adapting agriculture to climate variability and change. By conducting their own experiments, research farmer clubs developed and applied adaptive technologies to overcome the challenges forced on their communities by climate change. Their research results were shared among club members in climate field schools weekly, upon demand, or as end-of-season events. Guidance and analytical support was provided by the academic institutes involved.

> *"Farmers are key change agents for climate change adaptation as they hold experience and knowledge, are managers of natural resources and therefore responsible for their protection and sustainable use, and, at the same time, bring healthy food to our table."*
>
> *~statement from a CRAIIP team workshop*

1.2 About the manual

What is the aim of this manual?

This manual leads the reader through the participatory process of developing climate-resilient farming solutions in Climate Field Labs. It illustrates each step with examples. The climate change background explains the specific situation in Indonesia. Tools give detailed instructions for potential learning and research activities. Overall, the reader may track the course of the project in a comprehensive way and get useful hints on how the activities and lessons learnt can be used into their own programmes.

The manual encourages practitioners and researchers to make better use of farmers´ local wisdom. Farmers' practical innovations are often the first step to adaptation and change. However, farmers cannot solve the complex challenges of climate change alone. The manual guides readers on how to bring co-research on climate-resilient farming to life.

At the same time, the manual raises awareness of the importance of adopting participatory research with farmers while producing scientific results for the academic community. Similarly, other development agencies may draw lessons from the manual and make use or adapt the tools when scaling-out Climate Field Labs in Indonesia and beyond.

Who should read this manual?

This manual is designed to serve multiple user groups. It targets university researchers who wish to conduct baseline analyses of perceptions of climate change or engage with farmers in research practices for finding agronomic solutions. It can be used by farmer organisations who are looking for solutions to limit their members' vulnerability to climate change. NGOs, development agencies, and donors who may replicate, customise, and use the Climate Field Lab approach and other learnings from CRAIIP in their projects are potential readers. Policy makers who are interested in promoting bottom-up evidence creation for drafting local and regional policies are invited to make use of the offered guidelines.

The beginning of the manual targets those readers who are interested in the climate change situation in Indonesia and its impact on agriculture. The third part provides the conceptual framework of the Climate Field Lab approach and points out the different communities of practice on which the Climate Field Lab is based. It may be particularly useful for development practitioners for project design or for lecturers who wish to convey the paradigm behind co-creation of knowledge. Part Four contains the toolbox which can be used by students as empirical data collection tools or by NGOs or extension services to monitor and implement a project with smallholder farmers on increasing farmers' adaptive capacity to climate change. While all examples refer to Indonesia to illustrate the tools, the toolbox can be used in all countries where programmes ease the struggles of smallholder farmers who grapple with the impacts of climate change.

How to use this manual?

Following this introduction, this manual has four distinct parts. Part Two provides the climate change rationale of Indonesia based on a climate change policy analysis and climate data analysis. Risks to agricultural systems resulting from climate change in Indonesia complement this part. Detail is offered on how farmers in the two study areas in West/Central Java and South Sulawesi are affected by climate change and why it is difficult for them to adapt to these changes.

Part Three then introduces the Climate Field Lab approach. It provides its origins, objectives, activities, and actors as a potential tool for co-creating local solutions or adaptation strategies with farmers.

Part Four provides 18 practical tools for implementing the Climate Field Lab components. Starting from raising farmers' awareness of climate change, developing and adapting innovative climate-resilient technologies, assessing these technologies and processes, and scaling them out. In addition to practical tips and recommendations for action, examples, results, and lessons learnt from CRAIIP activities are provided.

Part Five lists all knowledge transfer products that have been co-created during the pilot phase of the project up until the publication of this manual. Part Six provides the annexes with additional information and materials.

More than 100 smallholders from Sulawesi and Java participated in this co-research project. Farmers participated in weekly climate field schools and conducted their own farmer-led research in cooperation with the local universities.

Source: Rein Syauta

Common features:

Information boxes and infographics provide and illustrate further technical explanations on specific terms related to climate change or building farmers' adaptive capacity and resilience.

Practical tips provide concrete suggestions for facilitators and scientists when replicating the Climate Field Lab approach.

Pulled quotes display the voices of stakeholders involved and give vivid insights into how farmers in Indonesia or scientists and NGOs perceive climate change adaptation and resilience enhancement.

Tools describe the purpose of the tools in the Climate Field Lab and explain step by step how to apply them.

Examples show what results have been achieved through the application of the tools. Selected examples from both project regions, i.e. from Java or from Toraja, are shown in alternation. Examples are presented as graphs, tables, drawings or photos.

Practical tip

Every situation is unique. You can learn from the experiences from Indonesia outlined in this manual, but always adapt and modify the tools to local situations and your specific objectives and needs.

2. How does climate change affect farmers in Indonesia?

Ms Esther, farmer and motivator in Tallang Sura' village, shares her perceptions of the impacts of climate change on farming.

Source: Silke Stöber

2.1 International and national perspectives

With more than 17,000 islands and a coastline of around 90,000 km, Indonesia is one of the world's most vulnerable countries to climate change. Rising temperatures, unreliable rainfall patterns, droughts, and floods are an increasingly common reality in Indonesia. Indonesia is not only a victim of climate change but also one of the largest emitters of greenhouse gases worldwide (Ritchie & Roser, 2017). Land use, land use change, and forestry (LULUCF) is the main driver of greenhouse gas (GHG) emissions and accounted for 63% of Indonesia's total emissions in 2016 (Republic of Indonesia, 2016). Mostly caused by deforestation for palm oil plantations, the atmospheric haze has led to tensions between Indonesia and its neighbouring countries (Javadi & Han, 2015). By signing the Paris Agreement in 2016, Indonesia acknowledged climate change as a common concern for humankind and pledged to pursue efforts to the 1.5°C global temperature increase pathway. Due to its vast size and large population, Indonesia is a key country in the worldwide discourse on mitigating climate change.

Climate change manifests in several ways. Overall, data indicate trends of increasingly higher temperatures and more annual rainfall (for more information, see infographic p.19). Further, the annual distribution of rainfall is changing, with wetter wet seasons and drier dry seasons. The regional distribution of rainfall is changing as well, with rainfall increasing in the northern regions and decreasing in the south of Indonesia (Ministry of Foreign Affairs of the Netherlands, 2018). Moreover, the onset of the seasons is changing, making rainfall predictions more unreliable. Future projections predict that continuing climate change will cause a higher number of extreme events, particularly droughts and floods.

The El Niño Southern Oscillation (ENSO) aggravates these tendencies and is occurring more often. An El Niño comes at intervals of two to seven years and brings warm water to the Pacific Ocean, which carries rainfall further east and leaves Indonesia and Australia in drought. La Niña usually comes after El Niño and brings warm currents to Oceania and more rainfall to Indonesia (see infographic p.20).

Climate change models project a delay in the annual monsoon season of up to one month. This has very strong impacts on Indonesian agriculture and consequences for food security.

Quick facts about climate change in Indonesia

Mean annual temperature is
25.8°C

Since 1990, mean annual temperature has increased by about
0.3°C annually
More "hot days" and "hot nights"[1] and fewer cold nights

Mean annual rainfall is
2,859 mm

Annual rainfall trends generally point upwards (12% increase over the past 30 years)

Increased intensity of dry and wet seasons

More rainfall in the rainy season

Less rainfall during July to September (4.8% decrease since 1990)

More frequent droughts
(now occurring every 3 years compared to every 4 years in the past)

Source: World Bank, 2020; Ministry of Foreign Affairs, 2018; Republic of Indonesia 2013; USAID, 2012

1. Defined as "hot" when day or night temperatures exceed 10% of the average day or night temperature for the period

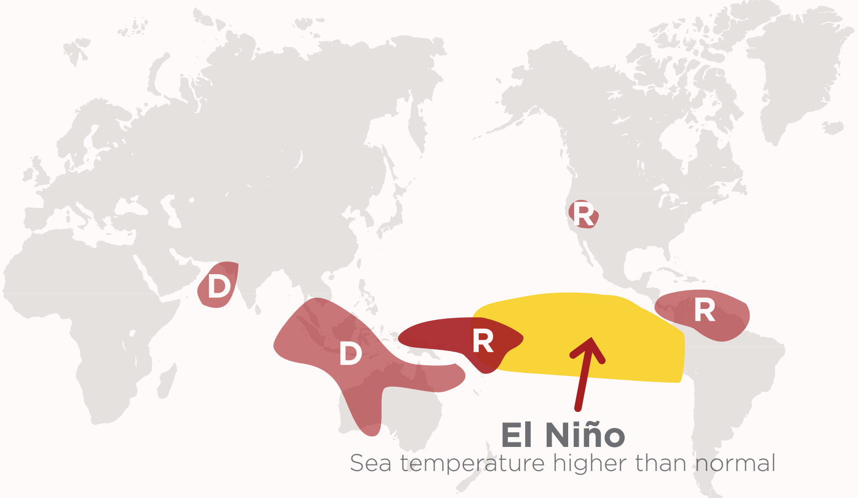
Indonesia designed its Nationally Determined Contribution (NDC) as a holistic approach to tackle climate change. Through changes in the land use, energy, and waste sectors and increased food, water, and energy resilience, Indonesia's NDC aims to mitigate and adapt to climate change. In its NDC, the Indonesian government has pledged to unconditionally reduce its greenhouse gas emissions by 26% and conditionally (depending on international support) by 41% of its business as usual (BAU) calculations. Since the LULUCF sector plays a key role in Indonesia's fulfilment of its pledges, the government set up a moratorium on the clearing of primary forests and the conversion of peat land that lasted from 2010 to 2016. Still, its intended effects were much lower than expected. In fact, the primary forest cover loss in 2012 was 0.84 million hectares, double the amount of the loss in Brazil, which is usually the top-ranked country for forest loss in the world (Margono et al., 2014). This seems to be a continuous trend. For example, in 2015, Indonesia had one of the worst forest fires on record (Yi, 2016).

What is El Niño?

El Niño (the boy) is an irregular event of abnormal warming of surface waters in east and central equatorial Pacific waters, which occurs every two to seven years. This ocean warming is caused by weakened or reversed easterly trade winds. This change affects rainfall patterns worldwide. As rain clouds normally form over warm ocean water, the rain travels to the east. The monsoon is weakened and brings drought to Indonesia, Australia, India, and the northern part of Latin America. Usually, on a dry El Niño year, a wetter La Niña (the girl) year follows. In a La Niña year, winds are much stronger than usual. The water in the Pacific Ocean near the equator drops a few degrees. La Niña blows the warm water to the western Pacific. This means that Indonesia and Australia receive much more rain than usual.

Climate impacts of warm El Niño events (April-September)

El Niño has different impacts in different parts of the world and at different times of the year. During the northern hemisphere summer, El Niño has been associated with drought in Indonesia, northern Australia, India and northeastern Latin America.



D indicates drought
R indicates unusally high rainfalls (not necessarily unusually intense rainfall)

Source: FAO, 1997

The National Climate Change Adaptation Plan (RAN API) is pivotal for Indonesia's climate governance. One of its main goals is to strengthen food security. By developing and implementing climate-adaptive technologies and adjusting farming practices to climate change, RAN API seeks to decrease agricultural losses resulting from unforeseen climatic conditions. Additionally, RAN API aims to increase ecosystem resilience through a combination of improved spatial planning and land use as well as capacity-building measures. It includes support for research and development for climate change adaptation.

Action needed for transforming soil fertility

To meet local demands for staple foods, Indonesia maintains a fertiliser subsidy programme for smallholder farmers who farm less than two hectares and are organised in groups. Chemical fertiliser application has been promoted in Indonesia since the mid-1960s. Today, the average fertiliser application rate is high (615 kg/ha); 89.5% of fertilisers applied are chemical (mainly urea) with only 10.5% being organic. This practice causes long-term soil fertility losses. As a matter of fact, about 70% of paddy soils have low organic carbon (less than 1.5%), low macro- and micronutrient levels, and are referred to as “sick soils” (Simarmata et al., 2016). Suryana (2019) concludes that alternative policies are required to address this high-input and inefficient strategy since it stimulates fraud, causes environmental damages through nutrient leaching and increased direct emissions from agriculture, decreases soil quality, and increases the occurrence of diseases with yield losses of up to 15–30%. Alternative policy recommendations include more efficient fertiliser use through precision farming, recommended dosages based on crop needs, more use of organic fertilisers to enhance soil health, and even higher rice retail prices to compensate for the increased workload that organic soil fertility strategies add.

Practical tip

After having read about the situation in Indonesia, consider how soil fertility manifests in your area. What policies exist or are needed to promote sustainable soil fertility and land management strategies?

2.2 Climate change in the two project locations

Indonesia consists of five agroecological zones; climate change manifests differently in each zone. The southern coast of West and Central Java face greater risk of floods and soil salinisation, while the mountainous Toraja increasingly suffers landslides and pests and diseases occurrences (Ardiansyah et al., 2017).

Historical weather trends show clear tendencies toward higher temperatures and more annual rainfall in Cilacap (Figures 2 and 4). In contrast, climate dynamics for Toraja from Pongtiku station indicate less clear tendencies (Figures 3 and 5).

Temperature trends in West and Central Java

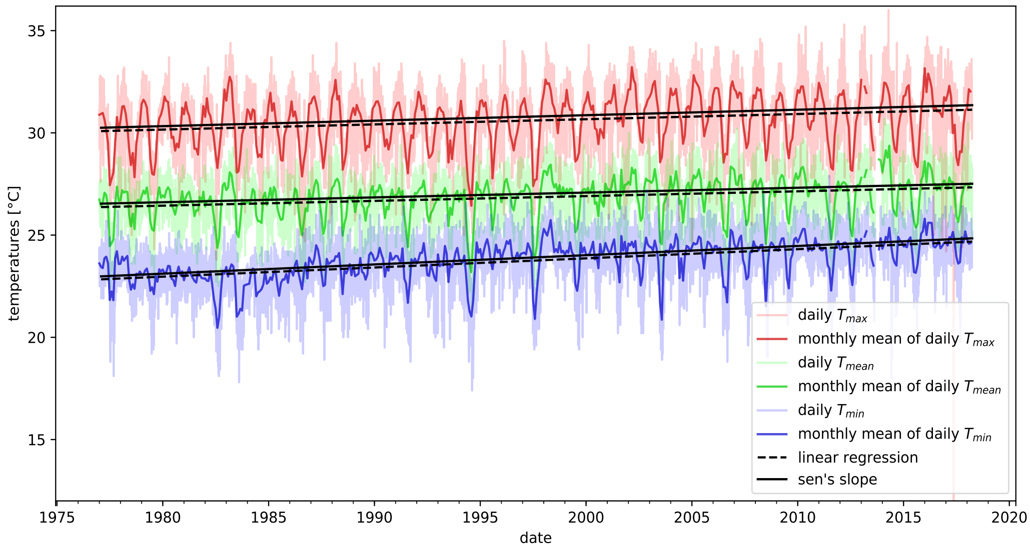


Figure 2 Temperature trends in West and Central Java (Cilacap station)
Source: Own representation of Cilacap data provided by Badan Meteorologi, Klimatologi, dan Geofisika (BMKG)

Temperature trends in South Sulawesi

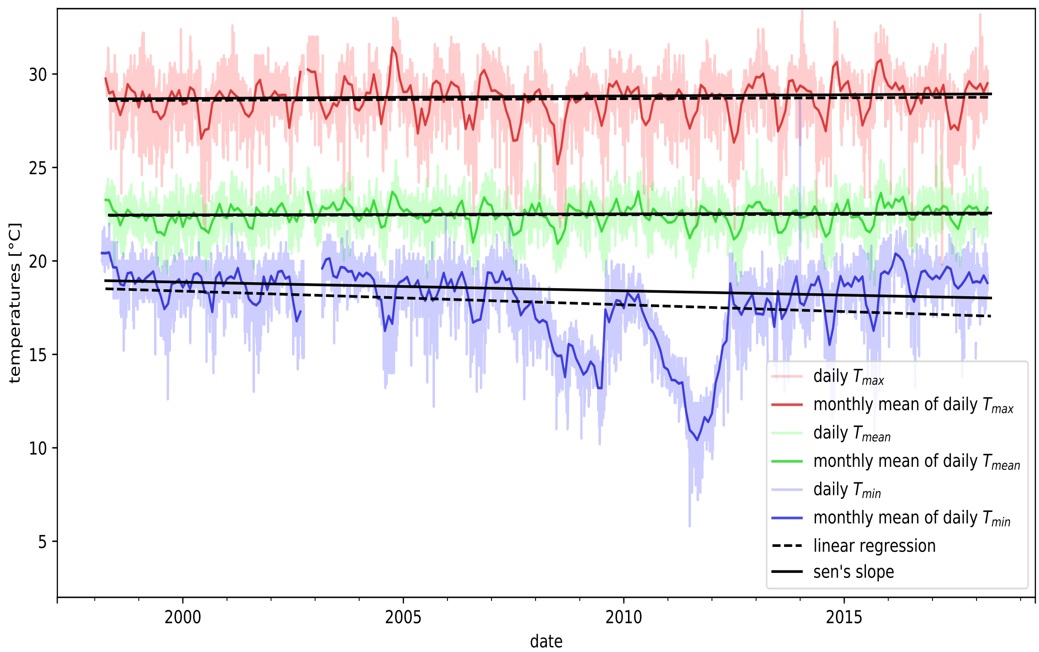


Figure 3 Temperature trends in South Sulawesi (Pongtiku station)
Source: Own representation of Pongtiku data provided by Badan Meteorologi, Klimatologi, dan Geofisika (BMKG)

Monthly precipitation trends in West and Central Java

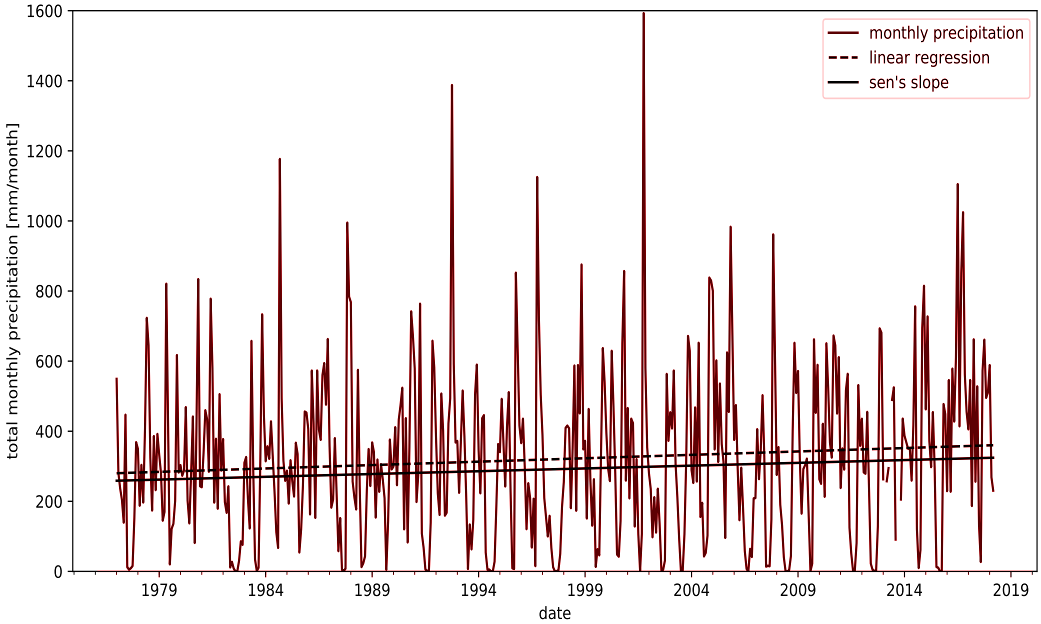


Figure 4 Monthly precipitation in West and Central Java (Cilacap station)
Source: Own representation of Cilacap data provided by Badan Meteorologi, Klimatologi, dan Geofisika (BMKG)

Monthly precipitation trends in South Sulawesi

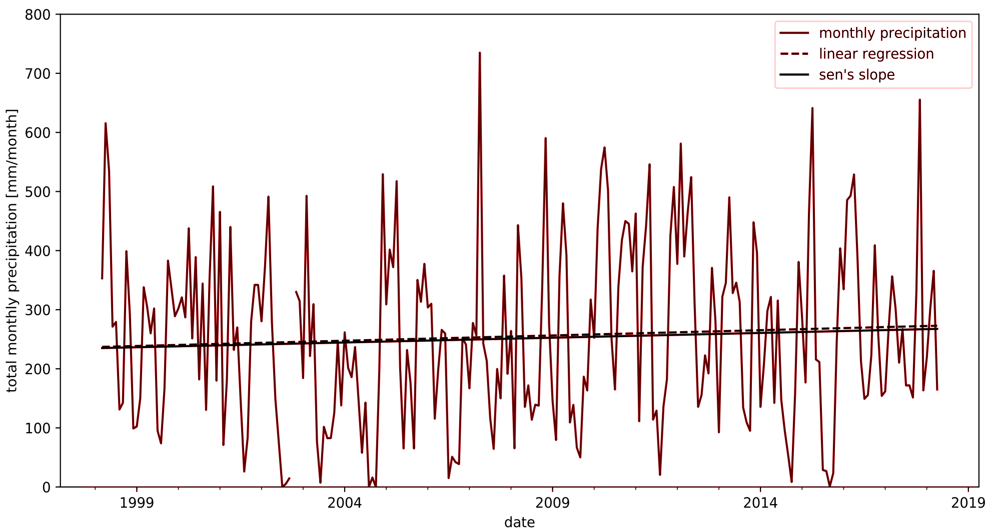


Figure 5 Monthly precipitation in South Sulawesi (Pongtiku station)
Source: Own representation of Pongtiku data provided by Badan Meteorologi, Klimatologi, dan Geofisika (BMKG)

Since Indonesia has a highly decentralised political system, regional policies and capacities vary. As Salahuddin (2014) contests, Indonesia's decentralisation makes it difficult for the national government to adhere to its international obligations, since most power rests with the provincial and local governments. Consequently, regional policy makers are crucial entry points for effective climate policies. Indonesia's National Communication under the United Nations Framework Convention on Climate Change (UNFCCC) in 2017 indirectly confirms this assertion, recommending that the government "prioritise the development of low-cost technology with substantial local content," to fulfil its pledges. According to the National Action Plan for Climate Change Adaptation, each district is expected to have a Regional Climate Change Adaptation Plan (RAD API), which is coordinated by the Regional Development Planning Body (BAPPEDA) and includes various mitigation and adaptation measures.

Climate change risks and policy responses in West and Central Java

In Pangandaran regency of West Java, JAMTANI cooperates with local authorities to shape their region's RAD API; while in Cilacap regency of Central Java, the planning is still in progress.

Climate-related disasters strongly affect rice farmers in the region who farm on land close to the sea. Sea level rise increases the inundation risks through abrasion of coastal land and tidal floods. In Cilacap and Pangandaran, 322,476 hectares were flooded between 2015 and 2017. Of these, a quarter (77,792 hectares) suffered crop failures. Further impacts are the salinisation of fields, topsoil erosion, and increased acidity. Reduced end-of-season rainfall caused cracked soils, which are difficult to manage. Farmers also cope with strong winds that push over rice plants and spread diseases faster. Nowadays, planthoppers and caterpillars are observed more frequently.

Climate change adaptation measures include mangrove restoration and flood breaks to protect lands from the sea, stress-tolerant varieties, floating paddy fields, early-warning systems, and agrometeorological learning to better oversee potential risks. JAMTANI initiated dialogues with local government to advocate for bottom-up climate change mitigation and adaptation projects in the RAD API planning. Communities are invited to propose climate-friendly projects. In this dialogue, it is emphasised that village funds should also be used for education and awareness programmes, not only for village infrastructure development.

Droughts often cause soil cracks. In paddy fields with clay soils, soil particles shrink and pull each other together more tightly, leading to cracks in the soil.

Source: JAMTANI

Smallholder farmers in Java are increasingly affected by floods. Farmers often have to replant their fields after floods destroy their first planting.

Source: JAMTANI

Crop failures due to damage caused by strong winds are increasingly common on the southern coast of Java.

Source: JAMTANI

Climate change risk and policy responses in Toraja

In Toraja, MPM partners with the local government on climate change issues and environmental concerns. The RAD API development process has not yet been initiated. A mark of success of the activities is that two of their partner villages won the provincial government's climate village trophy for their efforts towards climate change mitigation.

Due to its hilly topography and the increasing frequency of heavy rainfall, Toraja is particularly vulnerable to the effects of climate change. An increase in the risk of landslides is evident. Harvest failures due to hailstorms are more frequent. A strong consensus among farmers is their observation of greater pest and disease occurrence, particularly in the wet season.

To adapt to these changes, MPM promotes agroecological practices, the use of local varieties, organic farming, direct marketing of local produce, and community-based disaster risk management.

Due to steep topography, the mountainous villages of Toraja are often affected by landslides. More frequent heavy rains make the landslides more devastating (Bua'tarrung village, 13 April 2020).

Source: Rein Syauta

Dry spells occur more frequently as a result of climate change, necessitating supplementary irrigation. Sprinkler systems and mulching are expensive adaptation measures that require a reliable source of electricity and water.

Source: Bert Broekhuis

As consequence of climate change, diseases and pests multiply quickly, for example due to higher humidity levels. The tomato hornworm can wipe out entire gardens.

Source: Bert Broekhuis

2.3 Climate change risks and agriculture

"Climate change matters for us, as it impacts agriculture negatively. The temperature is higher than 15 years ago. It becomes difficult to decide on the right time of land preparation, as the onset of the rainy season is unpredictable. There are more pests and diseases and a higher resistance to pesticides. Lower yields, high chemical inputs and soil with low fertility and water holding capacity are common."

~Mr Endi Campernik, farmer, Padeherang village, Pangandaran, West Java

Climate change poses a multidimensional threat to farmers' livelihoods. Climatic variabilities and changes are especially threatening for small-scale farmers since they are highly dependent on favourable environmental conditions. Most of the farmers involved in the project farmed less than one hectare of land, and under rainfed conditions.

Increasing temperatures and changing rainfall patterns have had a serious impact on their agricultural production, farming practices, and, ultimately, on their daily lives. Hence, extreme weather events (such as flash floods due to heavy rainfall events) as well as pests and diseases attacks determine the outcomes of their farming through low production, crop failure, and increased workloads.

Climate change is also likely to exacerbate gender inequality within these households. Men are likely to migrate for work due to climate change and leave their spouses to manage their family and farms. The increased risk of disasters affects women disproportionally, as they are in charge of household cleaning and caretaking. During the Asian tsnunami in 2004, 70% of the victims were women (Habtezion, 2016). Moreover, lower overall earnings and access to education for women often translate into women's lower adaptive capacity, thus rendering them more vulnerable to climate change.

Small-scale farmers usually do not immediately relate their agricultural production challenges to weather or climate change and may not, therefore, adapt their farm practices to the changing conditions. As our evidence later shows, few farmers link changing weather patterns to their farming practices. This perception gap hinders farmers from finding suitable solutions to their problems. Further, maladaptation thrives under such circumstances, as farmers try to solve their farming issues through excessive use of fertiliser and pesticides, which leads to exhausted soils and further biodiversity loss.

To analyse the overall risk climate change poses to agriculture and food security in Indonesia, the global guiding risk framework of IPCC AR5 (2015) is employed. In this concept, risk is the result of the interaction of vulnerability, exposure, and hazards.

"When I was young, the weather was still organised, but now it is very difficult to see if we are in the rainy season or in the dry season, as the seasons blur."

~Female farmer, Tallang Sura', Toraja, Sulawesi

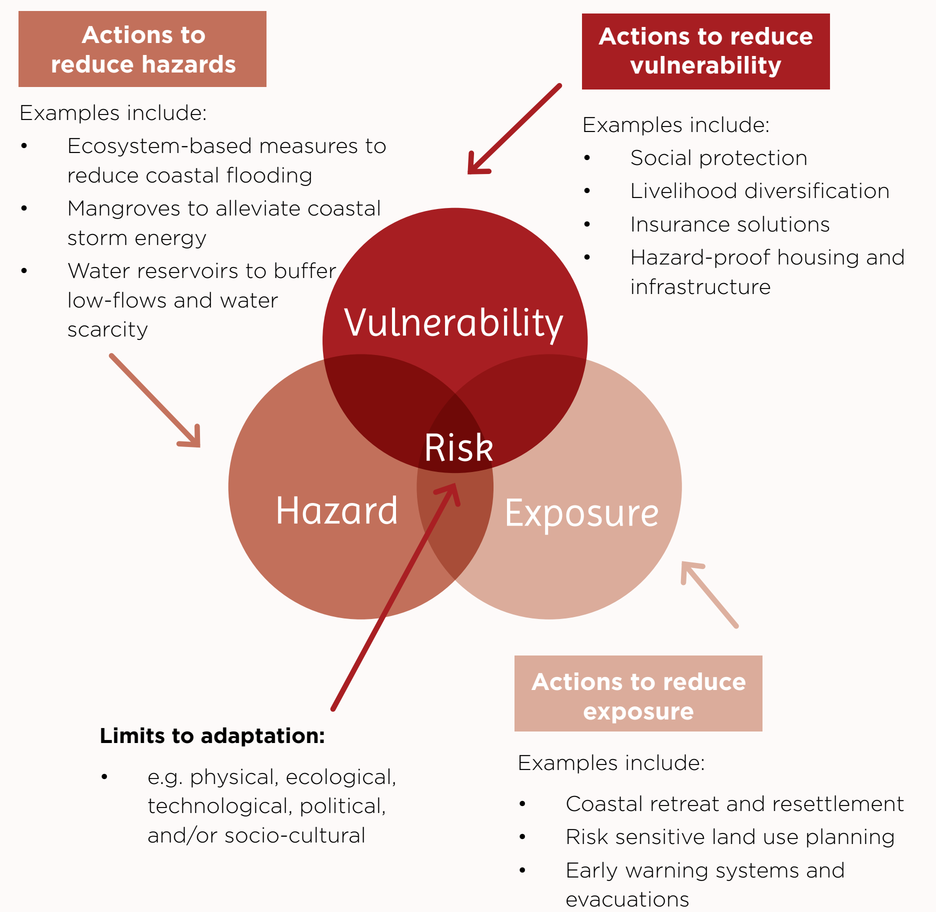
Elements of climate risk

A climate hazard is an extreme climate event (e.g. a tropical cyclone) or a slow-onset event (e.g. sea level rise) that may affect a specific area, its people, or an entire sector.

Exposure explains whether farmers or other groups, sectors, or regions are affected by a hazard. Sea levels rising, for example, might affect only those with rice fields close to the sea while farmers with elevated fields may not be affected.

Vulnerability explains whether farmers, sectors, or regions lack the capacity to adapt, by being unable to change their farming practice, by not diversifying income, or by not using other support systems (such as insurance or social schemes) in extreme events.

Indonesia's geographical predisposition (hazard), its growing population along the coasts (exposure), and low adaptive capacities (vulnerability), particularly in rural areas, add up to high risk.



Source: IPCC 2019

Climate risks in the project locations

Assessing the risk of climate change

Rice and chili farming in Toraja

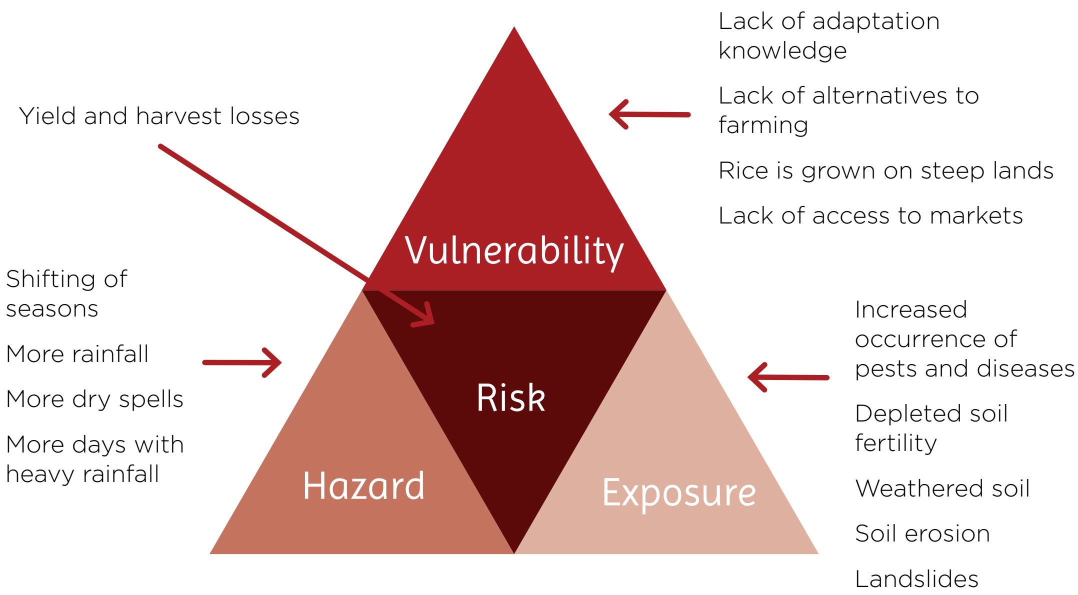


Figure 6 Climate change risks on paddy rice and chilli farming in Toraja

Assessing the risk of climate change

Paddy rice farming in Java

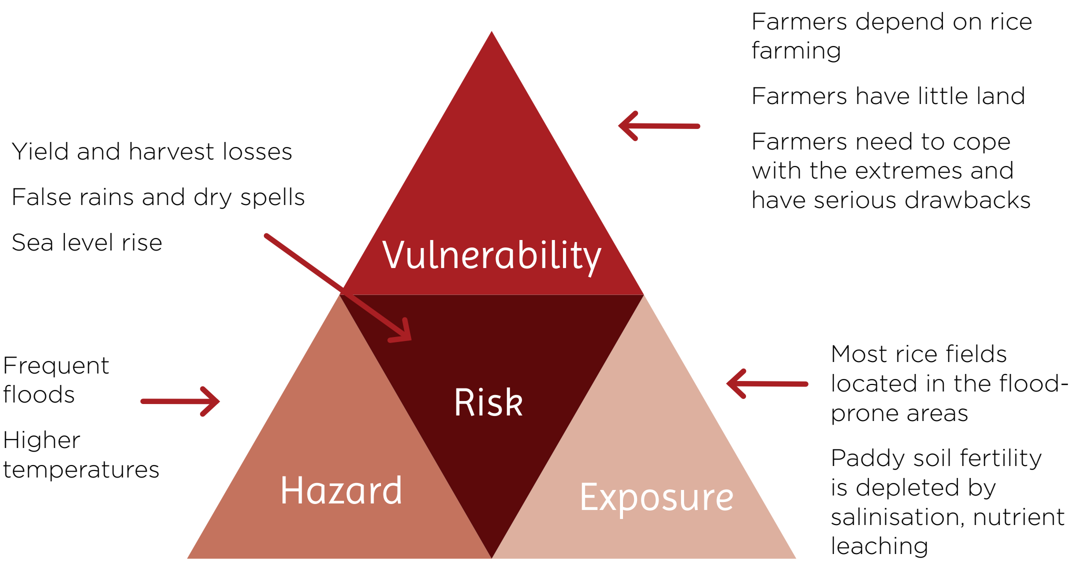


Figure 7 Climate change risks on paddy rice farming in Java

Rice: An important, though jeopardised, staple crop in a changing climate

At least 90% of the world's rice is produced in Asia, where it is the main staple crop. Indonesians consumed nearly 150 kg of rice per person per year in 2017. Climate change will severely affect food security by the middle of the 21st century, with the largest numbers of food-insecure living in South Asia (IPCC, 2014). Most simulation models show that higher temperatures and solar radiation will lead to lower rice yields and lower nutrient content because rising temperatures accelerate the process of rice development, which reduces the duration of growth (see Annex 1 p.166 and annex 2, p.167: Factsheet Rice).

A mix of potential adaptation strategies, such as crop breeding, crop variety selection, adjusted planting time, water management, crop diversification, and integration of local knowledge and practices are required to adapt. In general, adaptation needs in countries of the Global South are expected to be large, but adaptive capacities are often the lowest. In other words, many, if not most countries, cities, or communities, are not adequately adapted to existing climate risks, which means that currently there is an adaptation gap. Thus, raising the adaptive capacity is essential to lowering the risk of climate change. Such an effort needs to overcome a multitude of obstacles, which UNEP (2016) defines as "adaptation gaps".

Adaptation gap

An adaptation gap is the difference between what is actually done to adapt and the actions that are required to adapt, given the impacts of climate change. Such an effort needs to overcome a multitude of obstacles, such as finance, technology, and knowledge gaps, which Olhoff et al. (2016) defined in an UNEP publication as "adaptation gaps".

Financial gaps can occur at the national, regional, or local level. They are highly likely to increase under higher emission or business-as-usual scenarios. Fortunately, funding to achieve adaptation objectives has increased in recent years and scaling up adaptation finance remains a priority.

The **technology gap** refers, for example, to farming technologies that may be useful and already exist but are not available in a country. There might be barriers to their further uptake or they might be unknown to farmers and, thus, not used.

Addressing **knowledge gaps** could significantly contribute to the reduction of adaptation gaps. Gaps in knowledge are seen in three areas: the current knowledge base, knowledge production, and knowledge sharing. For instance, if affected people are not aware of climate change, its risks, and its challenges in their region, they will be unlikely to change their practices. While that knowledge is available to many researchers, links to practitioners and local communities are weak or missing. Integrating knowledge from different sources and making it available to decision makers at different levels is, therefore, the most important knowledge need.

Who closes the adaptation gaps? Adaptation refers to specific climate risks in each context. As climate risks are highly variable between locations, adaptation efforts must focus on local levels. Local actors, such as researchers, practitioners, local communities, and decision makers play a critical role in strengthening adaptive capacities. Their inclusion can produce low-cost, easy-to-implement, and no-regret adaptation strategies. National and international programmes should support such decentralised adaptation programmes.

Mr Endi and his wife, Hera, sell organically produced red, black, and white rice in small packages.

Source: Silke Stöber

3. The Climate Field Lab approach

The following section outlines the origins, aims, and general features of co-creating knowledge for increased climate resilience. By merging the knowledge systems of farmers and scientists or technical experts, all stakeholders have a better understanding of the impacts of climate change on crops. Consequently, entry points for the development of climate-resilient farming solutions can be more easily detected. It will be easier to understand the overarching concept if you consider the following three aspects:

1. Since climate change poses a series of challenges and current farming practices are insufficient to minimise climate risks, an innovative approach is required. CRAIIP bridges the knowledge gap between practical and academic knowledge. The project complements both traditions and treats them equally. The approach is the result of shifting paradigms and constant reconfiguration of how knowledge is created.

2. The Indonesian government signed the Paris Climate Agreement and is committed to a sustainable climate policy. In Paris, Indonesia presented an instrument of climate change adaptation in agriculture: the Climate Field School. In this method, farmers and local agricultural and meteorological services work together to design sustainable agriculture practices and roll out agrometeorological learning. Climate Field Schools were first rolled out in Indonesia 10 years ago (Ministry of Agriculture Indonesia, 2013). One can, therefore, draw on a wealth of experience.

3. CRAIIP pays particular attention to rice and chilli, as rice is the most important staple food in Indonesia at large and the chilli variety Katokkon is a local speciality in Toraja (Sulawesi); the results and examples in this manual are linked to the cultivation of these two crops.

3.1 From transfer of technology to co-creation of knowledge

Agricultural development in international cooperation has gone through a series of paradigm shifts. Dominant since the green revolution, the transfer of technology approach left its mark on many development projects. Under this approach, the dissemination of innovations is a linear system in which research institutes disseminate knowledge and technologies via extension workers to farmers. Often, the knowledge provided did not correspond to local needs and the promoted technologies did not match local conditions. Under this paradigm, academic agricultural knowledge was regarded as superior to local farming wisdom; this led to disregard for local knowledge.

Transfer of technology approach

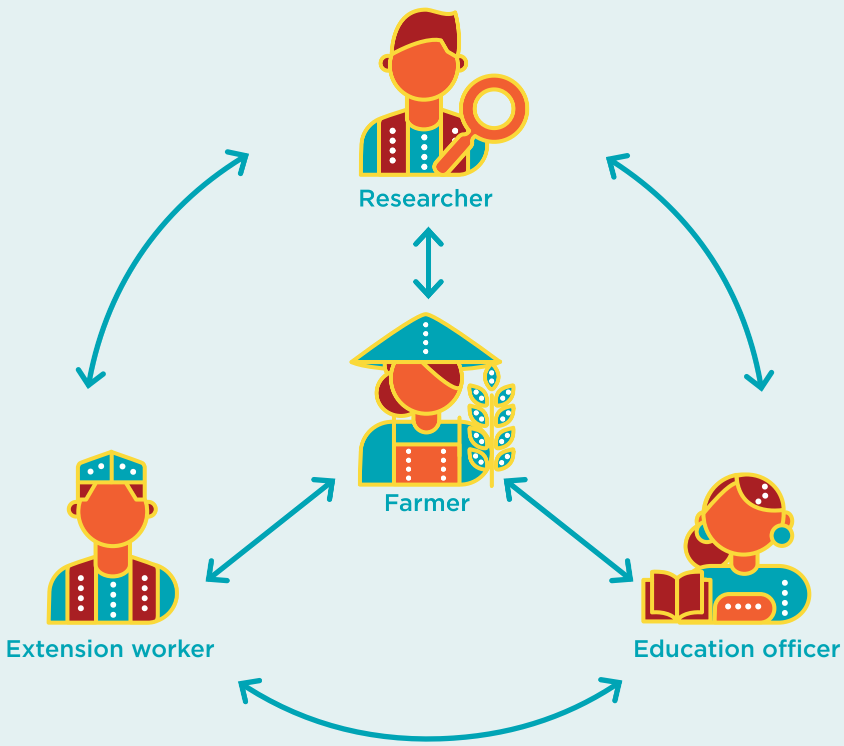
While the transfer of technology approach is still widespread, the overall innovation and dissemination system paradigm has shifted.

Agricultural knowledge and information system approach

The Global Forum for Rural Advisory Services (GFRAS) places farmers' needs at the centre of all advisory activities. A farmer-centred approach empowers smallholder farmers. Smallholder farmers become acquainted with tools to engage with policy makers and to advocate for their interests. Nevertheless, farmers are still seen as recipients of information and innovations.

The agricultural knowledge and information system approach does not see farmers' contributions and experimental capacities as equivalent to academic knowledge. Yet, the most relevant contributions to climate change adaptation and livelihood improvement often stem from farmers' own innovations. However, since there is often no systematic analysis of local wisdom, farmers' contributions are less visible.

Agricultural knowledge and information system approach



Source: Davis et al. (2018)

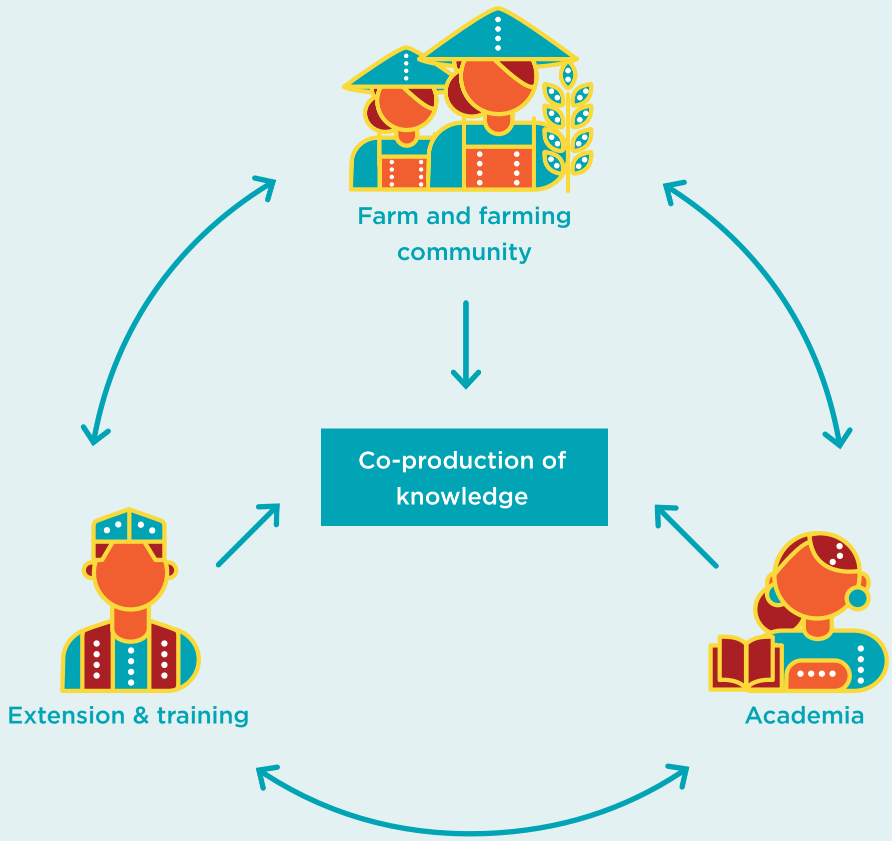
The FAO's High Level Panel of Experts on Food Security and Nutrition (HLPE) recognises this approach and endorses the co-creation of knowledge as a core agroecological principle (HLPE, 2019). Horizontal sharing between peers (for example, farmers) and vertical (between farmers and academia) boosts local and science-based innovations. Through "experiential learning and knowledge sharing among practitioners, and co-production of knowledge among multi-stakeholder networks," innovations evolve that are adapted to local contexts (ibid, p. 41).

Co-creating knowledge highlights farmers' innovative ideas. Farmers, scientists, and extensionists exchange knowledge on equal grounds, which we call co-research. For example, innovative agroecological practices from the farmer community are assessed according to scientific criteria, e.g. the active ingredients of a local bio-pesticide, while promising innovations provided by scientists are assessed according to local criteria, i.e. the benefit of composted manure.

Definition of co-research

Co-research means solution-oriented research that happens on the ground. Co-research stands for community research or cooperative (joint) research and puts scientists, community organisations, and farmers together to jointly understand problems and search for solutions. The community, for example farmers, mandate the research, and develop the research design, collect and analyse data and disseminate results together with academia. In this way, farmers are not the subject of research, but are researchers themselves.

Co-research approach



Kinds of knowledge

Farmer knowledge	Extension knowledge	Academic knowledge
Observational	Facilitating	Theoretical
Intuitive	Motivating	Analytical
Lived-experience	Enabling	Methodological
Local, traditional	Translating	Global, general
Vertical from parents to children	Transferring	Horizontal between locations
Local wisdom	Knowledge bridge	Formal knowledge

Demonstration plot: Co-research farmers of BatuSura' village harvest their rice plots and assess their yields of the tested rice varieties.

Source: Rein Syauta

3.2 What is a Climate Field Lab?

The Climate Field Lab merges an array of established communities of practice and expands their scope by incorporating a climate perspective. The main elements of the Climate Field Lab are climate-friendly farming, climate adaptation co-research, and climate field schools (see infographic p.37). Through regular exchanges between farmers and scientists (students and lecturers), smallholder farmers develop their analytical skills on farming in the face of climate change.

> *"Before, I did agriculture like a blind man. Now I can see and understand."*
>
> *~Farmer, West Java*

One of the elements of the Climate Field Lab approach is Climate Field Schools, in which problem-solving dialogues and agrometeorological learning take place. Farmer Field Schools bring farmers together to discuss their most pressing issues and develop solutions. In Indonesia, the Farmer Field School approach was introduced in 1989 and has been continuously developed since then. Climate Field Schools are Farmer Field Schools with an additional feature: apart from agroecosystem analysis and learning, they raise farmers' awareness and understanding of climate change. Farmers learn to observe the weather and keep records of their observations. They use rain gauges, thermometers, and other tools to keep track of weather trends in their area.

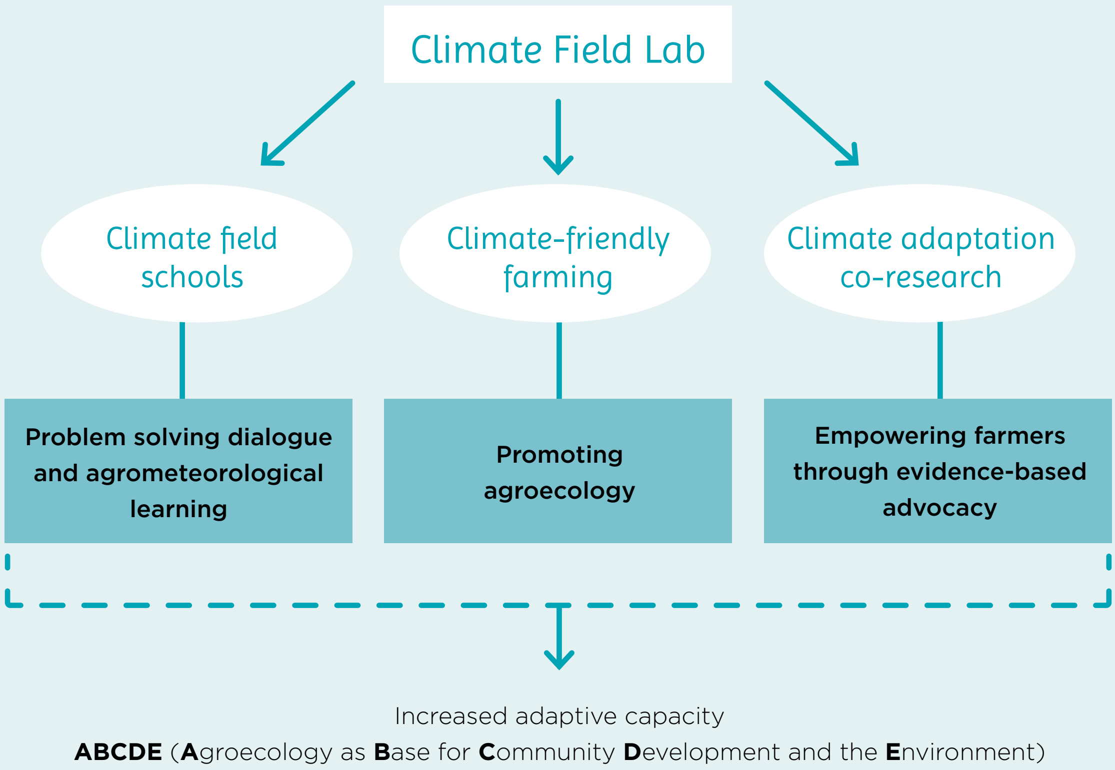
The main features of Climate Field Schools are:

- Participants work in groups of 15
- Weekly meetings are conducted throughout the full cropping season
- Each meeting includes a weekly weather update and comment on how weather has influenced crop growth, a joint agroecosystem analysis, a special topic raised by farmers, and a group dynamics activity
- Emphasis is placed on facilitating, not teaching (experiential, participatory)
- Meetings are conducted close to the learning field plots (e.g. in a shelter or a farmer's home)
- The main learning material is the cropping field
- Participants conduct studies to evaluate different management practices
- A final meeting is conducted at the close of the season to collect feedback and plan follow-up activities

The Climate Field Lab embraces the ecosystem-based adaptation approach and takes care of nature-based solutions in the fields of conservation, sustainable management, and restoration of ecosystems (Colls et al., 2009; UNEP/IUCN, 2021). In the farming context, this means that agroecology, biodiversity, and ecosystem services for farming are emphasised. The mitigation potential of agriculture is addressed by using climate-friendly farming techniques. To find the most appropriate technologies and solutions, co-research between farmers and scientists, in the forms of on-farm trials, demonstration plots, market surveys, and other techniques, is done.

The Climate Field Lab combines knowledge from farmers and from academia. By systematically analysing local wisdom and testing innovations on farms, the Climate Field Lab can upgrade existing technologies and provide space for new ones to emerge. In particular, the process generates easily reproducible, low-tech agroecological innovations, which are deemed "no-regret" strategies. These are measures, which are worth implementing no matter what will happen. If, for example, pests and diseases spread faster due to higher humidity, the use of natural predators like wasps or ladybirds would be a "no-regret" strategy, while the excessive use of pesticides would not be a "no-regret" strategy, as it causes high environmental costs and high purchasing costs for the farmers. In the long run, the Climate Field Lab enables the farming community and academia alike to advocate for better climate adaptation policies vis-à-vis policy makers. Thus, the approach fosters evidence-based and more effective problem solving. Overall, Climate Field Labs aim to increase the adaptive capacity of all stakeholders.

Elements of the Climate Field Lab



3.3 Who participates in Climate Field Labs?

Farmers that are interested in investigating new agricultural practices are called research farmers (in Bahasa Indonesia: *petani peneliti*). When collaborating in Climate Field Labs, they test and discuss the advantages and disadvantages of new farming techniques to adapt to the impacts of climate change on agriculture.

Research farmers

A research farmer (in Bahasa Indonesia: *petani peneliti*) can be described as a co-researcher in agricultural field trials. Research farmers formulate research questions; observe, count, or measure soil health, growth, and production parameters; and may control for pest and diseases infestation. They assess the results of the trial by reflecting on evaluation criteria and developing their own criteria for success. They participate in weekly Climate Field Schools and in monthly meetings, trainings, or farmer-to-farmer visits. They may also conduct simple trials on their own farms.

Research farmers of BatuSura' village measure the fresh weight of the chilli fruits per plant. On the right, a student from Universitas Hasanuddin (UNHAS) supports the research farmer in her work. The student will analyse the data from the field as part of her final thesis.

Source: Rein Syauta

Both project partners, JAMTANI and MPM, collaborate with research farmer clubs on practical investigations at demonstration plots in farmers' fields for at least two seasons. Research farmers participate in weekly climate field schools, monitor growth and production parameters, maintain demonstration plots, and jointly solve emerging problems.

The club members consisted of equal numbers of women and men. The average age in both locations was 45 years. In Toraja, the majority graduated from senior high school, while in Java most graduated from junior high school and many from elementary school. Farmers in Toraja grow cocoa, coffee, and clover as cash crops while farmers in Java grow rice and vegetables. In both locations, rice-based systems dominate, with farmers in Toraja rearing swine and farmers in Java raising poultry. Most research farmers in the villages of Java (83%) generate off-farm income; yet only 49% of the farmers involved in the research farmer clubs in Toraja do so.

Main features	Toraja	Java
Partner villages	Buntu Datu, Bua'tarrung, BatuSura, TallangSura', To'pao	Ciganjeng, Rawaapu
Elevation (m above sea level)	928	32
Research farmers/village	16	10
Percentage of women in the research farmer club	51%	41%
Average age	45	45
Highest level of education achieved	29% junior high school 52% senior high school	38% elementary school 48% junior high school
Percentage of farmers with off-farm income	49%	83%
Main cash crops	cocoa coffee cloves	rice vegetables coconut, banana
Main food crops	rice chilli, vegetables	rice vegetables
Livestock	pigs (most) chicken, ducks (some) goats (rare)	chicken (most) ducks (some) fish (rare)

Table 1 Profiles of research farmer clubs

General characteristics of farmers engaging in CRAIIP research farmer clubs in 2017 (n=113)

Practical tip

A group size of 10 to 12 persons per research farmer club worked well. Mixing both genders created good group dynamics. Research farmer club members felt it was important to share their experiences and lessons learnt with the larger community, and not to gain a reputation as an elite club. Sharing results strengthens social cohesion within and between communities and groups and enhances resilience to climate change.

Climate-related disasters also affect farming on slopes. Farmers of To'pao are aware of the need to adapt.

Source: Silke Stöber

3.4 What is actually done in a Climate Field Lab?

Agro-meteorological and agroecology learning in weekly Climate Field Schools	• Observing weather with rain gauges and thermometers in the field • Analysing actual weather against long-term trends • Keeping a climate diary to document weather extremes, rainfall, impact on crops, and seasonal plans • Agroecosystem analysis: Observing and learning together in weekly meetings • Producing compost, liquid organic fertilisers, biopesticides
Demonstration plots	• Maintaining a demonstration plot (randomised controlled field trials with repetitions) for at least two seasons • Observing and analysing growth and production parameters • Resolving emerging problems
Farmer-led experiments on their own fields	• Testing varieties • Developing traits by selecting and crossbreeding plants • Observing and documenting growth and performance of different soil fertility strategies and varieties • other isues upon demand
Real-time problem solving	• Assessing soil health through quick soil tests • Consulting in real time on pests and diseases via WhatsApp groups or other apps

Table 2 Activities of the Climate Field Lab

3.5 What are participants' roles?

Farmers formulate their own research questions and thereby set the research agenda. In practice, these questions are often related to improving yields and productivity, but may also be related to pest management or water saving technologies. Moreover, they transform academic inputs into practical solutions; collect and monitor data from experiments and demonstration fields; collect weather data; and provide land and labour. They benefit from better problem-solving skills and a wider self-tried and tested portfolio of agroecological solutions for adaptation to climate change.

Universities support farmer-led research through new techniques, methods, and analysis. They advise farmers on how best to maintain the demonstration fields and their experiments. They analyse data and provide expert knowledge on farmers' demand for innovative ideas. They train students to work with smallholder farmers and supervise the relationship. They gain evidence and empirical data for lectures and publication in national and international journals. They develop a network of smallholder farms, in which to place student interns.

NGO

Farmer Organisations / NGOs offer quality services to their members or support community development. They organise monthly and weekly meetings following the principles of adult education and invite experts to demonstrate innovations. They provide trainers and facilitate the Climate Field Lab process. They link with local governments, manage programmes, and acquire funding to continue the approach. In cooperation with universities, they may select and recruit students to support field work.

Policy makers use the farmer-led research results to formulate and implement responsive policies, particularly those in agriculture, environment, education, and research. They benefit from increased welfare and expertise in their respective constituencies.

3.6 Basic conditions and principles of Climate Field Labs

Before starting a Climate Field Lab programme with farmers, there must be a real need for research and learning activities, as these occupy time and resources from farmers. At the beginning of the project, objectives for the Climate Field Lab project should be defined. In Indonesia, both partner NGOs, JAMTANI and MPM, explained the necessity for their Climate Field Lab programme due to the following conditions.

- Climate-related disasters are prevalent in the farming community.
- Farmers suffer from income losses through these disasters. Consequently, farming is no longer seen as an economic activity. Farming systems need to adapt to climate change.
- However, farmers lack innovative solutions to develop resilience for climate-related disasters. Many innovations to adapt to climate change are not known or fully understood.
- Finally, farmers' participation in decision-making in agricultural field research is low.

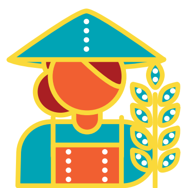
Practical tip

A planning exercise with staff and interested farmers, needs to take into account the following questions:

- What are the major conditions and circumstances that would explain the need for a Climate Field Lab programme in your area?
- How would you define the objectives of your climate change adaptation learning programme?
- Which research questions can not be answered by existing literature and knowledge and need to be taken up in a farmer-led research programme?

Objectives of Climate Field Labs by JAMTANI in Java

- Smart and independent farmers are able to manage their fields and produce quality products with higher market value, even in the dynamic environment of climate change.
- Farmers are considered as creative and independent problem solvers to adapt to the negative impact of climate change in a sustainable manner.
- Farmers' adaptive capacities to experiment and find climate-friendly solutions to their problems are increased.
- Farmers have widened their networks and have better access to information and communication channels with other research farmers, NGOs, and academic institutes.



Climate Field Lab programmes also define outputs and benefits, which are based on the needs of the farmers. Benefits might be similar to those of farmer-led research approaches.

1. In farmer-led research the problem-solving cycle from testing an innovation to a good practice is shorter than in conventional research.

2. The results of farmer-led research is published and made available to farmers. The documentation is published in the form of journals, factsheets, and modules, which include simple, easy-to-understand records to document relevant parameters (for example, growth, productivity, production techniques, and weather data).

3. Effective climate-friendly innovations or technologies that overcome farmers' climate change-related problems are available.

4. Farmers are enabled to express their interests and needs to decision makers and policy actors, e.g. on field days. They are able to present and deliver clear messages from what they have learned in their farmer-led research.

5. Farmers share their knowledge and experiences with group members, through appropriate and effective farmer group organisation and management.

6. The results of farmer-led research is replicable. Farmers apply and share their research results on their own land and in neighbouring fields. Other farmers have access to these trials and gain skills in the development and use of farmer-friendly and climate-friendly innovations.

7. Farmers access a support structure, which can be provided by government, NGOs, and CBOs.

Mr. Sahudi from Rawaapu village, Cilacap regency, tests the performance of stress-tolerant rice varieties on his own farm.

Source: Silke Stöber

Farmer-led research practices in Java and South Sulawesi

Farmer-led research is a type of research where farmers mandate the research, when experiments take place under real-life conditions, i.e. on-farm, by farmers, and most importantly, with goals and research questions set by farmers. While farmers are the principle planners, they receive support from science and rural advisory services in performing their tasks. Farmers conduct the work in the field, e.g. planting and maintaining the crops, and follow a standard operational protocol proposed by scientists or rural advisory services staff. The three parties involved discuss the relevant research question, implement the field trial, and analyse the results.

Various exchange mechanisms have worked in the CRAIIP project. In Toraja, UNHAS scientists travelled regularly to farmers for follow up and training. MPM staff supported farmers to independently monitor their results in weekly climate fields schools. Larger meetings were held to involve other people from the community and to share evidence on results and procedures.

In Java, UNPAD visited farmers to provide start-up training on green manure and stress-tolerant varieties. A postgraduate student supported the follow up activities in demonstration plots and ensured that data were regularly monitored. JAMTANI staff facilitated the weekly climate field schools and a monthly exchange among research farmers.

Lessons learned about the farmer-led research process used by CRAIIP (2017-2019)

1. **Keep it simple.** University researchers encouraged farmers to compare five or six varieties on five soil fertility strategies to generate a rich data set. However, this was too complex. A small number of treatments, for example three different varieties and two soil fertility strategies (or even fewer variations) are less puzzling and may better demonstrate differences.

2. **Develop standard operational procedures.** The planting season is a very busy time for farmers. While field experiments takes place, they also care for their own farms. Therefore, it is essential to put in place all materials, guidelines, records, and communication channels. The roles of the involved actors must be clarified, e.g. what to do in case of emergencies such as pest or disease outbreaks, flooding, or dry spells.

3. **Observe daily.** On-farm research requires intense observation. It is necessary that farmer researchers visit their field or demonstration plot daily to keep rainfall and temperature records. On a weekly basis, growth, and production parameters and pests and diseases outbreaks are observed.

4. **Robustness of data.** To get robust and reliable data, it is recommended to conduct on-farm experiments over several years or across many places. What seems to be of advantage in a season with unusual high rainfall might look totally different in a year with dry spells. Therefore, it's sensible and required to obtain multiple observations before drawing conclusions. One possibility is replications of treatments in one farm. Another possibility is the inter-farm comparison trial, where varieties are planted across farms or villages, possibly under similar agroecological conditions.

5. **Mitigate risk.** The advantage of on-farm experiments is that new practices can be tested on a relatively small plot of land. This helps farmers assess the risks posed by the new practice before adopting it. In Toraja, the risk was shared in the community, as several farmers shared the work on a demonstration plot and the owner of the land was compensated for part of the yield. In the case of harvest failures, the NGO would compensate for the yield loss by valuing the yield of the previous year. In Java, the risk was taken away from the farmers by renting the plot of land from an individual farmer. Farmers shared the work on the rented plot.

Ecological solutions are key for success. *Azolla pinnata* is a floating aquatic fern that binds nitrogen and replicates fast. It is used as green manure in rice paddies.

Source: Bert Broekhuis

4. Climate Field Lab tools

4.1 The steps of the Climate Field Lab process

This part of the manual presents various tools and methods, which were developed, tested, and refined in the project locations in West/Central Java and South Sulawesi. We describe each tool's aim, time requirements, resources/materials needed, and main facilitation steps. To better understand how the results of the tools could look, examples of their use in the two Indonesian pilot regions are included. In the infographic below (pp.49-50), we share a summary of the tools, presented according to their application in the project cycle, from awareness raising to scaling of process and results.

A Climate Field Lab starts with a group of farmers who are committed to joining a climate field school for at least one season. This includes designing a demonstration plot or experiments that should answer their own research questions, participating in weekly observations, analysing growth and production, and finding solutions to identified problems.
It is not necessary to walk through each tool in sequential order. If farmers, for example, have previously discussed the impacts of climate change on their farming, the steps of Stage One (Awareness raising) might be skipped or shortened.

When starting a programme, one can choose from the tool menu and select those tools that best serve the community. Team building and rules for participation are prerequisites for engaging farmers. As participation is voluntary, farmers may drop out if their expectations or interests are not met.

To warm up and create group cohesion, rituals and energisers are essential. The farmer clubs may want to give themselves a name or create a motto or song that they repeat in each session. Regular feedback between farmers, NGO facilitators, and visiting scientists is required to run and shape the programme.

Motivating for participation in Climate Field Labs

The Climate Field Lab approach follows the principles of Participatory Learning and Action (PLA). Flat hierarchies, appreciative attitudes and behaviour, interactive lessons with energising activities, dialogues, and exchange at the eye level are not a matter of course. You have to conquer them with the help of rituals and energisers.

One favourite energiser in the Climate Field Labs facilitated by JAMTANI is *Petani JOS!* In this activity, the facilitator calls, *"Petani"* (meaning "farmers") and the farmers response in chorus, "JOS!" (an abbreviation for *Jangan Omong Saja,* which means "not just talking"). This can be repeated when attention wanes or the mood slackens.

New farmers may join the club mid-season. Fellow farmers acquaint them to the principles and club rules. Since Climate Field Labs generally focus on one crop at a time to exploit the full learning potential, rice farmers may need to join for a full growing season, which lasts four to five months from transplanting to harvesting. In chilli farmer groups, farmers may join for the six months from planting to harvesting. While participation is voluntary, NGOs must facilitate weekly meetings with their expenses (e.g. lunch and transport) compensated according to their local customs and conditions. Materials, like seed or new equipment might be subsidised by the programme, while farmers dedicate their time, labour, and land. The demonstration plot necessary for the Climate Field Lab can be rented from a farmer or, if a farmer provides the land free of charge, they might be compensated later by getting the biggest share of the harvest. Detailed conditions for these arrangements must be negotiated within the research farmer club, depending on available budgets.

The Climate Field Lab toolbox

Encouraging farmers to view their landscape through a climate lens

Farmers´ perceptions of climate change

Tool 1
Group discussion on climate change and farming

Tool 2
Climate change perception survey

Tool 3
Assessing climate impacts on specific crops

Tool 4
Ranking of emerging pests and diseases

Agrometeorological learning

Tool 5
Weather records

Tool 6
Climate diary learning journal

Planning and implementing adaptation co-research

Screening of innovations

Tool 7
Inventory of agroecological farming practices

Tool 8
Adaptation potential of agroecological practices

Planning and designing experiments

Tool 9
Identification of research questions and expected results

Tool 10
Evaluating the season

Implementing of Climate Field Labs

Tool 11
Climate field school

Evaluating the season

Tool 12
Testing the taste

Tool 13
Interlocking realities

Tool 14
Field lab's benefit and learning impact

Tool 15
Before–after comparison

Scaling of processes and results

Tool 16
Sharing farmer wisdom

Tool 17
Producing people-friendly posters

Tool 18
Elevator demonstration

Women farmers were asked what aspects mainly motivated them to participate in the co-research. The ranking was done with maize kernels. Each individual thought about it for herself, and then they exchanged ideas. The main motivation of the To'pao women farmers was that they would develop a better livelihood through chilli cultivation so that their children would have a better future.

Source: Silke Stöber

4.2 Climate Field Lab tool descriptions

Tool 1 to 6: Encouraging farmers to view their landscape through a climate lens

Farmers' awareness of the impacts of climate risks influences their responses to climatic changes.

Farmers already have some good ideas about climate change and they often express those as remarks about how weather or their crops are changing over time; for example, it is common to hear farmers use phrases like "hotter", "drier", "more diseases", "more floods", etc. Despite these general observations, many farmers continue to use the same farming practices they have always used, hoping for good weather or fearing poor outcomes from changed practices. Since weather is changing, but their farming practices are not changing, they are inevitably disappointed by their low yields.

"Climate change affects our rice fields. Nighttime and daytime temperatures increase, water levels in rice fields increase, and we suffer from prolonged flooding."

~Research farmer in Rawaapu, Cilacap, Java, 2018

As a first step to changing current farm practices to more climate-resilient methods, farmers must accept that their general perceptions of changes in weather, soil, yields, pests, and diseases are not simply opinions about good years or bad years, but real, objective, and quantifiable observations of actual changes. What they have observed is real. Tool 1 and 2 can be used to collect the perceptions of climate change. But, until they have solid evidence of those changes and relate changes in weather to changes in climate to changes in their fields, crops, and livelihoods, they will not be empowered to make changes or pressure their local governments and community organisations to support their actions. To assess the impacts on crops and the emergence of pests and diseases, Tools 3 and 4 can be used.

Given the correct tools to measure, record, and analyse changes on their farms, farmers will be able to visualise their observations over time and compare them with historical climate trends. Instead of expressing general perceptions of the weather (for example, "heavier rainfalls"), farmers are able to articulate their climate change observations in a quantifiable manner that can be compared between villages and regions over time (for example, "in the last month, our crops were often damaged as we had five days with heavy rainfall of more than 50 mm"). With better understanding of the interrelations between weather, climatic changes, and agricultural production, farmers can make their own assessments of the most pressing climate problems and gain motivation to act, not only on their own farms, but in their communities. The agrometeorological learning (Tool 5 and 6) can be used to communicate to local decision makers. For this reason, awareness raising is the first step or "entry point" to adaptation to climate change.

"Understanding farmers' perceptions of how the climate is changing is vital to anticipating its impacts. Farmers are known to take appropriate steps to adapt only when they perceive change to be taking place."

(Chepkoech et al., 2018, p. 551).

Rawaapu village has experienced hotter temperatures, increased rainfall, heavy storms, and salinization of paddy fields as a result of climate change. To adapt to these changes and guard against potential losses and hazards, farmers work collaboratively to develop innovative farming and livelihood strategies.

Source: Silke Stöber

Encouraging farmers to view their landscape through a climate lens

Tool 1

Group discussion on climate change and farming

In this tool, farmers from the region have a guided discussion about climate change patterns, record main findings from their discussion, then reflect on their findings as a group with a weather expert.

60 Minutes

Objective	✔ To gather farmers' perceptions of climate variability and change in their local area ✔ To gain insights on how climatic changes occur in the region
Resources	✔ Facilitator ✔ Space for subgroups ✔ Flipchart paper ✔ Pens ✔ Weather expert
Participants	10 to 25 farmers from one or several villages; you may invite weather experts or meteorological services staff to comment on weather perceptions or to explain the climatic development of the region
General considerations	• Invite elderly people, particularly those who have been born in the village, to get long-term perspectives. • Choose a facilitator for the group discussion. • Document the results for each village. • Record men and women's perceptions separately and consider the need to form gender-disaggregated groups, as this may give a better group dynamic. • Create a participatory and friendly atmosphere and use farmer-friendly language. • Respect farmers' local wisdom, e.g. on traditional weather rules.

Steps

1. Invite (male and female) farmers from several villages.
2. Consider inviting an expert from the local meteorological office. In Indonesia, it is the Badan Meteorologi, Klimatologi, dan Geofisika (BMKG) office.
3. To create a common understanding, present the discussion questions (see materials) and clarify uncertainties.
4. Ask farmers to sit with the other farmers from their village.
5. Allow farmers time to discuss the questions one by one and document their findings.
6. Ask the farmers to reassemble and present their findings.
7. Ask NGO, CBO, BMKG, or university and farmers to draw conclusions from the findings and put the results into the context of climate change.
8. If historical weather or seasonal data is at hand, weather experts can compare farmers' findings with weather data from the stations.

Materials

Answer the following questions in your group. Document your answers on the flipchart. Think about a long time period, for example 30 years or since you are farming in this village.

Temperature

1. How do you feel that daytime temperatures have changed in your village?
2. How do you feel that nighttime temperatures have changed in your village?

Rainfall

3. How has rainfall changed during the last 30 years? While answering, make comments on:
    a. Number of rainy days: fewer, same, or more?
    b. Length of the rainy season: shorter, same, or longer?
    c. Intensity of rainfall: drizzle, moderate, or heavy?
    d. Number of dry days during rainy season: fewer, same, or more?
4. In which month is the rainfall
    a. the lowest: ......
    b. the highest: ......
5. When does the rainy season start: earlier, same, or later?
6. Please explain your traditional method(s) to forecast the weather in your village.
7. Can you still rely on these rules? If not, what has changed?
8. How do you think the climate changes you described (as per questions 1-7) affect your crops?

Practical tip

This climate change awareness baseline can be used later in the project's course to evaluate the participants' learning progress.

Income diversification through value addition and marketing are important adaptation strategies. The women group “Ibu Mandiri” (Independent Women) cusions financial shocks caused by climate change by producing and selling home-made seafood crackers (village Ujungalang, Cilacap).

Source: Bert Broekhuis

Practical tips

1. After farmers have shared their observations, it is important to discuss them. You can point to commonalities and differences between villages and general trends.

2. Facilitators should be ready to encourage participants to answer questions concisely. For example, farmers may report “more rain”, but this could have many meanings: it could mean more intense rain episodes/events, more rainfall annually, more rainfall outside the normal rainy periods, longer duration of rain events, etc.

3. The facilitator should conclude the group discussion by giving a short summary. In the given example, the facilitator would state: “Farmers of both villages gave clear and consistent statements on temperature changes, but their perceptions of the amount of rainfall and the length of the rainy season differed. It can be concluded that rainfall patterns differ greatly between locations or it is not easy to precisely observe rainfall.”

Tool 1: Group discussion on climate change and farming in two villages of Java, 2017

	Ciganjeng village	Rawaapu village
1. How do you feel that daytime temperatures have changed in your village?	Increasingly hotter, because longer dry season	Hotter
2. How do you feel that night-time temperatures have changed in your village?	Hotter	Hotter
3. How has rainfall changed during the last 30 years? • Number of rainy days • Length of the rainy season • Intensity of rainfall • Number of dry days during rainy season	More, but June/July less rain More Longer More heavy rainfall Fewer	Increase More Longer More moderate rainfall Fewer
4. In which month is the rainfall • the lowest • the highest	August–September, dry season can be very dry, but 30 years ago the soil was still a bit wet in dry season December–February	July January
5. When is the beginning of the rainy season?	Earlier	Faster
6. Please explain your traditional method(s) to forecast the weather in your village	Traditional forecast for onset of dry season: • When the little egrets come in groups • When the teak leaves fall • When the dew at dawn evaporates faster For rainy season onset: • When the kapok trees start flowering • When the direction of the sun shifts from North to South • When the Asiatic Bitter Yam (Dioscorea hispida) sprouts	Dry season onset: • When the leaves are falling • When the night temperatures are colder Rainy season signs: • When the temperatures in the evening get hotter • When the flowers of the kapok tree start blooming
7. Can you still rely on these rules? If not, what has changed?	Some are still partly applicable	They can still be used
8. How do you think the climate changes you described (as per questions 1-7) affect your crops?	• More pests and diseases • Declining yields • Reduced crop growth	Exploding pest infestations

Encouraging farmers to view their landscape through a climate lens

Tool 2

Tool Climate change perception survey[2]

This tool can be used instead or as supplement of Tool 1. This tool allows us to compare results between groups. Data can be collected either in a weekly group meeting or by distributing the questionnaire. After results are collected, they can be displayed visually and presented to farmers in a group meeting. This can be done by anyone who feels confident with the task: farmer leader, NGO staff member, or student, for example.

10 min – fill in the questionnaire
45 min – group meeting discussion

Objective	✔ To develop a baseline/endline of farmers' perceptions of climate variability and change ✔ To analyse differences in perceptions between participants of climate field schools (learner group) and, for example, farmers who did not attend (control group)
Resources	✔ Template and time to survey (digitally, by telephone, or face-to-face) ✔ Local university staff, student, or monitoring staff to analyse the data ✔ Farmer meeting to present and discuss results
Participants	Farmers or different groups of farmers, e.g. you could compare perceptions of farmers who participated in climate field schools and a control group who did not attend.
General considerations	✔ Translate the questionnaire into the local language. ✔ Test the questionnaire with one farmer or staff member then improve or adjust questions that were unclear. ✔ Be aware that the results of the interviews need to be regarded as 'snapshots', which can be influenced by many factors. ✔ To save time, think about completing this questionnaire during a farmers' meeting or combining it with a weekly climate field school.

2. The tool can be used as an alternative or a supplement to Tool 1, depending on your own time and resources. Tool 1 is a qualitative assessment of perception and opinions. In Tool 2, you generate comparable data, as answers are sorted by a Likert response scale. Farmers specify their level of agreement to a statement in five points: (1) Strongly disagree; (2) Disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree.

Steps

1. Determine the number of interviews needed. The optimal sample size is as many as possible. If you have 20 participants in a climate field school and you want to compare them with non-attenders, interview 20 non-attending farmers. Both groups should be as similar as possible in terms of age, gender, profession (full-time or part-time farmers), and education level.
2. Create a friendly atmosphere by introducing yourself, warming up with an ice breaker, sitting comfortably, and sharing a snack or drink.
3. Open the interview with a short introduction to the project and the purpose of the interview.
4. Start with an open question: What do you know about climate change in your country and your area? How does it affect farming? This ice-breaking question gives farmers a chance to express their thoughts in their own words and to answer preferably in an unbiased and unprejudiced manner.
5. Ask participants to complete the questionnaire (supplementary material Tool 2). Literate farmers can fill out the questionnaire independently, though may need some explanation of the Likert scale[3]. You should support illiterate farmers by filling out their surveys on their behalf.
6. Involve a local expert (student, university staff member, monitoring staff member) to analyse the data and create visuals of the results.
7. Share the results of the analysis back to the participants in farmer-friendly language.

Practical tips

The answer categories (numbers 1 to 5) are transferred into an Excel sheet, then calculate mean values and standard deviations for each answer.

You can make and present a variety of comparisons, for example:

a. climate change perceptions of women and men

b. climate change perceptions between villages

c. the impact of the Climate Field Labs in raising climate change awareness between participants of Climate Field Labs and non-attending farmers.

If you want to publish the data or create a formal data set for a research proposal, you may apply statistical significance tests to investigate whether there is a relation between the perception of climate change and the participation in the Climate Field Labs or whether there are differences by socio-demographic factors, such as gender, age, education level, or village.

Rising temperatures accelerate soil organic nitrogen decomposition. The already low organic matter of the paddy soils needs to be built up sustainably. Here, farmers in Java discuss building soil fertility with compost, legumes, and other soil ameliorants such as biochar.

Source: Silke Stöber

Supplementary material Tool 2:
Climate change perception questionnaire

1. How would you describe the impacts of climate change in your area? How does climate change affect your farming? There are no wrong answers. You can say anything that comes to your mind.

Questionnaire:

I will read out some straightforward statements. Answer the questions on a scale from totally agree to totally disagree. Try to think about the observed changes since you are farming in your village.

Categories:

1. strongly disagree
2. disagree
3. neither agree nor disagree
4. agree
5. strongly agree
9. cannot answer

Since you started farming in this village:

1. The daytime temperature increased.

1 strongly disagree	2	3	4	5 strongly agree	cannot answer

2. The nighttime temperature increased.

1 strongly disagree	2	3	4	5 strongly agree	cannot answer

3. The amount of rainfall in rainy seasons has increased.

1 strongly disagree	2	3	4	5 strongly agree	cannot answer

4. Extremely heavy rain events occur more frequently.

1 strongly disagree	2	3	4	5 strongly agree	cannot answer

5. Extremely dry periods occur more frequently.

1 strongly disagree	2	3	4	5 strongly agree	cannot answer

6. The number of days in each year where we had extreme storms has increased.

1 strongly disagree	2	3	4	5 strongly agree	cannot answer

7. The number of extremely hot days in each year increased.

1 strongly disagree	2	3	4	5 strongly agree	cannot answer

8. There are more pests and diseases in the dry season.

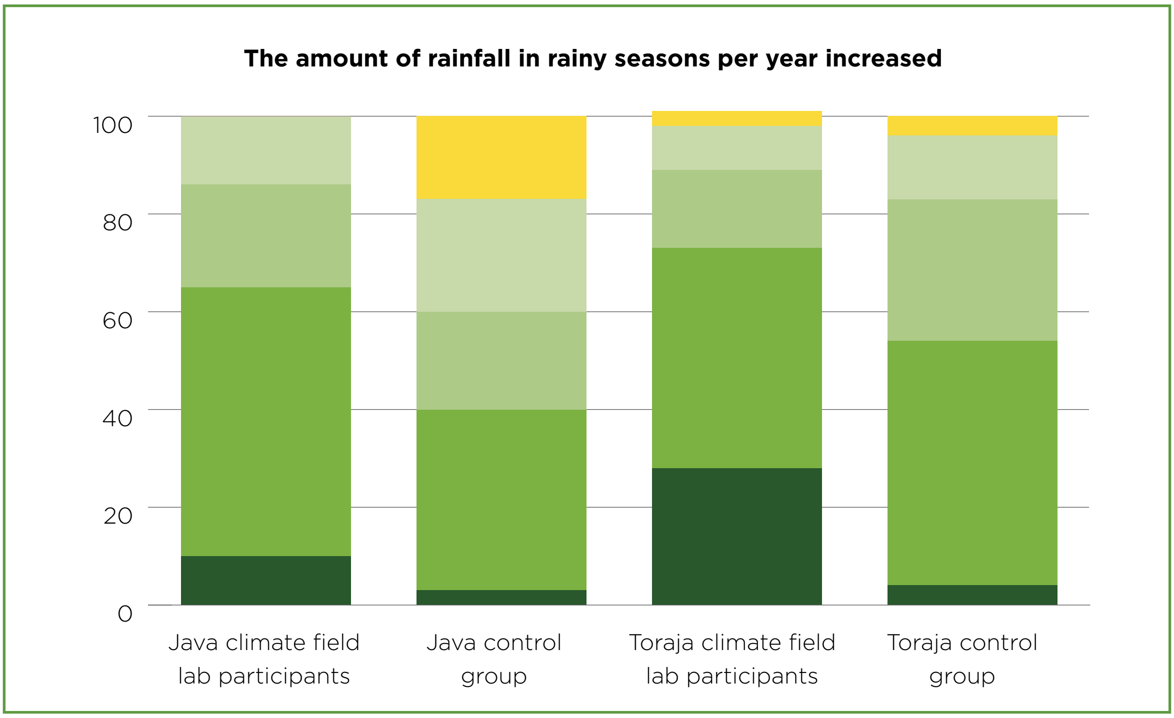
1 strongly disagree	2	3	4	5 strongly agree	cannot answer

9. There are more pests and diseases in the wet season.

1 strongly disagree	2	3	4	5 strongly agree	cannot answer

Farmers specify their level of agreement to a statement in five points: (1) Strongly disagree; (2) Disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree

Tool 2: Perception of night temperature and rainfall development



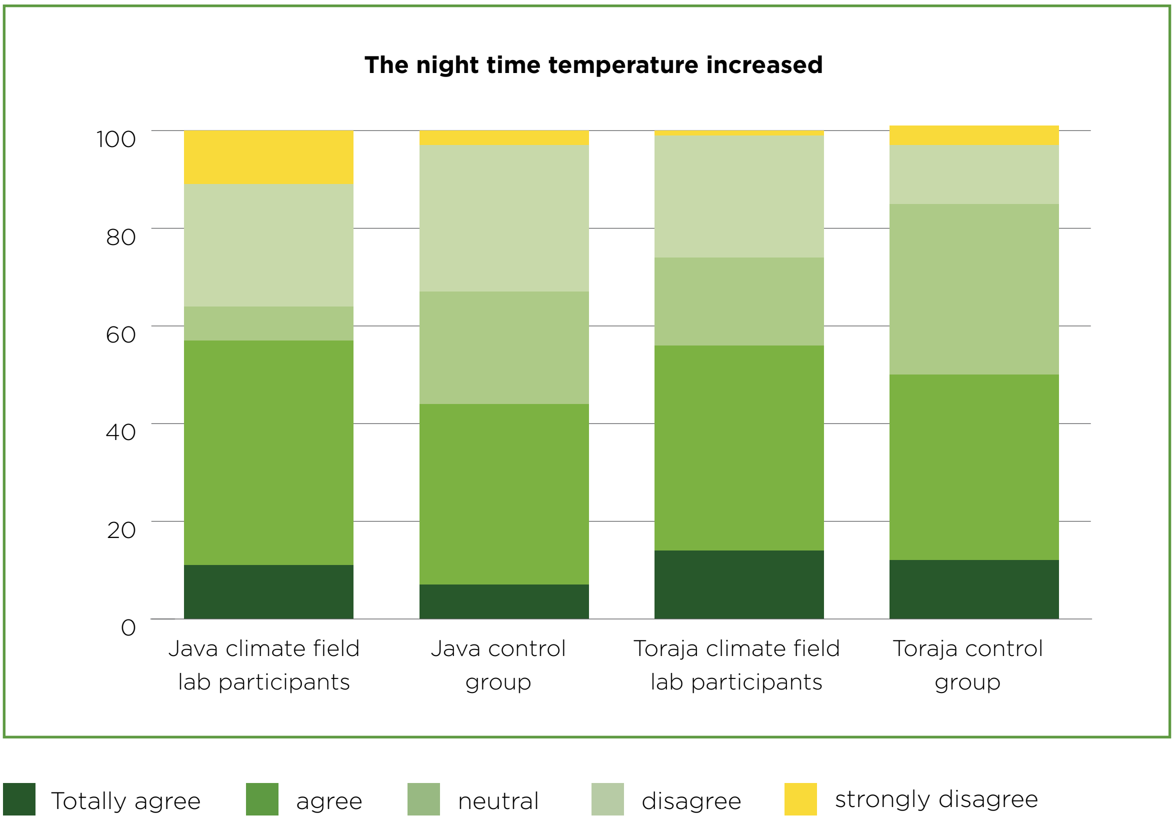


Figure 8 Precipitation and temperature changes as perceived by co-research farmers (2018)

In each survey, the questionnaire is either asked by enumerators or farmers fill it out themselves. In any case, it should not take too long to fill in. A pleasant environment and a good atmosphere help make the survey enjoyable, as pictured here in the villages of Toraja.

Source: Silke Stöber

Practical tips

1. The example graphs indicate that perceptions differ between farmers, as they are shaped by farmers' individual experiences and knowledge.

2. Some statements are rather consistent, because they are easy to observe and their impacts seem to manifest more uniformly. Most farmers report that heavy rainfall events are more frequent, pests and disease are more frequent during the rainy season, and daytime temperatures are higher (or there are more hot days each year).

3. It is useful to interlock the realities with perceptions and historical weather data (see Tool 13). When comparing historical weather data in Java with farmer perceptions in the area, one could conclude that farmer participants of Climate Field Labs have a comprehensive knowledge of nighttime temperatures, as their perceptions match historical weather analysis: nighttime temperatures have significantly increased in the period 1977 to 2017 ((compare Figure 8, p.62 with Figure 2 and 3, p.22).

In the village of TallangSura' the survey also took place with individuals in the shade under the houses.

Source: Silke Stöber

Encouraging farmers to view their landscape through a climate lens

Tool 3

Assessing climate impacts on specific crops

This tool can be used in farmer meetings as a self-reflection exercise. You can split farmers into specific crop groups. The crop expert provides concluding remarks, so farmers gain general and deep understanding of their observations.

60 minutes

Objective	✔ To strengthen farmers´ awareness of climate-related problems for their farming systems ✔ To support farmers in understanding the impacts of climate change on specific crops, e.g., rice and chilli. ✔ To discover village-level knowledge gaps around climate-resilient farming techniques and entry points for co-research with farmers
Resources	✔ Flipchart ✔ Pens ✔ Crop expert ✔ Handouts with information on crops and climate change (see annex 1)
Participants	Farmers, university researchers or crop expert, facilitator
General considerations	✔ As climate change affects crops differently, this tool needs to be applied for each individual crop. ✔ The study of climate change impacts is still an evolving research field. It is not easy to distinguish between climate-related effects on crops and those caused by other factors related to agricultural practices. An expert who can explain the science behind farmers' problems and translate farmers' observations into scientifically grounded explanations should be present.

Steps

1. Invite (male and female) farmers from several villages as well as an agronomy/climate change expert (see General Considerations above).
2. Split farmers into groups of 5–12 farmers from the same village.
3. Ask farmers to discuss the question: *What are the main problems you face in your fields for each crop that you grow?*
4. Present and cluster the problems they mention, for example on cards or on a flipchart in a plenary meeting.
5. Farmers then discuss the root causes of the identified problems and categorise them as either: climate-related causes (salinity, flood, drought) or related to farming practices.
6. List the current practices used to overcome the problem and potential solutions they could try in the future.
7. Finally, a crop expert should summarise and provide additional input on the basic facts of impacts of climate change on the specific crops (e.g., chilli and rice) and comment on actual and potential solutions. Web-based inventories and platforms may give further guidance (see links on page 67 in practical tips).

Azolla pond in Ciganjeng village, Pangandaran regency. Even the smallest spaces can be used for propagation ponds if space is scarce.

Source: Silke Stöber

Practical tips

If you are unfamiliar with the impact of climate change on crops, you may consult the FAO webpage mentioned below, link up to experts, or self-tutor by using practice-oriented digital platforms and apps. Here, you find a few examples of services in different local languages.

Access Agriculture: To promote agroecological principles and rural entrepreneurship through capacity development and South-South exchange of quality farmer-to-farmer training videos in local languages. When you enter climate change in the search function field, you will find a list of 46 videos that provide agroecological solutions (as per 25 February 2022).

FAO: The Climate Change Knowledge Hub (CC-Hub) gathers existing knowledge and resources on climate change in the agriculture and land use sectors. Its interactive features allow users to connect with peers, experts and capacity building providers. It also provides data, learning materials and activities, guidelines, policy advice and tools. The CC-Hub's overall aim is to enhance countries' knowledge and capacity to deliver on their climate and sustainable development goals.

Infonet, a channel of the Biovision Farmer Communication Programme (FCP), provides scientific and practical validated information and knowledge related to plant (crop), animal, human and environmental health. The resource gives farmers, trainers, students, and extension workers quick access to up-to-date and locally relevant agricultural information and related topics. Infonet-Biovision's aim is to increase human and animal welfare and health, improve regional and local food security and at the same time conserve the environment and biodiversity.

Plantwise.org | Knowledge Bank Home: The gateway to practical plant health information.

Plantix: A free-of-charge Android application that turns your phone into a mobile crop doctor. It diagnoses the diseases and pests in the field for a multitude of plants. It also works as WhatsApp services, you just would need to send a photo of the affected plant.

OISAT: The Online Information Service for Non-Chemical Pest Management in the Tropics (OISAT) aims to eliminate the use of hazardous pesticides, reduce overall use, risk and dependence of pesticides, and increase support for community-based control over a sustainable produced food supply. As pests and diseases outbreaks are very much linked to climate change and environmental degradation, agroecological solutions are provided.

Rice Doctor: The Rice Doctor of the International Rice Research Institute (IRRI) is a diagnostics tool that will help you to identify problems in your crop and provide actionable advice how to manage them.

Tool 3: Climate change impacts on paddy production

Paddy	Rawaapu village	Ciganjeng village
Problems observed by farmers	• Floods • Droughts • Pests and diseases • Rats in rainy season can destroy up to 75% of the harvest • Stemborer is worse than rats: due to very hot temperature in the day, rain in the night, stemborer populations increase	• Floods • Brown plant hoppers • Droughts • Salinity of paddy fields
Current practices	• Hunt for rats in the community and use chemicals • Visit farmer field schools to learn about stemborer (some farmers do not visit farmer field schools) • Transplant seedlings when they are at least one month old • Plant seedlings at irregular spacing	• Pilot floating paddy • Practice SRI for many years • Plant 5–7 times with 5–6 times failure • Apply agro-chemicals against Brown Plant Hopper without success • Those who practice organic farming feel climate change less than those who practice conventional farming • Other income from organic vegetable and home industry is necessary
Possible solutions	• Use flood tolerant varieties • Use drought tolerant varieties	• Use direct marketing of vegetables more • Use home industry more • Use flood-, drought-, and saline-tolerant varieties • Consider investment project: floating paddy, boats, tourism

Practical tips

Possible solutions should be proposed by the farmers themselves. These can be new farm technologies, marketing activities, off-farm activities, or even other strategies like access to credit or community infrastructure activities. It is not yet necessary to discuss feasible solutions, but to open the discussion to potential solutions. If farmers do not know any solutions or are not satisfied with their own solution knowledge, experts could suggest new solutions.

Tool 3: Climate change impacts on chilli production

Chilli	To' Pao village	Tallang Sura' village	Buntu Datu village
Problems observed	• Fruits are falling off • Curly leaves/tips • Fruits rot • Black spots • Fruit covered in ants • Blackening • Attacked by snails • Growth and yield still low	• Leaf/flower fall • Curly leaf • Fruit rot • Tips covered in ants • Leaves curly and clumped together • White spot under leaves • Black insects stuck to stem and branches	• Fruits fall off • Curly leaves • Fruits rot
Solutions	• Use different composts • Propagate local microorganisms and enrich compost with it	• Alter the type and amount of compost • Apply compost at intervals	• Use compost containing ingredients which meet the plants' needs • Rotate varieties • Space plants regularly

Practical tips

1. Discuss how climate change affects crops in more detail with farmers.
2. Invite experts to inform them about major impacts.
3. You may use specific information on the impacts of climate change on respective crops. For rice and chilli, you can find three fact sheets in Annex 1.

Worm compost in Bua'tarrung village, Tana Toraja regency

Source: Silke Stöber

Encouraging farmers to view their landscape through a climate lens

Tool 4

Ranking emerging pests and diseases

This tool works as a ranking exercise that can be done during one of the weekly climate field school meetings. Farmers observe pests and diseases in the selected field (see Tool 11). This tool gives a general idea of the distribution and harmfulness of local diseases and pests. Potential solutions to protect against pests and diseases are discussed.

60 minutes

Objective	✔ To identify the most relevant and destructive pests and diseases affecting specific crops in a changing climate ✔ To discover knowledge gaps and solutions to protect against emerging pests and diseases
Resources	✔ Display of the ranking template given in Step 1 below ✔ Flipchart, markers, pens ✔ Local crop pest and disease specialist and/or ✔ Posters (see poster example p.74), apps and webpages as mentioned on page 67 (such as Plantix, OISAT, Infonet, Plantwise)
Participants	Research farmers, facilitator
General considerations	✔ Do not forget that pest and disease attacks are common effects of environmental problems or unsustainable agricultural practices in addition to climate change. ✔ Due to changes in the patterns of rainfall and temperature, more crop pests and diseases emerge. Destructive rice pests, such as the brown plant hopper (BPH), spread quicker when very hot daytime temperatures are followed by night rainfall. Another example is the Bacterial Leaf Blight, which develops faster at higher temperature. Recently, it has become a dominant rice crop disease in Indonesia. ✔ Farmers do not always know the scientific name of pests and diseases and have their own names for them. Try to find the exact name of the pest and disease before advising on curative or preventive measures.

Steps

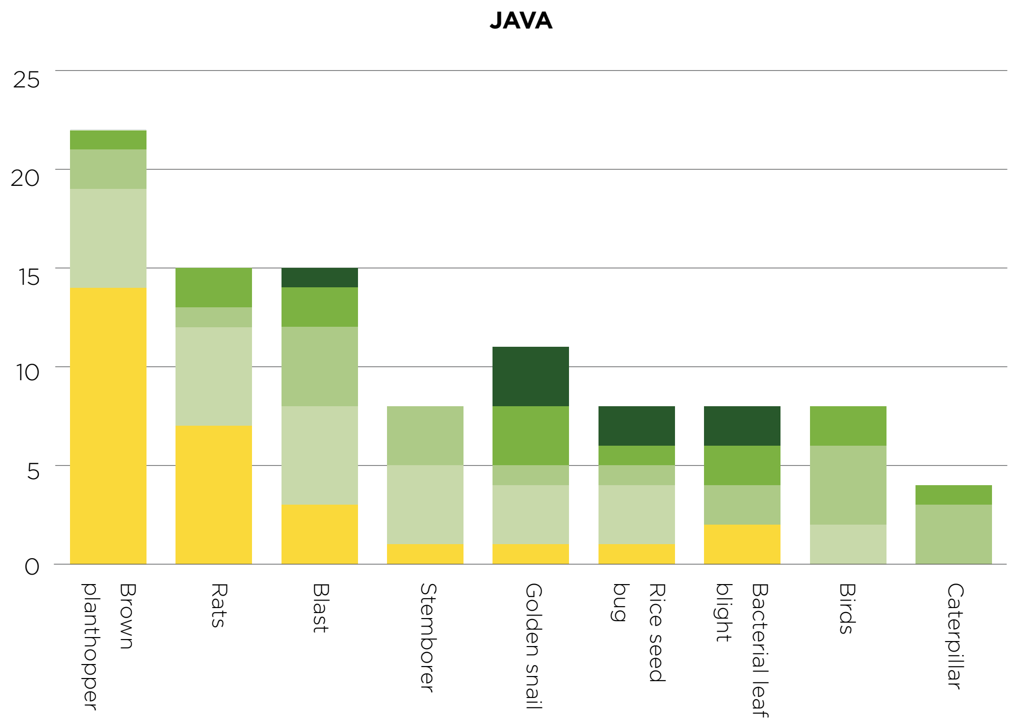
1. Invite farmers to a meeting, e.g. a weekly climate field lab.
2. Explain the objective of the session and distribute the template.

	Name of pest/disease	**When do you usually see this pest/disease?***
Most harmful		
More harmful		
Rather harmful		
Less harmful		
Least harmful		

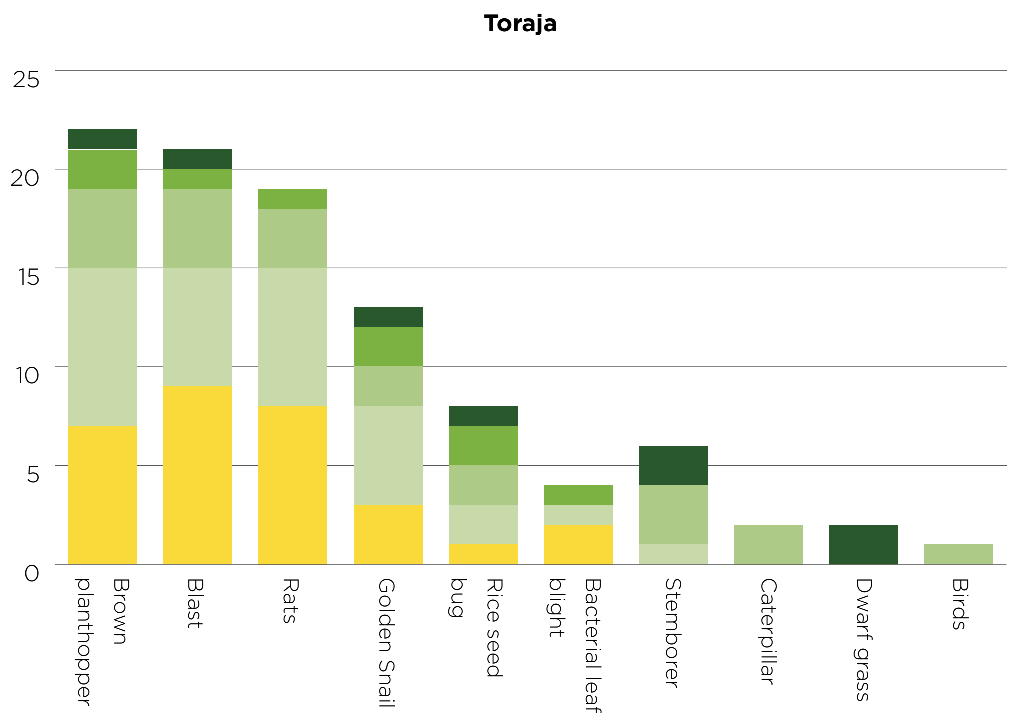
3. Farmers can complete the survey individually or in groups of two to four. Ask the participants to name up to five pests and/or diseases that affects the crop you wish to talk about (rice, chilli, maize). In the first row, farmers should fill in the name of the most harmful pest or disease on their farm (that is, the pest or disease which causes most damage or for which they don't yet have protective). They can then list four more pests/diseases in descending order of importance. Farmers also record when those harmful pests and diseases occur (season, time of day, or plant growth stage).
4. Summarise the farmers' results on a flipchart. By counting how often a specific disease or pest was recorded, you can come up with a ranking list of most to least frequently observed pests and diseases.
5. An invited pest and disease management expert can then advise farmers on the causes of pests and diseases and agroecological prevention practices. Provide visuals to discuss solutions (see examples pages 76-77).

* Please think about which season (dry or rainy), which part of the day (morning midday, afternoon, evening), and which growing stage (seedling, vegetative growth, flowering, seed development, before harvest) this pest/disease affects

Tool 4: Pest and disease rankings for rice



Tool used in 2018 with 29 farmer participants of Climate Field Labs in two villages in Java. The pests and diseases are ranked according to what farmers found most harmful to least harmful.

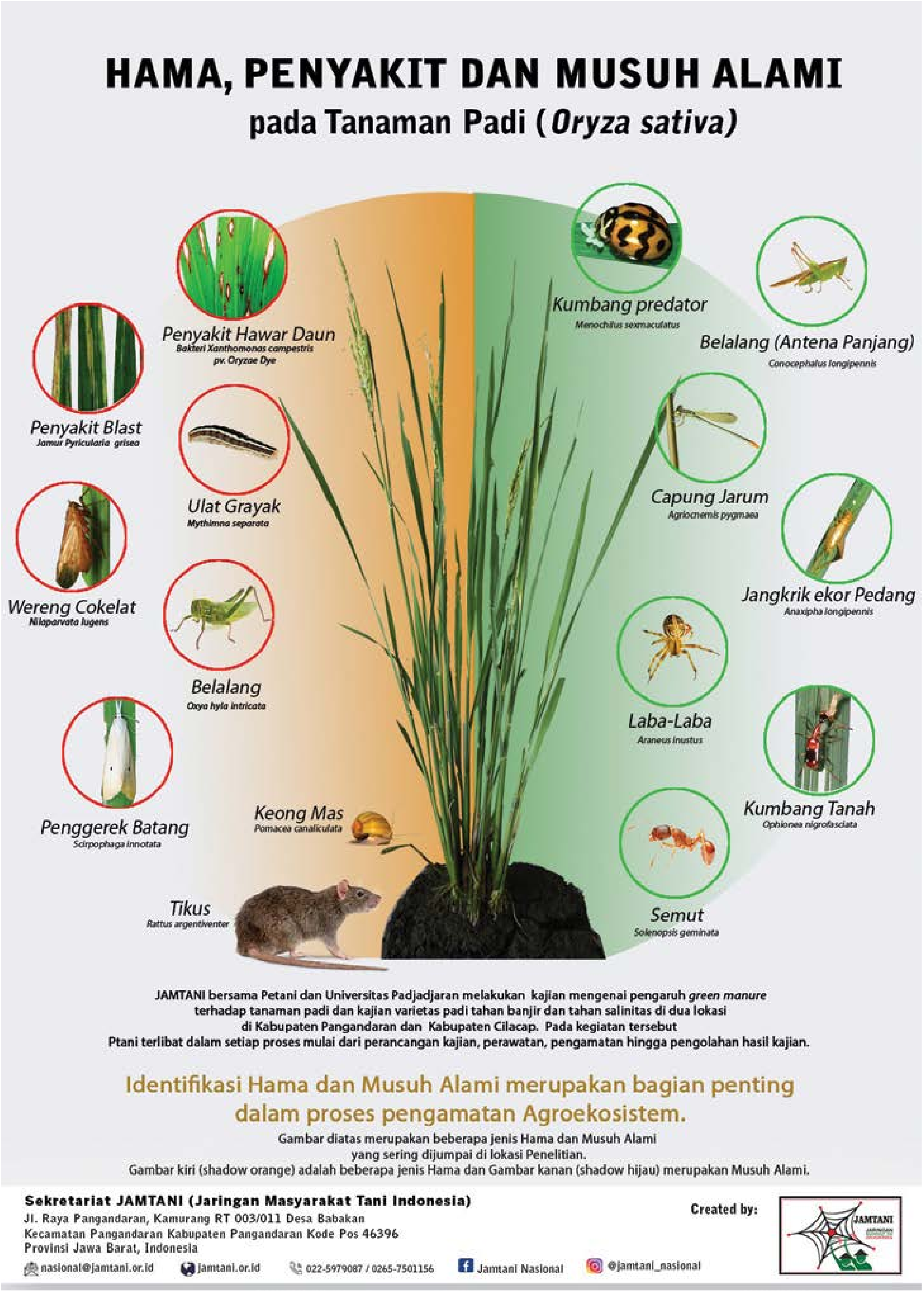


Tool used in 2018 with 74 farmer participants of Climate Field Labs in five villages in Toraja.

most harmful | more harmful | rather harmful | less harmful | least harmful

Figure 9 Pests and disease ranking in project locations

Java: Poster of pests and predators in rice



Practical tips

1. Conduct this exercise in a garden or field and let farmers collect the pests and infected plant parts.
2. Discuss with farmers which practices they have used to control those pests and diseases and whether these strategies were successful.
3. Categorise those measures as preventive and reactive activities.
4. Emphasise that preventive strategies to manage the crop and soil habitat form the basis of agroecological pest and disease management. Reactive or curative strategies such as using biopesticides (neem, tephrosia) should be a last resort to manage harmful pests and diseases.
5. Compare the occurrence of pests and diseases between villages or crops and experiment with farmers on new agroecological control mechanisms. These could be biological measures (biopesticides, predators, attractant traps, and repellent crops), mechanical (vigorous field hygiene, regular weeding, and collecting infested plants), and cultural practices (planting barrier plants or trap crops, mulching, intercropping, and crop rotation).

Agroecological pest and disease prevention

Pest and disease prevention activities include measures such as:

- field hygienic or sanitary measures, such as removing or burying of infested crops and clearing weeds where pests and diseases harbour;
- use of predators (spiders, ladybugs, or parasitic wasps);
- organic remedies (with marigold or lemon grass) and plant strengthening agents (biochar or azolla juice); and
- ensuring your crop is healthy since a healthy crop is less affected by pests and diseases. Good nutrient and water management, crop rotation, intercropping, and synchronous planting prevent pest and disease attacks.

Rice seed bug

- Remove weeds from the field and surrounding areas
- Use synchronous planting
- Capture pests manually in the early morning or late afternoon
- Use plastic bottle traps with golden snails

Source: PLANTIX

Rats

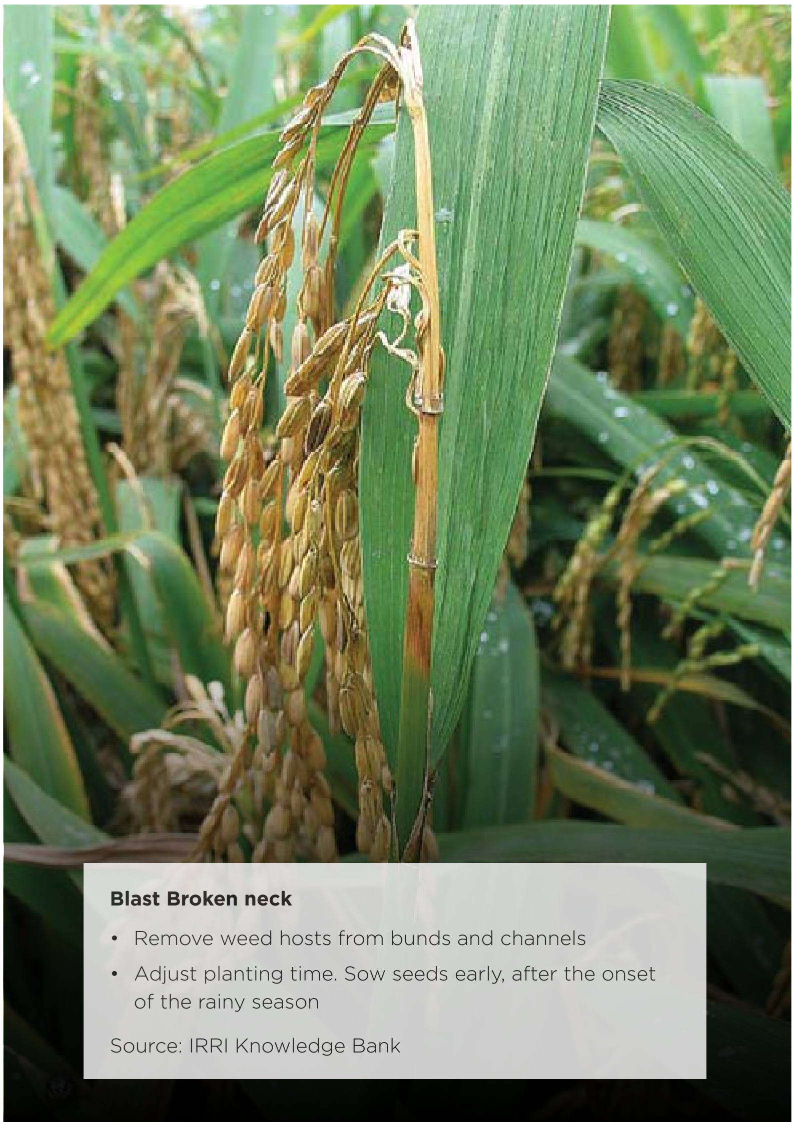
- Community action is key to successful control
- Build a trap field barrier system
- Use lime or lemongrass around the field to deter rodents
- General hygiene and clear from food scraps and rubbish
- Synchronous planting (plant within two weeks)

Source: IRRI Knowledge Bank

Brown Planthopper

- Remove weeds from the field and surrounding areas
- Make use of natural enemies such as lady beetles, spiders, and wasps
- Plant refugia (Zinnia spp.) around the field
- Spray liquid rice husk biochar

Source: IRRI Knowledge Bank



Blast Broken neck

- Remove weed hosts from bunds and channels
- Adjust planting time. Sow seeds early, after the onset of the rainy season

Source: IRRI Knowledge Bank

Green aphids

- maintain a high number of different barriers plants around the chilli plant
- use reflective mulch (silver foil)
- remove infected plant parts and remove weeds

Source: Rein Syauta

White flies

- plant tall crops like maize in dense rows as border crops
- monitor the field with yellow sticky traps
- use companion crops that attract or deter whiteflies like zinnias

Source: Rein Syauta

Fruit fly

- Remove fruits with dimples regularly
- Kill maggots by burning or burying
- Plant flowering crops around the field, such as zinnia, sunflower, or marigold to provide habitat for natural enemies
- Use fruit fly traps with male attractants (e.g. methyl eugenol)

Source: Rein Syauta

Thrips

- Mass trapping with coloured (blue, yellow, or white) sticky traps
- Botanical pesticides (e.g. garlic recipe)
- Reflective mulches deter thrips
- Crop rotation

Source: Rein Syauta

Agrometeorological learning

A further step in raising farmers' awareness of and assisting them find solutions to climate change impacts is to use agrometeorological learning to increase their understanding of the ongoing challenges of climate change and their consequences for their own livelihoods.

Farmers have always responded to climatic variability, particularly to changes in rainfall distributions and patterns, by adapting their practices. However, local knowledge systems to predict weather and climate patterns are becoming unreliable in the face of climate change.

Agrometeorological learning

Agrometeorological learning is an incremental learning process that allows farmers to assess and change their thinking, goals, and habits through acquisition and application of new meteorological and climatological knowledge. The agrometeorological learning process comprises the use of various practical tools, such as weather data recording and climate diaries, and requires collaboration with researchers, extensionists, and active farmers (Winarto & Stigter, 2016).

Garden visit during a training. Farmers tested the pest and dieases ranking Tool 4 in the garden of MPM in Kondoran, Toraja, in May 2022.

Source: Silke Stöber

Encouraging farmers to view their landscape through a climate lens

Tool 5

Weather records

This tool allows daily weather records to be generated at the village level. The information is collected by farmer volunteers. CBOs, NGOs, universities, or government then helps with analysis and production of visuals from the recorded data. Visuals can be used for discussions in farmer meetings.

45 minutes for introducing the idea, monthly meetings for discussing collected data and their graphs

Objective	✔ To practice how to read and record the daily weather ✔ To learn how to explain actual weather events so that one does not rely on anecdotes and folktales only ✔ To draw own conclusions on climate variability and change based on farmers' frequent observations. ✔ To acquire a knowledge base for adapting farming practices to climate change
Resources	✔ Rain gauge ✔ A thermometer that can measure minimum and maximum temperature ✔ Hygrometer (optional) ✔ Notebook to record daily data ✔ Farmer volunteer or animator to record the data ✔ Staff to analyse and prepare graphs
Participants	Appointed weather volunteer farmers, technical expert to share weather graphs

General considerations

- Farmers collect weather data in their own villages and fields.
- Based on preferences and equipment, weather data can be recorded in analogue or digital formats.
- It is important to support farmers in the monthly and yearly data analysis.
- Data collection needs to be as complete as possible. Blank cells (missing data) should not exceed 10%, as analysis will become impossible.
- To give the weather analysis more power and weight, long-term collection is required.
- Ownership of data needs to be clarified in the beginning, as time series data have a market value.

Steps

1. Volunteer rainfall and temperature observers are appointed by the farmer group. Volunteers measure and record the following values: minimum temperature, maximum temperature, daily rainfall (mm), and humidity. It is important to note that the measuring needs to take place every day at the same time and in the same location.
2. Collect information about basic meteorological facts relevant to farming, e.g. What is the definition of rainy season in your country/your area? How many mm of rainfall or how many hours of rainfall is considered heavy rainfall?
3. Farmers, NGO/CBO staff, or researchers present the data in a visual display (bar charts, for example, of monthly averages of the relevant meteorological facts).
4. Share the results (graphs) and discuss them with farmers and technical staff. For example, annual averages can be compared with long-term averages (the “Climate Normal”).
5. For the long-term averages, you may ask a technical expert from the local meteorological office to analyse historical weather data from the nearest weather station. You could then compare your actual year with the long-time average.

Climate Normal

The World Meteorological Organization (WMO) traditionally stated the Climate Normal represents the average conditions in a 30-year period. A 30-year time series is sufficient for statistical tests. Nowadays, given that change is happening much faster and longer time series may not be available, a new Climate Normal can comprise the average of the last five or ten years.

Tool 5: The 2019 and 2020 monthly rainfall compared to the ten-year average

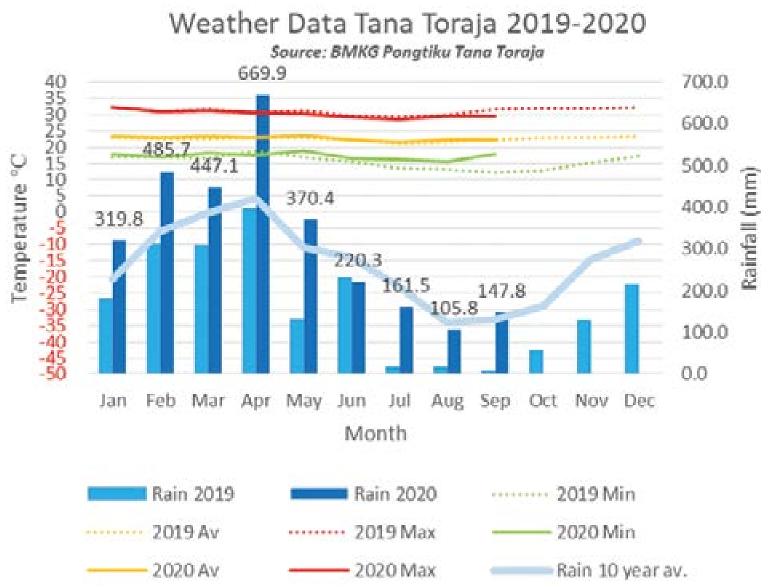


Figure 10 Toraja's monthly rainfall compared to the long-term average

Here you can see that 2019 was a rather dry summer with a cautious start to the rainy season. In 2020, there was lots of rain from January to May compared to the Climate Normal or long-term average. Farmers who viewed this graph were able to understand how changes in weather created challenges to their own farming in the previous season and may be able to better prepare for the next season.

The definition of the onset of the rainy season

The analysis of the start of seasons is defined in each country by their meteorological office. In Indonesia, it is the Agency for Meteorology, Climatology and Geophysics (BMKG). The onset of the rainy season is determined by the *"dasarian"* (10 days) rainfall data. Each month is divided into three *dasarian: dasarian I* is the period from the 1st to the 10th, *dasarian II* is the period from 11th to 20th, and *dasarian III* is the period from 21st until the end of the month. The start of the rainy season is marked by rainfall in one *dasarian* equal to or more than 50 millimetres followed by two subsequent *dasarian* with 50 mm each. The onset of the seasons can occur earlier (advance), the same, or later (recede) from its normal average taken over 30 years.

Tool 5: Long-term trends in extremely hot and extremely cold days/nights in a year

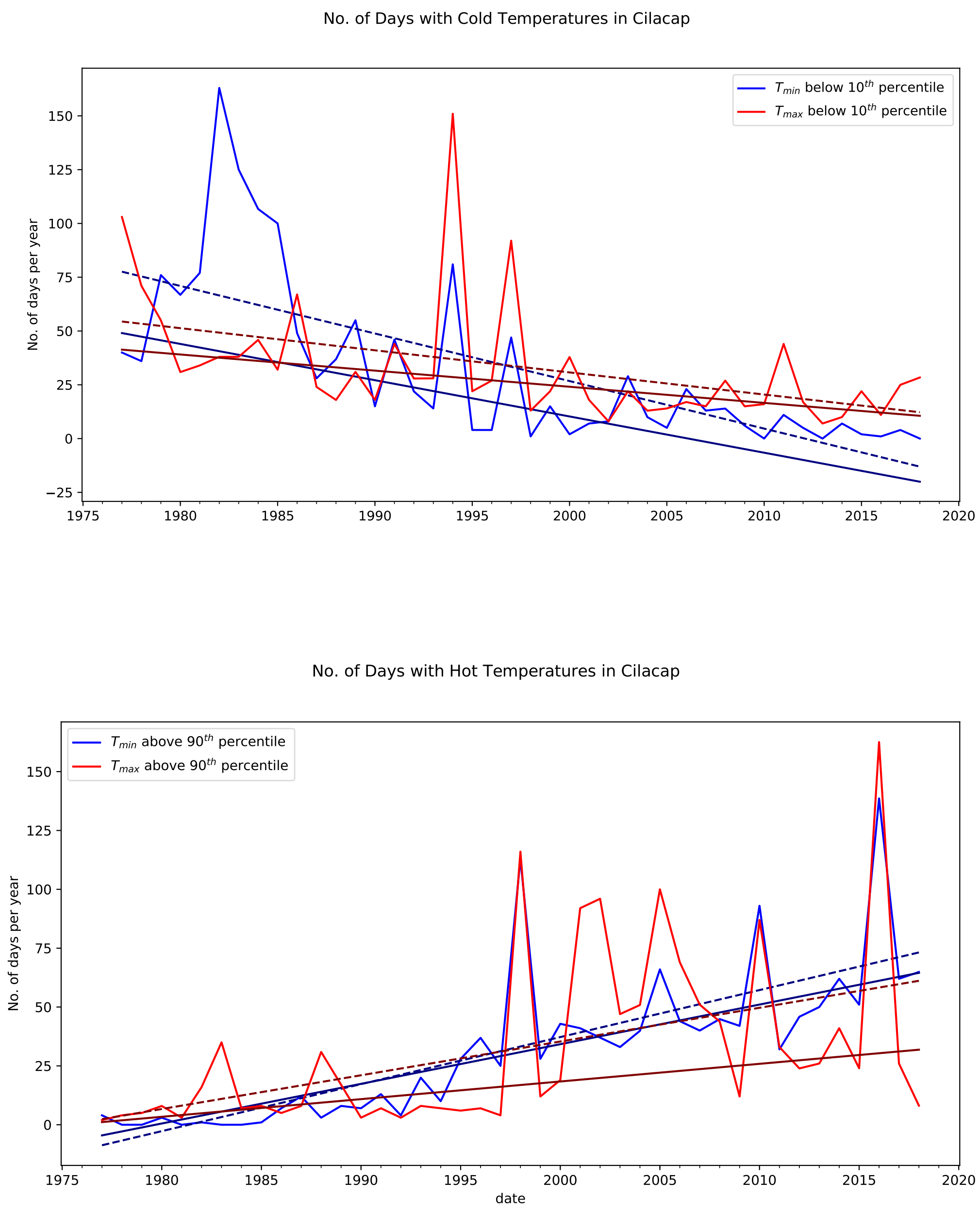
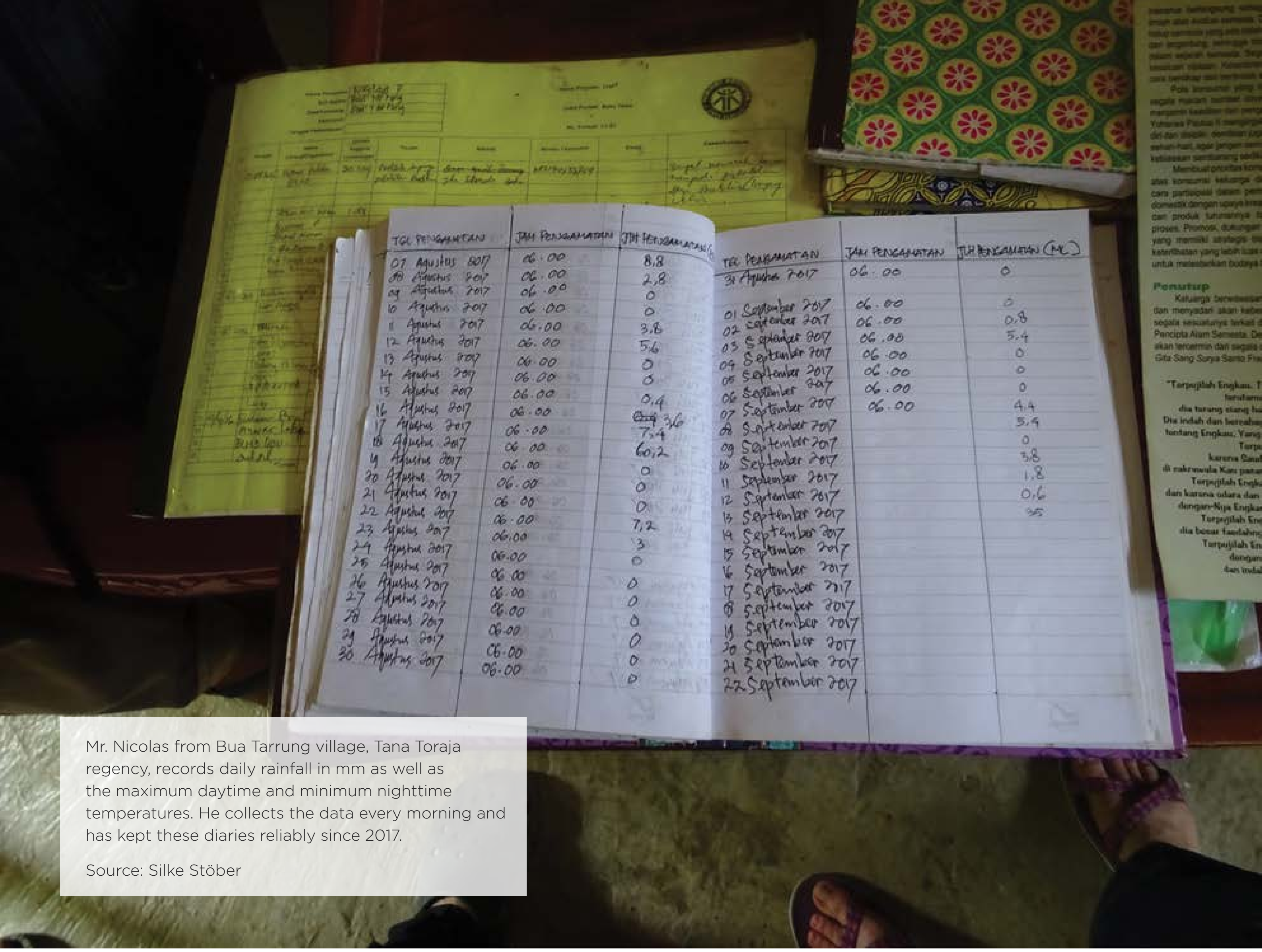


Figure 11 Historical temperature analysis (hot and cold days) in Cilacap, Java

Here you see that in West Java, Cilacap the trend to more extreme hot days and nights is positive for the period 1977–2018. The trend for extremely cold days and nights at the same time is negative. The study used two different parameters to explain the trend: the solid line is the Sen's slope; the dashed line shows the linear regression.



Mr. Nicolas from Bua Tarrung village, Tana Toraja regency, records daily rainfall in mm as well as the maximum daytime and minimum nighttime temperatures. He collects the data every morning and has kept these diaries reliably since 2017.

Source: Silke Stöber

False rains and other climate change-related threats

A climate change-related problem for farmers in Indonesia is false rains. This is a typical new irregular phenomenon in some countries like Indonesia, which formerly had a predictable rainfall pattern. With false rains, the rainy season seems to start with a few rainy days, but then stops and a dry spell occurs. For farmers, this is a serious threat. They may have started to plant and suddenly face serious water shortages as their fields dry and their young seedlings die.

Practical tips

1. Check with your local meteorological office as to the exact definition of strong rains, dry spell, hot days, etc.
2. In a meeting with farmers, discuss what they think are the most serious climate-related threats in their villages.

Rain gauges and minimum–maximum thermometers are set up in villages to record daily weather data.

Source: Silke Stöber

Encouraging farmers to view their landscape through a climate lens

Tool 6

Climate diary learning journal

This tool relies on a printed booklet that is designed before distribution by the facilitator of the Climate Field Lab. All climate field school participants should receive their own copy, as it can be used as learning journal. Every week, farmers should fill in and record their observations related to weather and farming made during the week.

45-minute – introduction
15 to 30 minutes – individuals to fill in their journals and reflect back, for example, in weekly meetings

Objective	✔ To build a more complete picture of the weather variability that farmers experience ✔ To raise awareness of the benefit of weekly reflections on weather and related impacts on farming
Resources	✔ A booklet for each farmer to be filled in individually (see also Annex 6)
Participants	Research farmers or members of farmers groups, facilitator
General considerations	✔ All farmers receive a seasonal or annual diary. ✔ Recording is voluntary. ✔ Diaries are kept by farmers and brought to the weekly or monthly meetings.

Steps

1. Distribute booklets to all farmers and brief them on the benefit of writing down their learnings.
2. Discuss with farmers how and when to fill in the booklet, for example, at home before the weekly meeting or during the weekly meetings. Farmers in South Africa filled it in every Friday and called it *"Fri-diary"*. Toraja farmers filled in their books during weekly climate field school meetings. Weather data should be recorded on the left side of the booklet and farming notes should be recorded on the right hand side.
3. Discuss the research farmers' diary recordings as a group during their weekly or monthly meetings. Compare the number of extremely warm or cold days and nights and heavy rainfall events. Discuss how weather events have impacted their farming results and activities.
4. In a final season analysis, you may want to share the weather records as per Tool 5 and compare them with the climate diary. Interesting parameters for discussion may include the number of very hot days, number of days with heavy rainfall, beginning of rainy season, number of flooding events, and dry spell periods.

Materials

Feb 2018	Week Ending	Saturday			
		3	10	17	24
Rainfall	Heavy				
	Light				
	Dry				
Daytime Temperature	Hot				
	Normal				
	Cool				
Night-time Temperature	Warm				
	Normal				
	Cold				

Monthly-Report-on-farming
Observations-on-my-field 1st week 2nd week 3rd week 4th week
Activities/Steps-Taken:
Plans-for-Next-Month

A booklet with a laminated cover, page for general information (ex., name of farmer), 12 pages for months, and empty pages for additional notes. An example of a page for the month of February 2018 is shown below. A template is found in Annex 6.

Tool 6: Climate diary

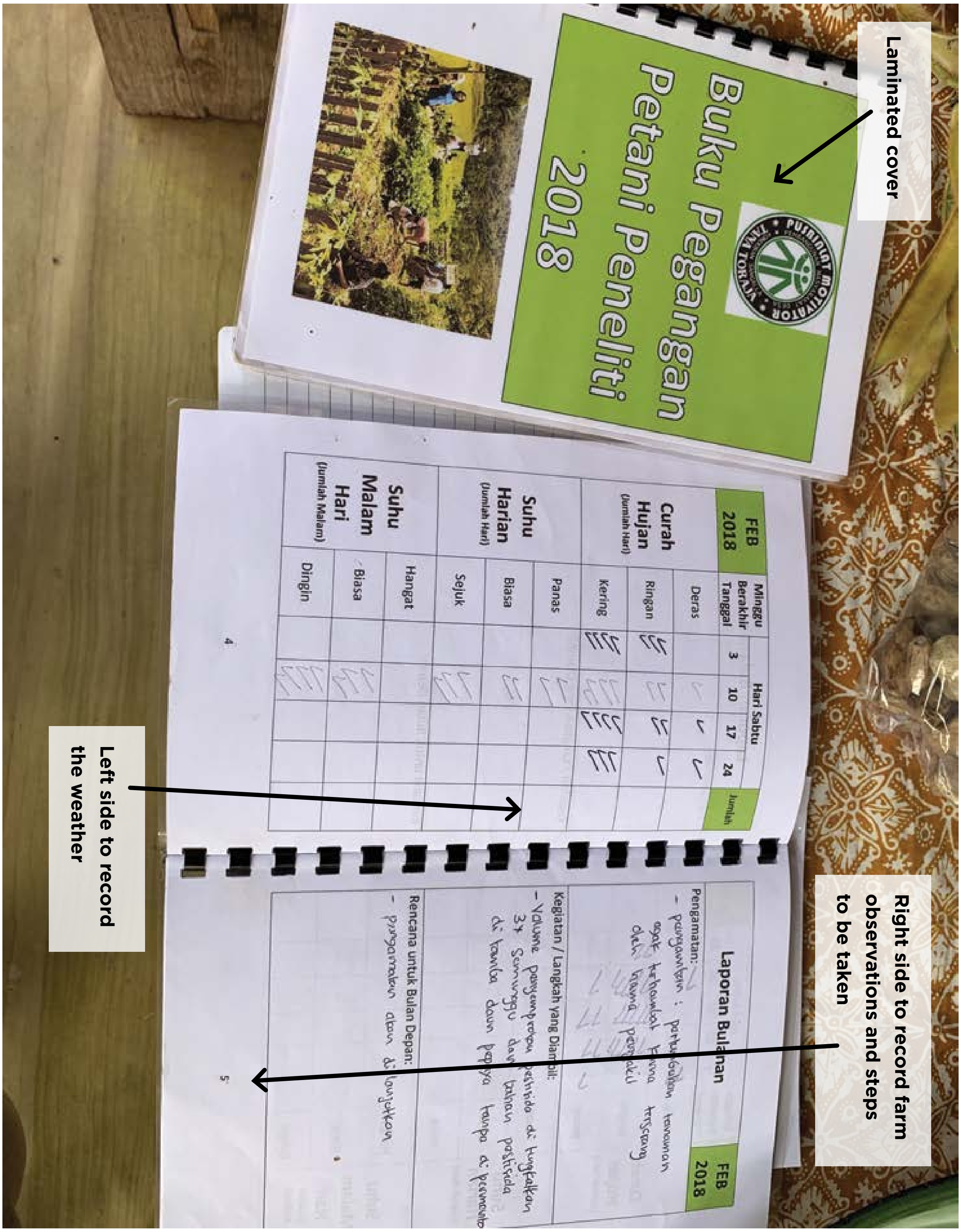


Figure 12 Climate diary learning journal from 2018

"Our research farmer club has used the climate diaries until all pages of the booklet were filled. They are useful. On the left side we fill in weather observations. On the right side we record ideas how to improve farming. We share our observations in weekly meetings."

~Esther, Head of research farmer club Tallang Sura'

Tool 7 to 11: Planning and implementing adaptation co-research

The vast majority of farmers who are farming in the areas where the Climate Field Lab Tools were tested are aware of climate change impacts.

Two-thirds of them try to implement no-regret practices to minimise their climate-related risks. Still, breaking with old farming habits (for example, adjusting planting times and methods) is easier said than done.

The tools presented in this section were developed to help farmers discover and try out innovative no-regret practices. The process starts with an inventory of agroecological farming practices in Tool 7. It is followed by a deeper assessment of those practices (Tool 8). In a next step, the design of experiments to test new practices is explained and a guideline of how to monitor them is presented (Tool 9). Tool 10 guides on the participatory design of the farmer-led experiments. Tool 11 explains the heart of the climate field lab and tips are given on how to run the weekly climate field schools.

"Almost all farmers are affected by the negative effects of climate change and suffer from natural disasters. However, only three quarters (76%) of farmers in Toraja try new agricultural practices to adapt. This phenomenon is called the risk perception paradox, which says that farmers are aware of the risk, but do not react directly. The remaining quarter (24%) are not adapting, although they are aware of the impacts of climate change."

~Max Hollburg (2021)

"Co-research is a powerful approach to increase adaptive capacities. Research farmers are farmers that 1. design new things (= they INNOVATE); 2. do the new things (= ACTION); and 3. finally benefit from the new things (= IMPACT). The impact should be not only on farm but also off farm in the fields of marketing and business, which we call no-regret adaptation through agroecopreneurship."

~Prof. Dr Tualar Simarmata and Tandu Ramba during an international seminar on research farmers and agreecopreneurs on 24 May 2022

Co-research farmers from Java present their innovation to students, an effective low-cost soil analysis technique. The light bulb shines brighter when the cation exchange capacity of the soil substrate is higher (20 May 2022 at UNHAS).

Source: JAMTANI

Tool 7

Inventory of agroecological farming practices

This tool is used as introductory learning session when it comes to the field implementation of a climate field school. It captures what farmers already know about agroecological farming practices and which promising practices they would like to try in the future. The result could be a nice visual that may even decorate a community hall to show the actual diffusion of agroecological practices.

120 minutes + 30 min break – facilitators synthesize an inventory on a board or other visual display

Objective	✔ To gain a general picture of known agroecological farming practices employed in their villages ✔ To reflect on the diversity of pre-existing practices and options for solving their problems ✔ To be aware that many innovations can be derived from their own practices
Resources	✔ A set of DIN A4 visuals (Annex 7) as visual representations of good agroecological practices, possibly laminated for longer use (see Supplementary material Tool 7, p.91) ✔ A well prepared list of good agroecological practices to record answers ✔ Flipchart or other big piece of paper with a labeled spider web of agroecological practices drawn on it (see Step 4 and Example Tool 7 [p.92] below)
Participants	Farmers' group, facilitator, and assistant
General considerations	Encourage farmers to talk openly about their ideas and innovations. Emphasise that farmers often already know and use many good agroecological practices.

Steps

1. Display the picture cards in a way that allows everyone to see and hold/touch them.
2. Distribute the lists of agroecological practices to individuals or small groups of farmers and invite them to name and record all the agroecological practices that
   - have heard about,
   - have learned about in climate field schools/previous trainings,
   - have tested in your own field,
   - they use on their farms.
3. Make sure that everybody answers for themselves. This way you can record all the individual answers, even if they are different.
4. Once farmers have finished their recording, copy their answers and draw the points in the spider web. For example, if you have 29 farmers, and all have heard about a practice, put the dot on the outer line of the web at 100%. If only 15 farmers have heard about, put the dot at approximately 50% (15 out of 29 is 52%).
5. Allow a discussion about the spider web. For example, you can cluster the agroecological practices into four categories:

- below-ground or soil management
- above-ground or crop and water management
- knowledge exchange and training
- marketing and services and find which categories are more common than others

6. Finally, get an idea on farmers' perceptions of the actual benefits of each of the agroecological practices. You could, for example, give them each two votes to select the most promising or least promising practices. Or, simply ask which practices are most promising and why and which are the least promising and why. You may also ask farmers what prevents them from trying new practices out and what they would need to try them?

Bernadeth Palinggi from Buntu Datu village, Toraja, grows cash crops like cloves, pepper, and cocoa intercropped with corn, cassava or sweet potatoes. She also sells flowers, kale, green beans, and raises chicken, buffaloes, and goats. Her main challenge is that droughts or extreme rainfalls regularly damage her crops. In the climate field school she became aware, that these extreme weather are a negative impact of climate change. She is proud to having learnt to interact at eye level with scientists and that she gains knowledge like a university student.

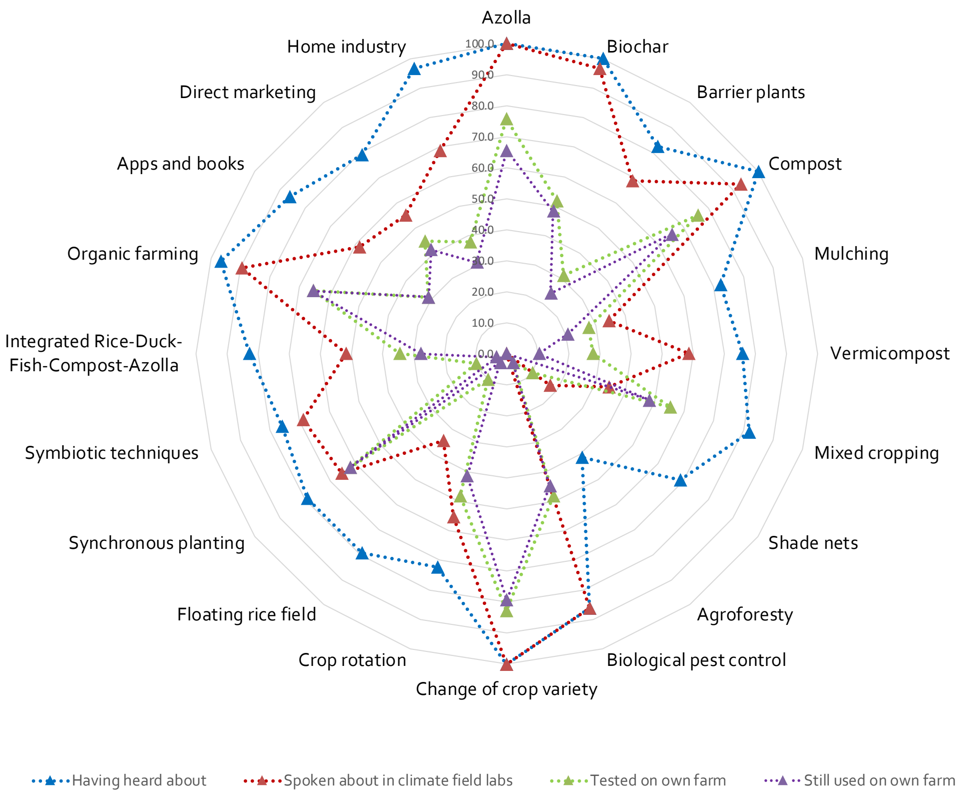
Source: Rein Syauta

Supplemenatry material Tool 7: Good agroecological practices (list to tick off)

Agroecological practices	*I have heard about*	*We have talked about in farmer training/climate field school*	*I have tested it on my farm*	*I still practice this on my farm*
Agroforestry				
Apps and books				
Azolla				
Barrier plants				
Biochar or other soil ameliorants				
Biological pest control				
Stress tolerant crop variety				
Compost				
Crop rotation				
Direct marketing				
Floating rice fields				
Home industry				
Integrated rice-duck-azolla-compost farming				
Mixed cropping				
Mulching				
Shade nets				
Symbiotic techniques				
Cropping calendar				
Vermicompost				

Tool 7: Inventory of agroecological practices in selected villages in Java

The example shows that the majority of farmers use azolla, organic farming, and compost on their own farms in addition to changing the variety of rice they plant. Apps and books are less common; also the integrated rice-duck-fish-compost-azolla farming or floating rice field is not widely used.



Tool tested in 2018 with 29 farmers from research farmer clubs in Pangandaran and Cilacap

Figure 13 Inventory of agroecological practices in Java

Practical tips

1. The inventory helps to survey potential innovative practices with the farmer groups and identifies which good agroecological practices are already scaled out and can be used as examples of good practice.
2. The list is not a blueprint. For your specific situation, you would need to prepare a general list with potential agroecological practices used in this area.

Tool 8

Adaptation potential of agroecological farming practices

The tool allows for deeper investigation of the potential of currently used agroecological practices to build resilience to climate change.

90 minutes

Objective	✔ To better understand current farming practices and their potential for adaptation ✔ To discuss the climate-friendliness of innovative options and understand maladaptation ✔ To identify gaps and challenges to adoption of innovation options
Resources	✔ Inventory as per Tool 7 ✔ Flipchart with classification template of adaptation practices (see information box, p.95) ✔ Flipchart with criteria or questions (p.96)
Participants	Farmers group, facilitator, and a technician who is familiar with agroecology and climate change
General considerations	✔ Current agroecological farming practices are evaluated against their climate change adaptation potential. Categorisation of innovations as hard, soft, green, planned, and/or autonomous helps farmers to better identify characteristics of the adaptation practice. ✔ The climate-resilience checklist helps farmers assess the chosen practice from several perspectives. As required, the checklist can be extended or shortened.

Steps

1. Display the inventory of current agroecological practices.
2. Show a flipchart listing adaptation classification as follows

	Planned	Autonomous
Hard		
Green		
Soft		

3. Ask farmers to categorise the agroecological practices under the appropriate headings (see Infobox: Classification of adaptation practices p.95).
4. Ask farmers to add other new or innovative adaptation practices that they are most interested in. Their suggested practices should be relevant to climate change, such as use of stress-tolerant varieties, but also the replacement of chemical inputs (mitigation).
5. You may explain that adaptation should ideally be climate friendly. As soon as adaptations include a climate-unfriendly technology, they are called maladaptations.
6. Show another flipchart with the checklist listing criteria to assess the climate resilience of adaptation practices (see supplementary material Tool 8. p.96).
7. Let farmers select the practices they want to talk more about, for example by giving three votes to each farmer and selecting the adaptation practices with the most votes.
8. Evaluate the chosen adaptation practices against the criteria. Discuss advantages and disadvantages along environmental, social, and economic criteria. Ask the adaptation expert to support the discussion with technical expertise.
9. Conclude by asking farmers what their take-home messages from the session is and what they would like to try out in their fields.

Maladaptation

Maladaptation refers to practices that favour adaptation in the short term, but adversely affect systems' long-term resilience and/or adaptive capacity to climate change, because they are actually harmful to socioecological systems (Magnan, 2014). An example is the increased use of pesticides as a response to increased pest occurrences.

Adaptation

Planned adaptation comprises practices and technologies, which require planning support or collective action by the government or the community. Autonomous adaptation refers to independent activities by an individual farmer done on their own farm. You may further distinguish between hard, green, and soft adaptation. Hard refers to infrastructure investments, like dams or drainage canals. Soft adaptation encompasses knowledge and social network related actions, e.g., the use of social media for marketing or the participation in training. Green adaptations are agroecological or natural resource-based interventions, e.g., the restoration of mangroves or planting trees around the field to protect against strong winds.

Classification of adaptation practices (examples)

	Planned adaptation	Autonomous adaptation
Hard	• Improved roadways • Improved irrigation dams and canals • Drainage canals	• Processing facilities for home industry • Water harvesting • Water pump, well
Green	• Restoration of mangroves • Drought- and saline-tolerant rice varieties • System of Rice Intensification (SRI) • Floating rice fields	• Water retention measures (mulching) • Biological pest control • Compost use
Soft	• Weather insurance • Climate field school • Early warning system	• Farmer-to-consumer direct marketing • Social media and apps for weather, pests, marketing

Supplementary material Tool 8

Checklist to assess farming practices for climate resilience				
Criteria	**Indication / Specification**	Yes	No	Not sure
Water saving potential	• Does it improve water use efficiency? • Is water quality improved? • Does it contribute to conserving/capturing water?			
Energy saving potential	• Does it reduce energy consumption? • Can this practice use renewable energy sources?			
Carbon capture potential	• Can CO_2 be captured through increased biomass? • Does it increase soil organic matter? • Does it reduce soil disturbances?			
Nitrogen efficiency	• Does it reduce nitrous oxide emissions? • Does it lessen nutrient leaching?			
Weather extremes	• Does it reduce the impacts of climate hazards? Which one? • Does it prevent from climate risks? In which way?			
Knowledge and culture	• Is it farmer-friendly (low tech / simple, easy to use)? • Does it rescue and/or validate local knowledge or traditional practices? • Does it respect local culture and religious norms? • Are the products nutritious and tasty? • Is the practice currently in use by farmers who would be willing to invite others to view the practice on farm?			
Economics	• Is the innovation more beneficial than the current practice in terms of income and investments? • Does it save labour? • Does it stabilise yields? • Can we expect higher yields? • Can we sell it on the market? • Does it reduce costs?			

Tool 8: Economic assessment of organic rice farming

Gross margin calculation for conventional and organic paddy production Campernik group, Podaherung village				
	Conventional	**Organic Year 1**	**Organic Year 2**	**Organic Year 3**
Paddy yield (t/ha)	6.0	3.0	4.2	5.36
Husked rice grain yield (t/ha): *From paddy yield, you have to subtract 40% of the weight to arrive at the quantity of husked rice. In the harvesting process, 10% of the losses arise by drying, 25% by dehusking, and 5% are other losses.*	3.6	1.8	2.5	3.2
Quantity sold on ordinary market (t): *A farmer cannot expect to sell all their rice on premium markets, so the calculation assumes that 40% is sold on ordinary and 60% on premium markets.*	3.6	0.7	1.0	1.3
Quantity sold on premium market (t): *30,000 Indonesian Rupiah (IDR) is the premium market price.*	0.0	1.1	1.5	1.9
Average Price (IDR)/kg husked: *Black rice is the most expensive type, followed by red and white rice. Prices for organic rice may be double those for conventional rice.*	9,500	9,500	20,000	20,000
Price premium (IDR): *Premium prices can be achieved from year 2 onwards*	no	9,500	20,000	30,000
A: Total value of output per hectare (IDR): *Average price per kg multiplied by husked rice quantity (kg)*	34,200,000	17,100,000	50,400,000	83,569,200

Table 3 Economic assessment of rice farming (organic and conventional)

	Conventional	Organic Year 1	Organic Year 2	Organic Year 3
Inputs per hectare				
Land preparation (IDR): *Costs for contract ploughing*	1,000,000	1,000,000	1,000,000	1,000,000
Seed (IDR): *8-10 kg if planted only once, 3 seedlings/hole (SRI technology), as sometimes planting is done twice (due to flooding) 12 kg are calculated; a 5 kg bag costs 90,000 IDR.*	216,000	216,000	216,000	216,000
Synthetic fertiliser (IDR): *A 50 kg bag costs 150,000 IDR and 10 bags (500 kg) are needed per hectare.*	1,500,000	0	0	0
Organic fertiliser compost (IDR): *year one: 10 t compost/ha, year 2: 6 t/ha, from year 3: 4 t/ha, one tonne of compost costs 150,000 IDR*	0	1,500,000	900,000	600,000
Labour for organic fertiliser (IDR): *collecting organic materials, compost, transport, spreading, 50.000 IDR/day.*		500,000	300,000	200,000
Liquid organic fertiliser (3 applications): *1 bottle costs 70,000 IDR, each time two bottles are used, application is done three times*		420,000	420,000	420,000
Labour for organic liquid fertiliser: *3 times: 1 vegetative, 1 in between 50-70 DAP, 1 in generative*		300,000	300,000	300,000
Pesticides (IDR)	180,000	250,000	250,000	250,000
Labour: *Observation, special treatment, control, yellow trap*		500,000	500,000	500,000
Weeding: *Labour costs*	500,000	500,000	500,000	500,000
Harvesting, threshing, and transporting: *Labour costs*	700,000	700,000	700,000	700,000
Land rent	2,800,000	2,800,000	2,800,000	2,800,000
Tax 2% of paddy yield x 6,000 IDR	720,000	360,000	504,000	642,840
Milling: *10% of grain harvest value*	3,420,000	1,710,000	5,040,000	6,428,400
B: Total Costs per hectare (IDR)	11,036,000	10,756,000	13,430,000	14,557,240
C: Gross margin per hectare (IDR) (A–B)	23,164,000	6,344,000	36,970,000	69,011,960

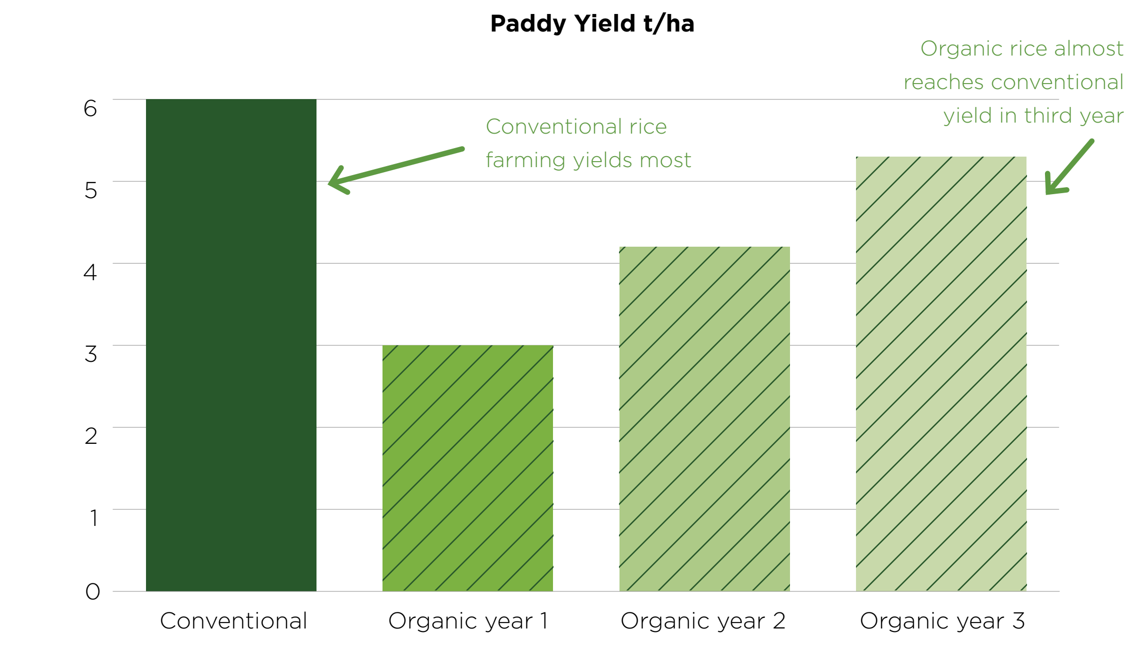
1 Euro = 15,256 IDR (28.04.2022)

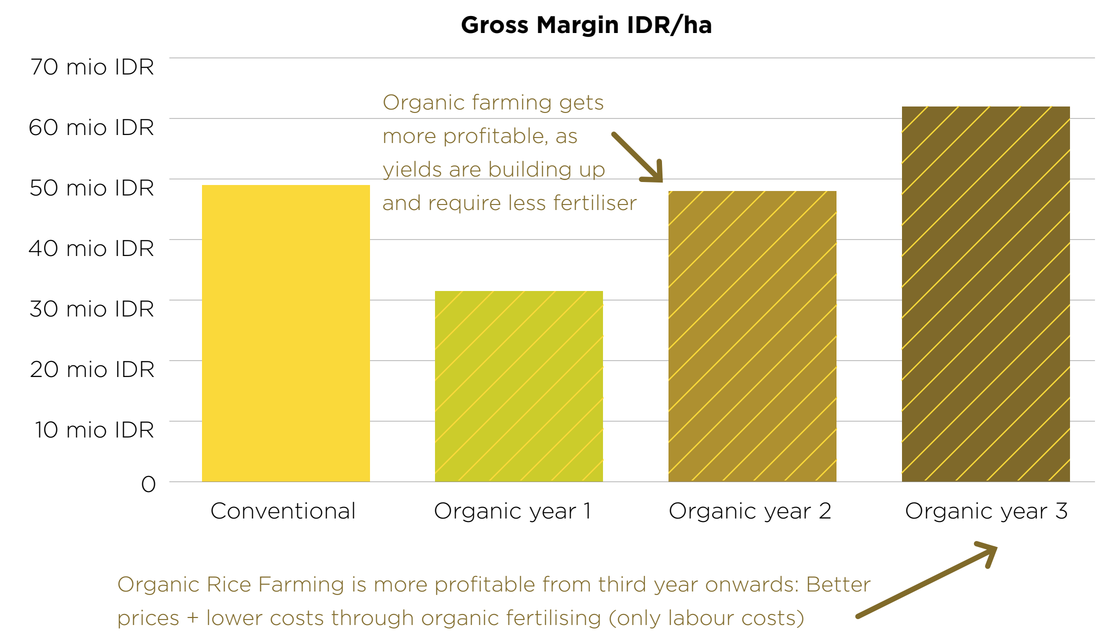
Table 3 Economic assessment of rice farming (organic and conventional)

Stress-resistent rice varieties are tested in the demonstration plot in Rawaapu, Java. Farmers have been monitoring growth and productivity parameters for the entuire season. At harvest, they will evaluate the yield for each tested rice variety.

Source: JAMTANI

Tool 8: Benefits of adopting organic rice farming under SRI





Prices 2018 (IDR/kg)	Conventional	Organic
White rice	12,000	16,000
Red rice	14,000	25,000
Black rice	15,000	31,000

Figure 14 Economic benefits of organic rice farming
Source: data provided by JAMTANI (2018)

Planning and designing experiments

Farmer-led research often deals with trials and experiments taking place in the farmer's field or at a demonstration plot under the auspices of a farmer group. An on-farm experiment is a good tool to test or improve management practices. In this manual, attention is given to on-farm trials and not to trials that need a controlled environment, e.g. taking place in a laboratory or a greenhouse. On-farm trials do not compete with lab trials, but complement the more complex controlled-environment trials.

"The ultimate goal of the trials needs to be defined by the farmers themselves. Farmers decide what kind of cake to bake, and then we bake the cake together (farmers, NGO, universities) and choose the right ingredients."

~Tandu Ramba, Manager, Motivator Pembangunan Masyarakat, Toraja

Sumyati is a farmer from Mekarasih, Paledah village, Pangandaran, Java with 0.84 hectares of paddy land. She is curious and likes to try new things, also taking into account local wisdom, for example the traditional planting calendar, the *pranoto mongso*. Scientists should support farmers in field research and provide the latest information on easy-to-replicate technologies, particularly to reduce the work burden of women.

Source: JAMTANI

The agricultural sector could reduce its carbon dioxide emissions. Some of this reduction can be achieved by substituting renewable energy for the fossil fuels used to power irrigation. Do-it-yourself windmills can pump water (Rawaapu village, Cilacap regency).

Source: Silke Stöber

Tool 9

Identification of research question and expected results

This on-farm experiment should answer farmers' own questions. Farmers become co-agents of research by asking and researching questions like, " What do I, as a farmer, want to get out of this trial? What do I want to find out? Which problems can it address?"

90 minutes

Objective	✔ To involve farmers in such a way that they become leaders in their own on-farm experiments ✔ To define the most important research questions farmers have ✔ To provide a clear statement of expected outcomes for the experiment (hypothesis)
Resources	✔ Flipchart paper and pens ✔ Example of research question and expected results (supplementary material Tool 9, p. 105) ✔ Glossary field trials for display and distribution to farmers (Annex 3)
Participants	Up to 15 farmers from Climate Field Labs from a defined territory; scientists (crop specialists or field trial planners); NGO staff member as facilitator
General considerations	✔ Encourage farmers to take the lead in the research, e.g. by an energizing slogan: *"You decide which cake to bake, universities and NGO support with the ingredients, recipes and baking methods."* ✔ **Keep research simple**. Don't try to answer many questions with one trial. It could be one simple question that is answered with yes or no. For example: "Will this new rice variety produce a higher yield than the standard rice variety that I usually plant?" ✔ A research question always compares two practices. The example above compares a new unknown and already common rice variety; the two practices are called "treatments" and will be compared. ✔ There are many yes/no questions that can be answered. Brainstorm potential questions with farmers.

Steps

1. Explain the general considerations and encourage farmers to formulate simple research questions. Let one or two farmers share their ideas on research questions, as examples. The facilitator concludes why this question must be a simple Yes/No question.
2. If more than 10 farmers participate, you may split them into subgroups. For group division, you can list the main climate change and farming problems as per Tool 3. Farmers can join the group by choosing the major farming problem, e.g. saline fields, low yields, pest infection.
3. Farmers discuss (in sub-groups) potential research questions and write the most important questions on flipchart paper.
4. Farmers present their research questions. Judging or discouraging farmers' ideas is not allowed, as each question is a relevant research question.
5. Scientists may reflect how relevant particular research questions are from a scientific point of view. They can also explain how this research question may be translated into an experimental design.
6. Depending on your resources and programme priorities, you can identify the most relevant research question for investigation in the next planting season.
7. Introduce the meaning of the term "expected outcome" of the experiment or "hypothesis". You may show a table with an example research question, hypothesis, and required data for collection (see supplementary material Tool 9 p.105).
8. Help farmers formulate expected outcomes for the experiment. When they differ, continue to discuss with them until you come up with a few joint expected outcomes. Explain that this expected outcome is what scientists call a hypothesis.
9. Close the session and provide an overview of the experimental design. If time permits, you can introduce the glossary of field trials as per annex 3. Display and/or distribute the terms to the group.

Hypothesis or expected outcome

A clear statement on the expected outcome of your experiment is called a hypothesis. Even with limited experience or knowledge, you may expect a particular performance from a new practice. It is important to write it down. At the end of the season, you can compare the hypothesis with the actual results then reflect on if your expected outcome is true or false.

Supplementary material Tool 9:

Research question, hypothesis, and data to be collected in on-farm research

Research question	Hypothesis	Data to be collected
Can I substitute synthetic fertiliser with compost and maintain my yields?	A compost application of 10 t/ha provides enough nutrients to get the yield I want.	Yield Soil nutrient content before and after harvest
Does the stress-tolerant rice variety perform better in flooded conditions compared to the local variety?	When planted and managed in exactly the same way, under flooded conditions, the growth of flood-tolerant variety is better.	Number of panicles Yield
Will the yield raise when I top prune my chilli?	There are more fruits per plant, more harvests, and a higher yield of bigger fruits.	Fruits per plant per harvest Number of harvests per plant Yield per plant Size of fruit per plant per harvest

Farmers of Buntu Datu practice the system of rice intensification (SRI). They cultivate rice with organic fertilisers, plant with young seedlings transplanted in straight rows with wider spacing, and alternate the water level. This keeps the soil moist but not inundated. In the middle is a pond fo fish to escape, when water level in the field is reduced.

Source: Silke Stöber

Tool 9: Research farmers' expectations of the results of chilli variety trials in Toraja in 2018

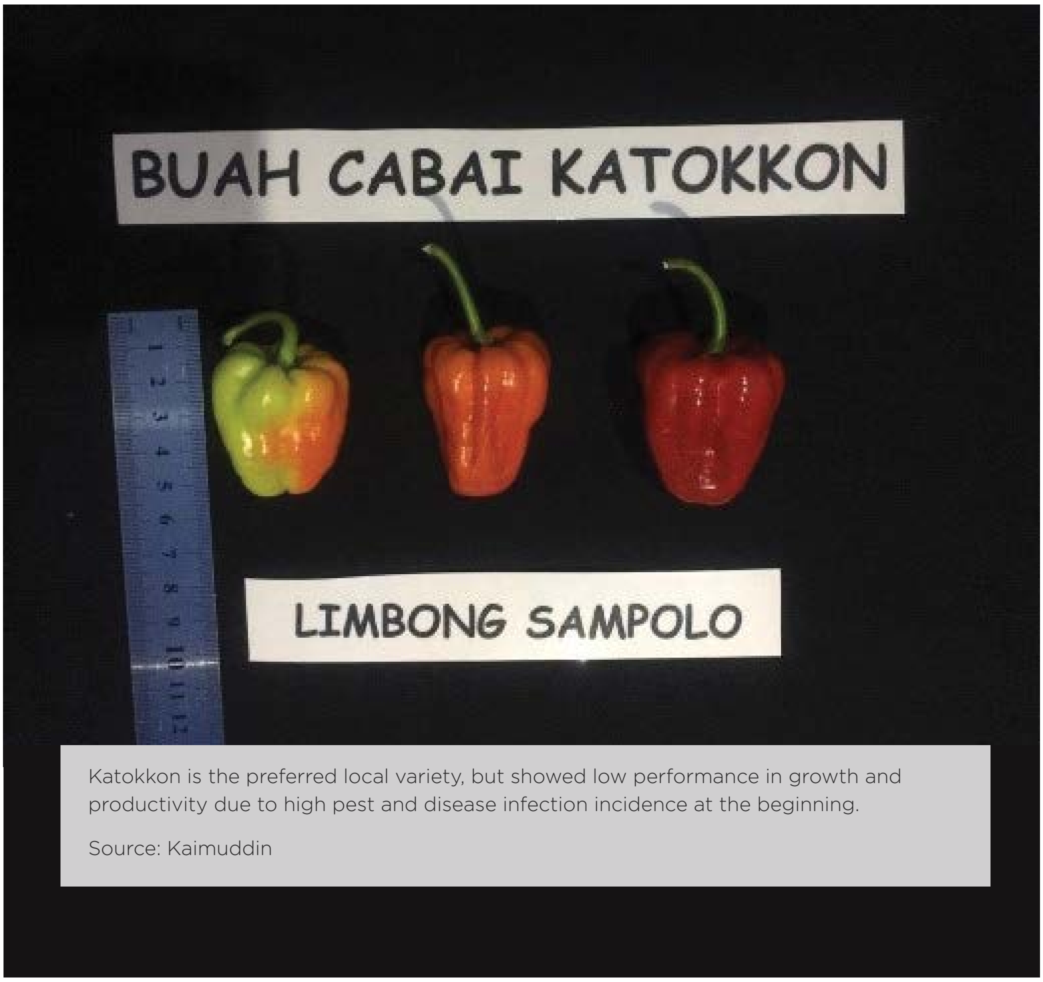
Before they started the field trials, the majority of the co-research farmers in Toraja expected the highest yields from the local landrace *Katokkon* and the variety *Sret*. After the first season, however, the results were as follows:

The introduced varieties *Sret* and *Dewata* (lowland varieties) perform better for yield and plant morphology.

The local variety of chilli (landrace *Katokkon*) is the most popular, even though the performance was affected by high pest and disease infection.

In 2018, farmers produced mainly for home use and taste was a priority criteria for variety selection.

It was, therefore, decided to focus on increasing productivity of the local landrace *Katokkon* in the coming season's field research. Initial suggestions for improvement have been considered. These range from improved seed selection, new forms of seed priming, improved field hygiene, and even more attention to biological pest and disease control.



Katokkon is the preferred local variety, but showed low performance in growth and productivity due to high pest and disease infection incidence at the beginning.

Source: Kaimuddin

Tool 9: Planning a rice trial in Ciganjeng village, West Java

Research question: Does the stress-tolerant rice varieties Mendawak and Inpari 34 produce better yields than the commonly planted variety *Ciherang* and Bangir?

Treatment: Four rice varieties in organic farming. The plot followed the System of Rice Intensification (SRI) combined with the principles of organic farming. The land was prepared by mechanical ploughing. Prior planting, 10 tons/ha goat manure was applied. The plots were fertilized at day 21 (day after planting) and 42 (day after planting) using a knapsack sprayer filled with organic liquid fertiliser.

Layout: Split-plot design. The plot measured 16 m^2 (8 m × 2 m) with a 0.5 m buffer in between, the size of the experimental plot was 200 m^2.

Factors: Varieties: Mendawak and Inpari 34 (stress-tolerant); Ciherang and Bangir (control)

Factor level: 5 kg seed per hectare, seedlings transplanted from the nursery 8 days after seeding. The planting technique followed the double row modified planting system Jejer Manten. (see infographic p. 108)

Trial period: October 2017 to April 2018

Test variables (data):

1. Vegetative Phase

Plant height (cm) (every second week from 14 DAP*, 35 DAP, 49 DAP, 63 DAP)

Number of tiller (every second week from 14 DAP*, 35 DAP, 49 DAP, 63 DAP)

2. Generative Phase

Number of Panicles at 63 DAP, 77 DAP, 91 DAP, 105 DAP

3. At Harvest

Number of panicles per clump, panicle length, grain weight per clump, weight of 100 grains, Yield per plant

* DAP=days after planting

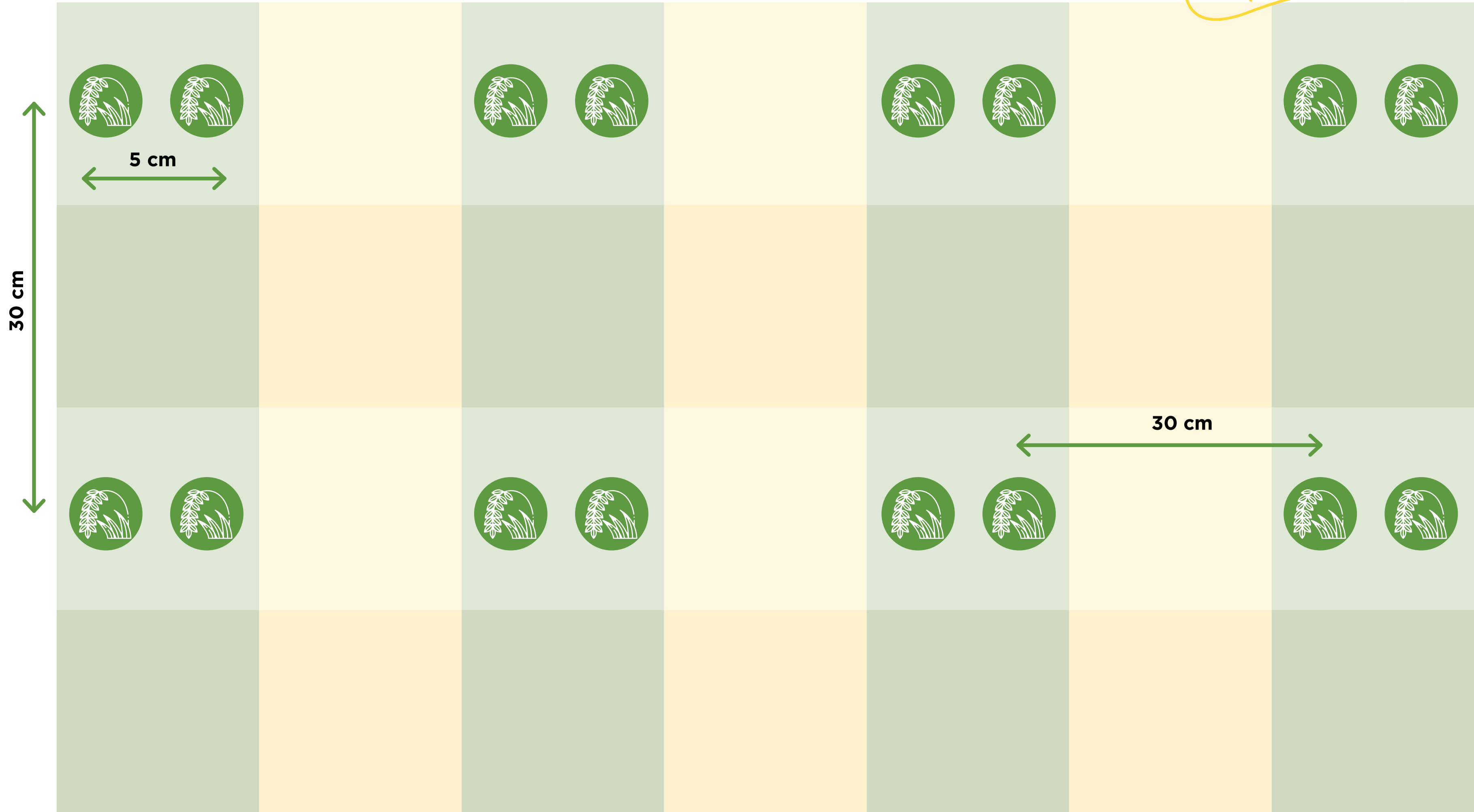
Source: Prayoga et al. 2018

Practical tips

Less is more. As many farmers will be new to this type of trial, we suggest starting with single-factor experiments. Over years, as farmers gain experience and confidence, the complexity of the experiments could grow to include multifactorial experiments. Often simple research questions bring the best results.

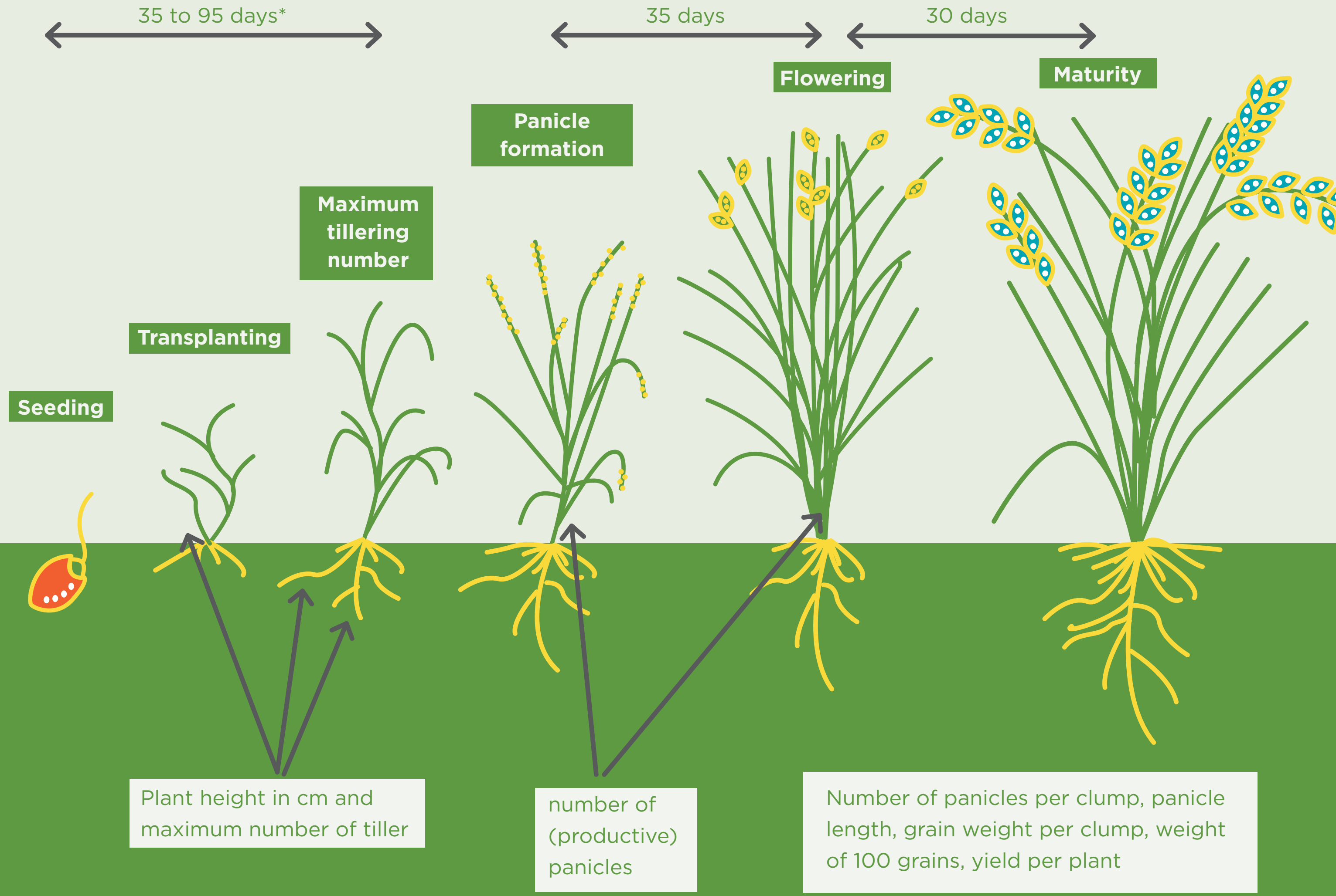
Do not overburden farmers by requesting too much data. If you develop standard protocols and data needs, methods, and frequencies upfront, everybody knows what they are getting into. If you need to answer questions that are more complex, do this on the university campus or under more controlled environments.

The Jejer Manten planting system



The Jejer Manten planting system brings more sunlight into plants. There is a distance of 5 cm between the double rows, and a 30 cm distance and between each double row vertically and horizontally. The increased light intensity leads to increased water use efficiency. Both effects mean that the plants can absorb more nutrients. The overall productivity is increased.

Growth stages of rice



The growth of the rice plant may be divided into three phases:

1. The vegetative phase runs from germination to panicle initiation.
2. The reproductive stage which runs from panicle inititation to flowering.
3. The ripening phase which runs from flowering to maturity.

*depending on duration of variety (short , medium, and long duration)

Research farmers gain autonomy and a sense of agency through designing trials, collecting data, and analysing it. This work begins by self-defining the most relevant research questions farmers want to address (Ciganjeng village, Pangandaran regency).

Source: Silke Stöber

Tool 10

Experimental design

Farmers usually know their fields very well and know in which parts they can expect better yields and where the soil is less fertile. Therefore, it is important not to experiment only on the best or the worst parts of the land, as this would lead to unrealistic results. To have confidence in the experimental data, it is necessary to replicate and randomise the field experiment in such a way that the results are reasonable and unbiased. This session invites farmers to understand and design standard layouts for a randomised field trial.

120 minutes

Objective	✓ To understand the necessity of randomisation and replication ✓ To practice drawing different standard trial layouts
Resources	✓ Flipchart paper ✓ Pens ✓ Figure A copied on flipchart before the meeting ✓ Glossary field trials and Figure 15 A p.113 for display copied on a flipchart and for distribution to farmers (Annex 3) ✓ Two standard experimental layouts copied on flipchart before the meeting (see examples Figures 15 B and 15 C p.114-115) ✓ Developed standard operational procedures (example Annex 4)
Participants	Farmer participants from Climate Field Labs within a defined territory, academic advisor (crop specialists or field trial planners), NGO staff member to facilitate
General considerations	✓ An agricultural experiment in the field requires a design that accounts for spatial effects of the soil, e.g. fertility variations, or drainage differences. ✓ The location of the experiment should have been chosen before the session takes place. The potential size should be clear.

- You may explain the difference between demonstration fields where you test a few varieties (can be randomised, too) and a more complex field experiment with two factors.
- Experimental layout and design considerations are complicated. Explaining layouts in a farmer-friendly way takes practice. Understand that it may take farmers some time and practice to fully understand the concept and your patience with their learning process is supportive.
- It is more than sufficient to introduce two standard layouts: the randomised complete block design and the split-plot design.
- Less is more: The introductory explanation should not include more than two factors (e.g. variety and soil fertility) with two different levels (=factor level) each, which are four different treatments in total. If each treatment is replicated three times, you will have twelve treatment arrangements.

Steps

1. Write the research question on a flipchart. As an example, you may show the question: Does the new variety perform better under compost enriched with bokashi fertiliser?
2. Draw an example of a field and note the length and width in meters at the outer edge.
3. Introduce and discuss the important terms by explaining factor, treatment, plot, and block which are displayed on the flipcharts (see Figure 15 A and Annex 3).
4. Introduce and discuss randomisation and replication by asking how spatial variations in the field (soil quality, proximity to water sources, etc.) might affect certain treatments disproportionately. From there, the randomised design can be introduced to counter the likelihood of this.
5. Show the outline of an example design (Figure 15 A).
6. Let the farmers discuss individually or in buzz groups to fill in the treatment squares on their handout. Display the solution on the flipchart with the help of the farmers.
7. Conclude the session by answering farmers' practical questions, e.g. where and when will I plant my trial? How many plants will I put in each plot? How will I randomise plot locations to ensure the trial is unbiased? or showing them examples from your own research (see Figures 15 B and C)

Example Tool 10: Figure A

On-farm trial sheet to be displayed and filled by participants

Block	**First replication**	**Plot 1**		
		Plot 2		
Block	**Second replication**	**Plot 3**		
		Plot 4		
Block	**Third replication**	**Plot 5**		
		Plot 6		

Task: Draw up a trial plan for two varieties of chilli (Chilli V1 and Chilli V2) and a version with bokashi fertiliser (S1) and the standard farm compost variant (S2).

1. How many treatments are included in one block?
2. If you replicate the trial three times, how many blocks and how many treatments do you need?
3. If you decide to take three varieties to be tested, how many treatments will you have? If you repeat the treatment three times how many treatment arrangements will there be in total?

Answer 1: Factor V (e.g. variety) (V1, V2) x Factor S (e.g. soil fertility method) (S1, S2) = 4 treatments (V1S1, V1S2, V2S1, V2S2)

Answer 2: Three blocks and 12 treatment arrangements

Answer 3: V1S1, V1S2, V2S1, V2S2, V3S1, V3S2 = 6 treatments, and 18 treatments in total

Figure 15 A On-farm trial sheet for farmer participants

Example Tool 10: Figure B

Randomised split-block design for a rice variety in different organic soil fertility strategies in West Java, Ciganjeng

Block Compost 10 t/ha	**1. repetition**	Variety 1	Variety 2	Variety 3
	2. repetition	Variety 3	Variety 1	Variety 2
	3. repetition	Variety 2	Variety 3	Variety 1
At least 0.5 m between the blocks to avoid mixing up soil fertility treatments				
Block Azolla 1o t/ha	**1. repetition**	Variety 1	Variety 2	Variety 3
	2. repetition	Variety 3	Variety 1	Variety 2
	3. repetition	Variety 2	Variety 3	Variety 1
Block Sesbania 1 t + Azolla 5 t + compost 3 t	**1. repetition**	Variety 1	Variety 2	Variety 3
	2. repetition	Variety 3	Variety 1	Variety 2
	3. repetition	Variety 2	Variety 3	Variety 1
At least 0.5 m between the blocks to avoid mixing up soil fertility treatments				

Split block design of a rice variety/soil fertility experiment in Rawaapu village in 2019. In this experiment, each block is administered homogeneously in terms of the factor soil fertility with each block containing either a) farmer compost (10t/ha), b) green manure (sesbania 1 t/ha + azolla 3t/ha + farmer compost of 3 t/ha), or c) azolla (10t/ha). A distance of 0.5 metres is kept between the blocks. Each block is divided into plots. On each of the plots, one variety (e.g. Inpari 41) is planted.

A sign attached to a bamboo or wooden pole indicates the specific rice variety in a randomised split-plot design in Rawaapu village, 2019.

Source: JAMTANI

Figure 15 B Randomized split-block design for a rice experiment

Example Tool 10: Figure C

Randomised complete block design for a chilli experiment in Toraja, Buntu Datu

Block A	**Plot 1:** Variety 3 Dewata	**V3** farmer style compost	**V3** no fertiliser	**V3** enriched compost
	Plot 2: Variety 1 Leatung2	**V1** enriched compost	**V1** farmer style compost	**V1** no fertiliser
	Plot 3: Variety 2 Sret	**V2** farmer style compost	**V2** no fertiliser	**V2** enriched compost
Block B	**Plot 4:** Variety 2 Sret	**V2** enriched compost	**V2** farmer style compost	**V2** no fertiliser
	Plot 5: Variety 3 Dewata	**V3** enriched compost	**V3** farmer style compost	**V3** no fertiliser
	Plot 6: Variety1 Leatung2	**V1** no fertiliser	**V1** enriched compost	**V1** farmer style compost
Block C	**Plot 7:** Variety Leatung2	**V1** farmer style compost	**V1** no fertiliser	**V1** enriched compost
	Plot 8: Variety 2 Sret	**V2** no fertiliser	**V2** enriched compost	**V2** farmer style compost
	Plot 9: Variety 3 Dewata	**V3** no fertiliser	**V3** enriched compost	**V3** farmer style compost

Legend: V1: Leatung2; V2: Sret; V3: Dewata

The randomised complete block design is a standard design for agricultural experiments. Each block contains a complete set of treatments (in this example, there are nine treatments). The treatment consists of two factors: variety and soil fertility strategy, with each factor having three factor levels. Each plot contains the main factor, which is the variety (V1, V2, V3) and a subplot, which is the soil fertility strategy (farmer-style compost (S1), control with no fertiliser (S0), and enriched compost with tithonia leaves 75% (S2) (see annex 2).

Figure 15 C Randomized complete block design for a chilli experiment

Factor, factor level and treatment

Each factor has a certain number of factor levels. The respective number of factor levels of each factor is multiplied to calculate the number of treatments. Each block contains all treatments in a complete block design (see annex 2).

Factor V (e.g. variety) (V1, V2, V3) x Factor S (e.g. soil fertility method) (S1, S2, S3) = 9 treatments (V1S1, V1S2, V1S3, V2S1, V2S2, V2S3, V3S1, V3S2, V3S3)

Practical tips

The glossary of terms of a field trial are to be introduced to farmers. In annex 3 you can find a photocopiable resource. It is recommended to display the terms on a flipchart for farmers to discuss. When going through the terms with farmers, you visualise the research question, draw a layout with plots, block, treatment and factors, and write down all the test criteria you would need to collect to document the field trial.

Farmer-led research must be very well prepared. All materials and standard operations should be agreed in advance with all participants. For this purpose, it is advisable to have a written plan of the standard operational procedures. This must include who is responsible for what work, who provides what materials, how to act in case of problems. An example for on-farm research in chilli is provided in annex 4.

A farmer demonstration plot for chilli variety trials that were tested in Buntu Datu, Tana Toraja regency from 2018 to 2020.

Source: Rein Syauta

Tool 11

Climate field schools

The heart of the Climate Field Labs are the climate field schools. In weekly or bi-weekly meetings, data from the field trial or a demonstration plot are collected using a standardised procedure. Each day begins with observation in the field, followed by calculations and preparation of the presentation. After the final presentation, the next steps are decided and, possibly, a snack or lunch is served.

One morning session, about four hours

Objective	✔ To monitor data according to research plan ✔ To jointly develop solutions for upcoming problems
Resources	✔ A place in the shade close to the field ✔ Forms to write down field observations (see example for observed parameters p.120 and annex 5) ✔ Parameters and how to measure them according to standard protocol ✔ Flipchart paper, pens, and tape ✔ Tools and devices for measurement as required by the experiment (e.g. pH meter, soil salinity meter, rain gauge, scales, measuring tape, spade) ✔ Compensation of transport, meal, time according to local customs
Participants	Farmer participants of the Climate Field Lab within a defined territory and a facilitator from an NGO. If possible, invite a crop specialist.

General considerations

- Make sure that farmers know in advance what to expect
- Start with observations in the field when the sun is not yet too hot
- Guide untrained farmers on using the measuring instruments correctly and recording measurements on their own.
- Assist in calculating means and in comparing actual values with those from the previous session.
- Hand out certificates of participation after a full season.

Steps

1. Assemble at a meeting point and hand out forms and instruments to record data. Explain which kind of data are to be measured and how to measure it correctly.
2. Split into small groups of farmers and measure the data.
3. After taking measurements, gather the farmers in a shady meeting place and help them process their data. For example, if they counted the number of fruits on 10 chilli plants, they could calculate the average number of fruits per plant and compare this value with the previous week.
4. All collected parameters must now be calculated for the specific treatment. For example, if there were three repetitions, the average of the three repetitions could be calculated and recorded.
5. All subgroups make a flipchart showing their results and present their results to the larger group. This is a good time for them to share other observations or concerns that they find important or interesting, for example, commenting on the occurrence of pests and diseases and the number of caterpillars or rice bugs or showing others pests they have collected or reporting on the number of beneficial insects or other phenomena.
6. After all farmers have presented their findings, solutions and next steps are discussed. If required and available, crop specialists may provide advice and farmers can share their advice on their own solutions as practices on their own fields.
7. The meeting closes with a snack or a lunch and the agenda, date and time for the next meeting are announced.

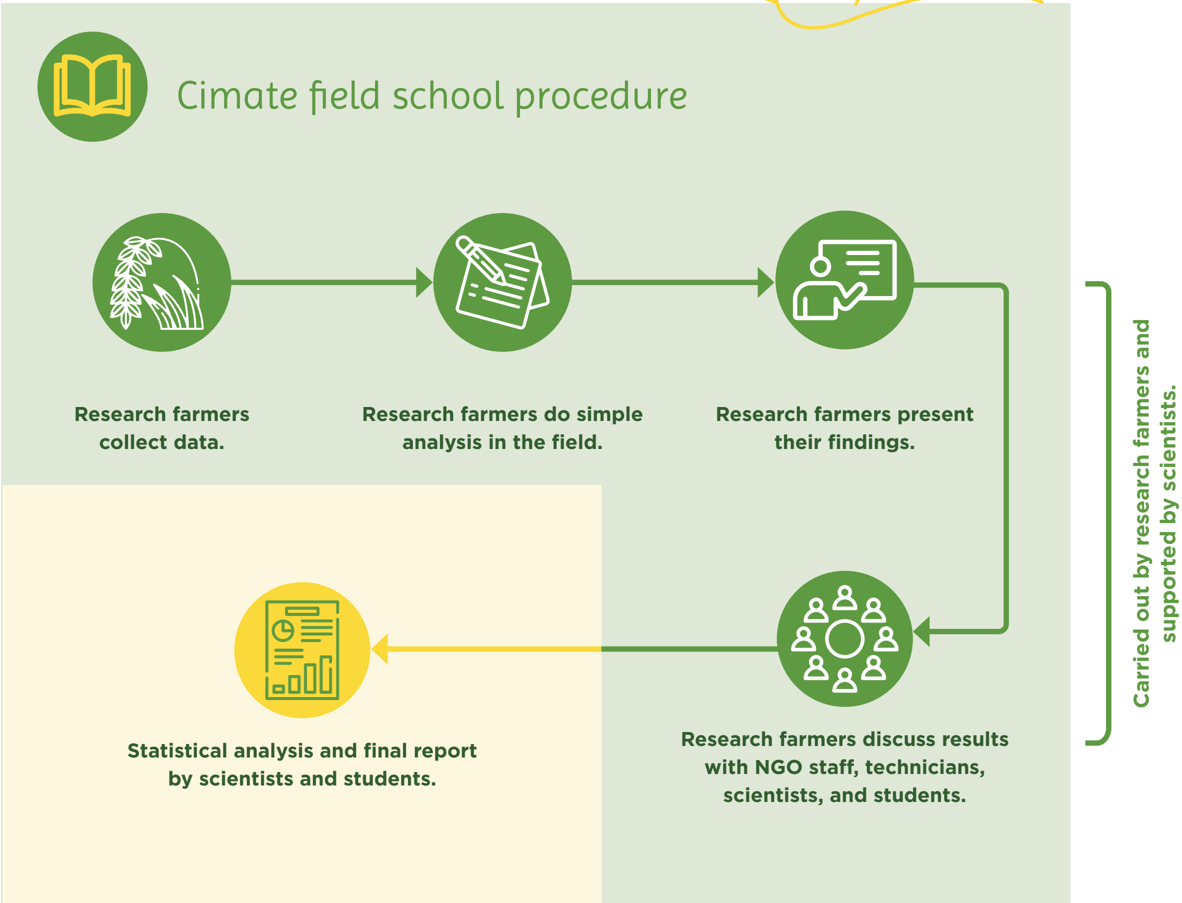
Practical tips

1. Make a good plan as to how often you will meet the research farmer club. While it is important to meet frequently enough that important steps in data collection and monitoring of results can take place, be respectful of farmers' time. Decide jointly on the meeting day, frequency of meetings (weekly or bi-weekly), and start time.
2. When dividing up the research farmers, who will observe what, it has proven useful that two research farmers always measure the same plot. In this way, one pair is responsible for each plot.
3. If you have chosen which factors should be tested with which parameters (see example Tool 9, p.120), you need to make a parameter observation plan to guide farmers on what to monitor in the morning. This may differ from session to session depending on the growth phase, be it vegetative, generative, ripening, or harvest (see also annex 5).

Co-research farmers meet regularly to maintain the plot. Watering, weeding, and biological pest and disease control are day-to-day activities self-organised by the research farmers. In TallangSura' village, the group meets once a week to discuss who will be responsible next for each maintenance task in the chilli variety demonstration plot.

Source: Silke Stöber

Climate field schools in Ciganjeng village



In 2018, Climate field schools in Ciganjeng village, Java, took place every Wednesday morning from 8-12 PM during the rice growing season. 15 research farmers assembled regularly to collect, analyse and discuss observations. Observation sheets and examples are provided in Annex 5.

Tool 11: Growth and productivity parameters to be measured in chilli and rice

Chilli	Rice
Height (in cm)	Height (in cm)
Number of productive branches per plant	Number of tillers
Total number of flowers per plant	Number of productive tillers
Total number of harvested fruits per plant	100-corn weight (g)
Total fruit weight per plant per harvest (g)	Yield per plant (g)
Number of harvests	Growth duration (number of days after planting until harvest)

Co-research farmers (from right to left) measure the plant height of the rice plants with a folding rule, check salinity with a TDS meter, test soil pH with a pH meter, and record the data in a notebook.

Source: Silke Stöber

Example of simple good practice developed during a climate field lab

During a climate field school meeting, research farmers developed an innovative rice field early warning system. By promoting better synchronization of planting cycles, farmers can better control pests and diseases, and manage the water in a joint effort. The communication system predicts and warns farmers about weather-related risks, water shortages, and infestation of pests and diseases.

Rice field early warning system communication with colour-coded flags

- Flags in the traffic light colours (red, yellow, and green) are hung in clearly visible places at the edge of the field. Coconut palms, for example, are a good choice for displaying the flags as they are high enough and can be climbed relatively easily.
- The flags themselves are irritating at first, as they contain neither election advertising nor other symbols. The farmers wonder what their meaning might be, so they start a discussion and ask the neighbour or other farmers in the field. At some point, the meaning of the flags gets around.
- Green flag: It's time to get started: Prepare your land and prepare your seedlings in the nursery.
- Yellow flag: Take care! The water channel will be moved soon. Please check your fields, if there is still enough water.
- Red flag: Pests and diseases attack or no more water in the field.

Climate change team communication

Community traffic light early warning system flags. The green flag indicates planting can go ahead, yellow draws attention to water levels, and red indicates a problem requiring attention, e.g., pest infestation.

Figure 16 Communication system in the rice field to give alerts

Source: JAMTANI

Evaluating the season

Results and processes in the Climate Field Labs are evaluated in different ways. This section presents four tools that can be used to evaluate the activities:

- Tool 12 is a tool from marketing research that shows how the taste of the tested varieties can be evaluated;
- Tool 13 discusses different evaluation criteria from crop production and how they can be asked by farmers and scientists and used for the final evaluation;
- Tool 14 captures the effect of climate field schools on building adaptive capacity; and
- Tool 15 presents how to carry out a simple before-and-after comparison of the changed production methods.

Climate field schools can also be conducted on other crops. In Bua'tarrung village, Toraja, for example, different varities of coffee are cultivated and growth, productivity as well as disease and pest infestation are observed.

Source: Silke Stöber

There are many ways to evaluate the progress and the results of co-research. Results must be celebrated and shared with others, as Toraja research farmers do this here at University of Padjadjaran. You can show the positive results and be happy about them. You can also honestly point out the challenges and reflect on your mistakes with others.

Source: Rein Syauta

Tool 12

Testing the taste

Farmers as well as breeders are increasingly interested in the cooking and processing quality and taste of varieties. Important traits for rice might be for example seed shape, texture, water uptake during cooking, and cooking time. For chilli, above all is its spiciness, but juiciness and sweetness might also play a role. Simple sensory tests are an entertaining way to assess the varieties jointly.

60 minutes

Objective	✔ To evaluate the taste of new varieties ✔ To discuss other important culinary traits that farmers consider important
Resources	✔ Product to be tested, e.g. cooked rice from various varieties ✔ Blindfolds and earplugs ✔ Flipchart ✔ A taste observation ranking sheet for each farmer (see Figure 17, p.127). Create your own sheet in a tabular format. ✔ Flipchart ✔ Optional: chef or rice cooker
Participants	Farmer participants of the Climate Field Lab within a defined territory and a facilitator from an NGO. If possible, invite a crop specialist.
General considerations	✔ In sensory tests, the 9-point hedonic scale (from Like Extremely to Dislike Extremely) is often used. Less scientific, but sufficiently informative and less monotonous when applied, is preference ranking, which is outline below. ✔ Don't skew farmers' opinions by allowing them to talk about their impressions before ranking their choices. Earplugs may discourage them from exchange of opinions. ✔ By using a blindfold, farmers can focus on the real taste and smell. They are less distracted by the appearance of the cooked rice and cannot guess the variety by seeing its colour.

Steps

1. After having harvested the varieties from the demonstration plots, invite research farmers to a meeting. Interested farmers from the community may also join.
2. Explain that each farmer should give their opinion individually, as taste preferences depend very much on personal preferences.
3. Decide who will start first, e.g. by drawing lots.
4. Farmers taste each variety one after another while blindfolded. If possible, allow them to stand/sit behind a curtain or other barrier so that their taste test is unobserved.
5. The farmers rank their preferences on the variety evaluation template.
6. The farmers give their rankings to the facilitator who transfers the data onto a flipchart after all farmers have had a chance to taste the rice varieties.
7. After everyone has given their score, the tallied flipchart is shown to the group.
8. Farmers are asked about their choices. In other words, "So what is good about the winner?" Record the quality aspects on the flipchart. The facilitator probes until nothing further arises. The farmers should then answer, "What is good about the second-best variety?" and, "What is bad about the less tasty varieties?"
9. Their answers to the above questions would inform a list of all the traits that are relevant for the farmers. The outcome developed is a variety trait template.
10. Wrap up the discussion by asking questions, such as: "Why do we have so many different preferences between the varieties?" or "What other traits are important to consider?" and "How can we use this information for the next program/ season?"

Tool 12: Sheet variety evaluation template

Best taste	Second best taste	Less good taste	Worst taste	Main reason
Bangir				Most aromatic
			Ciherang	Too bland
	Inpari 34			Savory
		Mendawak		Too large grain, too firm

Figure 17 Filled evaluation template of sensory test

Tool 12: Taste testing cooked rice in Ciganjeng village (29 participants)

Habitual preferences are shaped by culture and tradition. The Ciherang variety is promoted by the local government and is planted on most of the area, even though its taste attributes are ranked low. The taste of the traditional local variety Bangir is most liked. However, its plant physiological features are poor. A farmer chooses a variety for different reasons. Taste and aroma are only two of many reasons (see Tool 13).

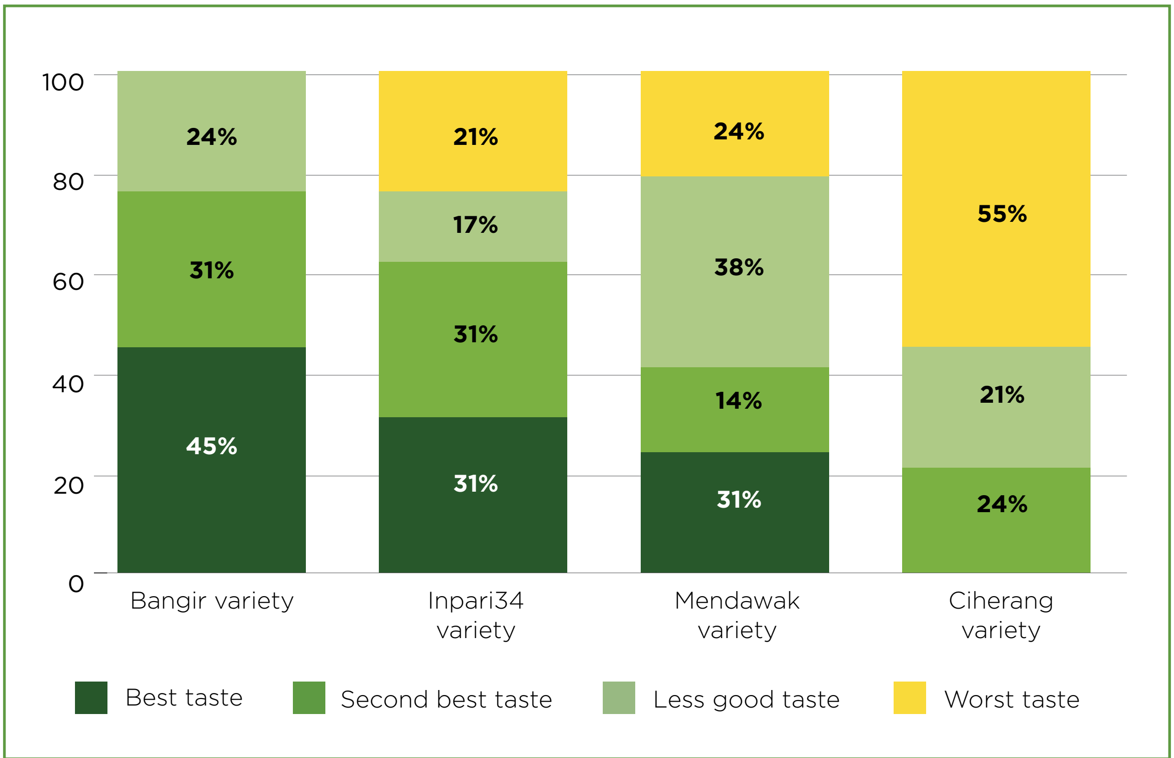


Figure 18 Taste test results for four rice varieties

Preparing for taste testing different varieties in Ciganjeng village, Pangandaran regency 2018.

Source: Silke Stöber

Evaluating the season

Tool 13

Interlocking realities

Farmers have their own preferences, expectations, and concerns when growing and eating their farm produce. The decisions and choices about what to grow and eat are complex. Sometimes, farmers make decisions based simply on what they have always done. Behaviour change and new techniques are more likely to be chosen if observations and farmers' insights are discussed and exchanged. In the climate field lab, local wisdom is linked with the academic knowledge and by interlocking those realities; trade-offs of choices are recognised and evaluated.

120 minutes

Objective	To evaluate the results of the previous planting season's production experiments against data on farmers' perceptions and observations
Resources	✔ Print outs of easy-to-read summaries of experiments (graphs and tables) ✔ Score cards of each plant to be assessed (see supplementary material tool 13: score card rice and chilli) ✔ Flipcharts and pens or digital means for presentation and assessments
Participants	Research farmers who participated in field trials, other interested farmers, facilitators, scientists.
General considerations	✔ Before the meeting, make sure that the academics involved have prepared their plant growth or soil analysis in easy-to-read graphs and tables (see example on rice variety guide). ✔ Score cards use a 4-point Likert scale which forces the user to form an opinion that is either positive or negative, as there is no safe middle or neutral option. You may adapt this to a 5-point Likert scale to allow for neutral answers. ✔ Develop score cards for production and for marketing. In this handbook, you find examples for rice and for chilli on the next pages.

Steps

1. Invite research farmers for a final meeting to evaluate the season. Invite farmers who have explicitly expressed interest from the community as well.
2. Share easy-to-read summaries (digitally or as print outs) and explain the major findings, clarify questions, and discuss results briefly.
3. Distribute score cards and let farmers fill them in individually. Alternatively, present the score card on a flipchart as a tally sheet, so everybody can place a vote directly on the flipchart.
4. Calculate the means of each trait and present the attributes/traits in a graph (spiderweb or line or bar chart).
5. Discuss trade-offs and how to overcome them. Debate if there are only win/win situations or that trade-offs must be accepted; e.g. a flood-tolerant rice variety may have strong morphological features, but underperforms in taste and marketability.
6. 6. Wrap up the session by getting advice from research farmers for the upcoming research activity: research questions, resources needed, etc.

Practical tips

1. Empower research farmers by emphasising that all knowledge, both local wisdom and academic knowledge,are of equal value and importance (compare infographic 14: Kinds of knowledge, p.35).
2. Not all traits are relevant for farmers, but still might be relevant for academic reasons. You could also ask farmers to prioritise the traits. Ask empowering questions like: How do you, as a research farmer, evaluate the varieties? Which criteria are most important to you?
3. You can also query these score cards anonymously. This has the advantage that farmers answer honestly and openly without running the risk of being criticised for their opinion afterwards.
4. Wrap up question: What was your research question for the on-farm trial and was your research question answered with the results of the trial? What should be done next?

"In a training course, I have learned how to cross-breed rice plants. Back home, I experiment to crossbreed the varieties Ciherang and Rojolele. I expect to gain the good traits from each: the long panicle from Ciherang, and the number of tillers, the good taste and the texture of Rojolele."

Endi, farmer, breeder and trader from Padaherang, Pangandaran, West Java.

Farmer Endi demonstrated how he crossbreeds rice varieties.

Source: Silke Stöber

Supplementary material Tool 13:
Rice score card

Name of Farmer...

1. Describe excellence and weakness based on your observations in the season

Name of tested rice variety	Strengths	Weaknesses

2. Score each variety based on the traits listed in the table
(4 = very good, 3= good, 2= medium, 1=less good)

Trait	Variety				Variety				Variety				Variety			
	4	3	2	1	4	3	2	1	4	3	2	1	4	3	2	1
Overall performance (morphology)																
Height in cm																
Number of tillers																
Number of productive tillers																
Stem stability																
Leaf shape																
Panicle type																
Seed shattering																
Grain shape																
Yield																
Taste																
Stress tolerance to droughts, floods																
Growth duration																

3. Do you intend to plant any of the tested varieties on your own farm in 2018?

☐ YES ☐ NO

If yes, which one:..

4. Would you like to continue farmer-led research in the next season?

☐ YES ☐ NO

A key element of co-research is the real-time in-field analysis to create a good understanding of collected data.

Source: Silke Stöber

Rice variety guide

A rice variety guide provides first-hand information from the local Climate Field Labs to help farmers decide which variety to grow. Data from the experiments inform farmers about growth and productivity and can be supplemented with data from the variety breed suppliers. Specific field conditions where the varieties have been trialed need to be given.

The example guide below provides the results of performance criteria that research farmers rated as important.

Tool 13: Rice variety guide: Results of farmer-led research in Ciganjeng, West Java

	Mendawak	Bangir	Inpari34	Ciherang
				
Climate field lab field conditions	Tested in Ciganjeng in lowland rainfed flood-prone paddy in the rainy season of 2018, SRI (1 plant per hole), spacing 25 x 25 cm, organic soil fertility strategies with azolla, sesbania, or goat compost (10t/ha) or a mix of all three			
General character of variety	Flood resistant	Traditional, red, hard long grain	Saline tolerant	Semi-dwarf
Harvest age (DAP)*	115 days	130 days	111 days	120 days
Stem stability	Hard, stable, less than 100 cm	Tall, stem is soft and thin, prone to wind break	Stable, high	Stable
Height (cm) 63 DAP	84 cm	96 cm	101 cm	86 cm
Number of (Productive) tillers 63 DAP	35 tillers, but not all are productive	30 tillers, almost all are productive	24 tillers, all productive	23 tillers, all productive
Seeds per panicle	Lots of seeds per panicle		Longer panicles, largest number of seeds per panicle	High proportion of seed per panicle
Yield t/ha	7.84[a]	6.82[b]	6.89[b]	6.75[b]
Pest resistance	Prone to Brown Planthopper biotype 2 and a little resistance to biotype 3	No information yet	Little resistance to Brown Planthopper biotype 1 and slightly prone to biotype 2 and 3	Prone to Brown Planthopper biotype 2 and little resistance to biotype 3
Disease resistance	Little resistance to Blast Disease and brown spot	No information yet	Little resistance to leaf blight, bacteria pathotype 3, prone to pathotype 4 & 8. Prone to Tungro Virus type Resistant to blast disease type 033 & 173, prone to blast disease type 133	Resistance to leaf blight and bacteria strain/ level 3 and 4.
Drought tolerance	Dwarf growth if little water	Little resistance to drought	Little resistance to drought	Little resistance to drought
Flood tolerance	Good growth in flooded field	Plants fall when flooded	Good growth in flooded field	Good growth in flooded field
Salinity tolerance	High, up to level 12 dSm-1	No tolerance	Medium, up to 8 dSm-1	No tolerance
Rice texture	After cooking, not good	Very tasty, very good	Tasty, very good	Tasty, very good

Source: Prayoga et al 2018 and JAMTANI performance result reports

*DAP = days after planting

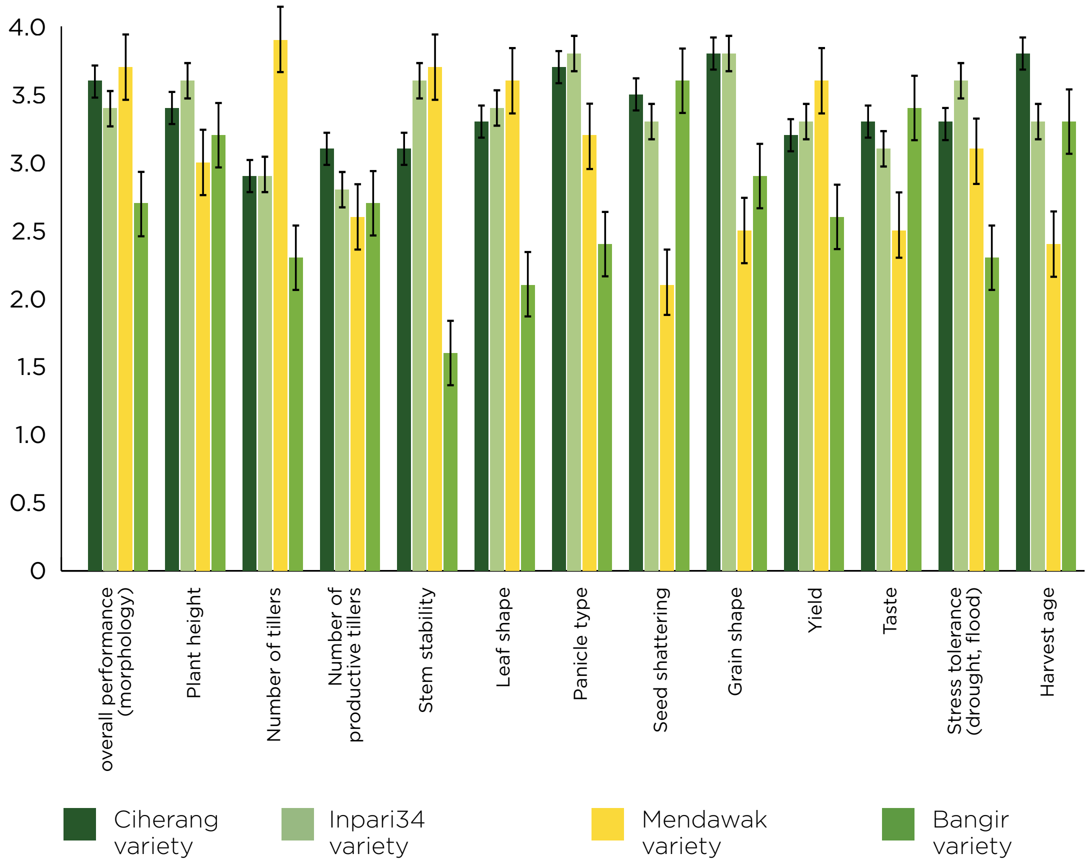


Figure 19 Rice score card (10 farmers in Ciganjeng, rainy season 2018)

The bar chart displays farmers' preference for various characteristics of the four rice varieties. While some traits might be more important than others, farmers often want a high-yielding variety. Yield-wise, the Mendawak variety was judged as best performing and had the highest grain yield (6.21 t/ha in 2018).

However, other farmers emphasized the importance of stress tolerance. Inpari 34 performed highest in that trait. It tolerates long periods of water inundation, which is an important characteristic, as rice fields in the Ciganjeng village are often flooded.

Practical tips

1. When you get stuck with your excel graphs, consult online tutorials or share and discuss them with your colleagues to help you get a grasp on their comprehensibility.
2. Make sure that you explain standard deviation in a simple way, such as: The standard deviation is a statistical measurement of how values vary from the average.
3. A low standard deviation means that the data is close to the average. A high standard deviation means that there is a large difference between data points.

Supplementary material Tool 13:
Chilli score card: Consumption and marketing

Name of Farmer..

On a scale from 1 to 4, how important is: size, colour, aroma, pungency, freshness/look, chemical-free, locally produced chillis/food, free of spots? (4=very important, 1=rather unimportant). Please put a cross in the respective box.

	Very important 4	Important 3	Less important 2	Rather unimportant 1
Size/length of fruit				
Colour of fruit				
Aroma				
Pungency				
Freshness				
Produced without chemicals				
Locally produced				
Free of spots				
Shape				

Tool 13: Katokkon chilli

Growth and productivity are also vital aspects in chilli production. The local chilli landraces that were tested in Toraja performed differently from the introduced varieties bought from a seed supplier in terms of yield. In general, research farmers preferred the varieties that were most resistant to pests and diseases, had a hot and fruity-aromatic taste, and had a high number of fruits per plant. The pungent local chilli Katokkon is therefore highly preferred, even though its productivity was in the beginning rather low (due to poor seed selection and preparation resulting in high pest and disease infection) (Kaimuddin et al., 2021).

Chillies should be produced without chemicals, according to 19 research farmers in Toraja. For them it was, on average, the most important criterion for chilli consumption and marketing. While the price of organic chillies is often the same as for conventionally grown fruits, there is a growing awareness of chemical-free products and their potential to fetch better prices. Being locally produced by women's groups is a positive social aspect ranked almost equally important. Pungency and aroma are other important criteria, while shape and freshness are less relevant for the farmers.

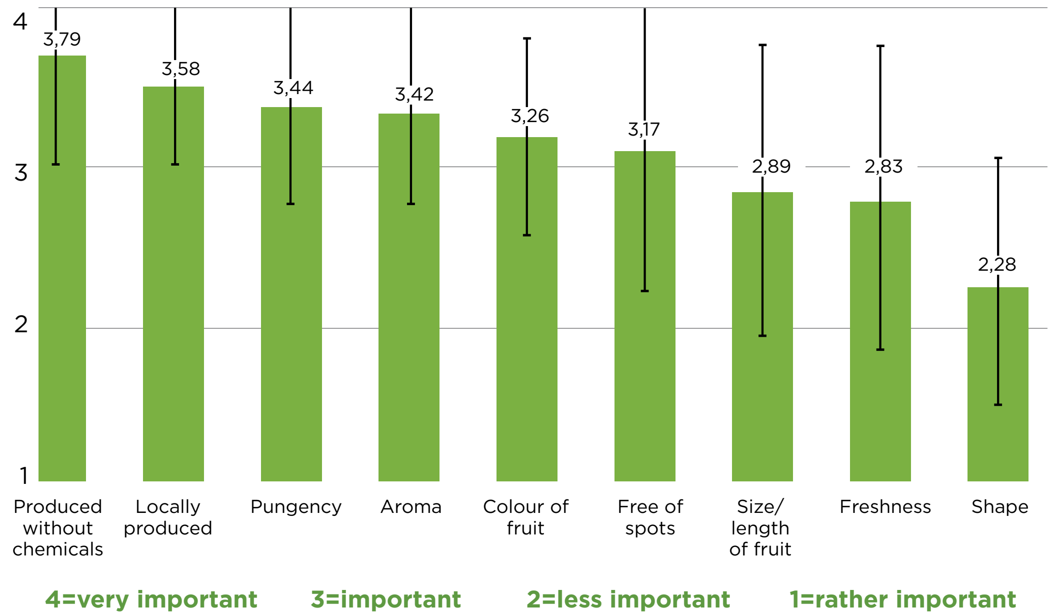


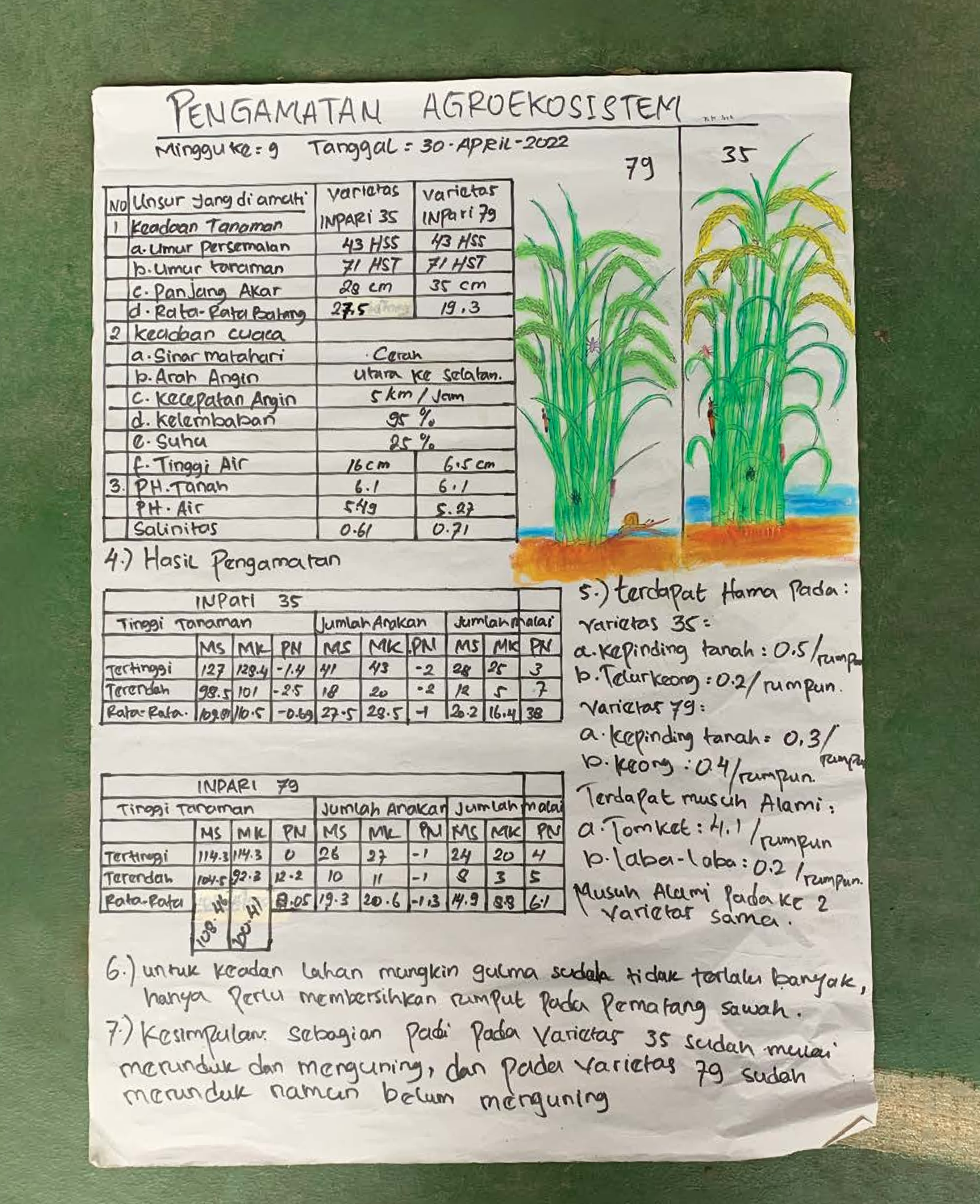
Figure 20 Importance of different traits of chilli for consumption and marketing (average scores of 19 farmers in Toraja)

Practical tip

The black bars show the standard deviation. A long bar indicates very different perceptions within the group, which then scatter widely around the mean value, for example the freshness and the size of the chilli fruit.

Locally produced and chemical-free Katokkon chilli is very popular with market consumers in Rantepao, Tana Toraja regency.

Source: Silke Stöber



PENGAMATAN AGROEKOSISTEM

Minggu ke: 9 Tanggal: 30-APRIL-2022

No	Unsur yang di amati	Varietas INPARI 35	Varietas INPari 79
1	Keadaan Tanaman		
	a. Umur Persemaian	43 HSS	43 HSS
	b. Umur tanaman	71 HST	71 HST
	c. Panjang Akar	28 cm	35 cm
	d. Rata-Rata Batang	27.5	19.3
2	keadaan cuaca		
	a. Sinar matahari	Cerah	
	b. Arah Angin	utara ke selatan.	
	c. Kecepatan Angin	5 km / Jam	
	d. kelembaban	95 %	
	e. Suhu	25 %	
	f. Tinggi Air	16 cm	6.5 cm
3.	PH. Tanah	6.1	6.1
	PH. Air	5.49	5.27
	Salinitas	0.61	0.71

79 35

4.) Hasil Pengamatan

INPari 35									
	Tinggi Tanaman			Jumlah Anakan			Jumlah malai		
	MS	MK	PN	MS	MK	PN	MS	MK	PN
Tertinggi	127	128.4	-1.4	41	43	-2	28	25	3
Terendah	98.5	101	-2.5	18	20	·2	12	5	7
Rata-Rata.	109.81	110.5	-0.69	27.5	28.5	-1	20.2	16.4	38

INPARI 79									
	Tinggi Tanaman			Jumlah Anakan			Jumlah malai		
	MS	MK	PN	MS	MK	PN	MS	MK	PN
Tertinggi	114.3	114.3	0	26	27	-1	24	20	4
Terendah	104.5	92.3	12.2	10	11	-1	8	3	5
Rata-Rata	108.46	100.41	8.05	19.3	20.6	-1.3	14.9	8.8	6.1

5.) terdapat Hama Pada:
Varietas 35:
a. kepinding tanah: 0.5/rumpun
b. Telur keong: 0.2/rumpun.
Varietas 79:
a. kepinding tanah: 0,3/rumpun
b. keong: 0.4/rumpun.
Terdapat musuh Alami:
a. Tomket: 4.1/rumpun
b. laba-laba: 0.2/rumpun.
Musuh Alami Pada ke 2 varietas sama.

6.) untuk keadaan lahan mungkin gulma sudah tidak terlalu banyak, hanya Perlu membersihkan rumput Pada Pematang sawah.

7.) Kesimpulan: sebagian Padi Pada Varietas 35 sudah mulai merunduk dan menguning, dan Padi varietas 79 sudah merunduk namun belum menguning

Co-research farmers can record their findings by drawing the growth stage of the rice plant, its performance results, and their observations of pests and diseases. Drawings are powerful in adult education as they help farmers remember information.

Source: JAMTANI

Tool 14

Climate field lab's benefits and learning impacts

It is useful to invest in smallholder farmer training to close knowledge gaps in climate change adaptation. Training and extension activities such as the climate field lab cost time and money. Research farmers may feel privileged to take part, others may drop out, as they have too little time or may not get enough out of it. In order to assess the impact of the training sessions, it is essential to find out about farmers' motivations and the impacts of their learning.

90 minutes

Objective	✔ To evaluate the success of the climate field lab in terms of benefits for participants, the environment, and the community at large ✔ To become aware of weaknesses and find entry points for improvement.
Resources	✔ Facilitation guideline (see supplementary material p.140), brown paper ✔ Flipchart and markers ✔ Corn seed or other material to rank impacts
Participants	Research farmers who participated in the training activity, facilitators
General considerations	✔ Host a final climate school meeting to evaluate the participants' learning. ✔ Combine the meeting with a certificate award. A certificate is a form of recognition for farmers who have invested time and resources in learning. ✔ If you also require a quantitative assessment for lab's donor, a paper, or a policy brief, you may also distribute a final questionnaire or conduct a ranking/scoring exercise to complement your qualitative assessment.

Steps

1. Gather the participants of the climate field lab. Consider inviting drop-outs as well.
2. Collect answers to the questions of the facilitation guidelines and record them carefully on cards.
3. Cluster the answers on benefits into main clusters for each target (participants, community, environment)
4. Collect the answers from each farmer on the weaknesses of the climate field lab and cluster them accordingly.
5. Summarise the discussion by asking a final question to each farmer (choose examples of guideline 3a., 3b., or 3c.)
6. Optional: Based on the clustered benefits, conduct a ranking/scoring exercise or distribute a questionnaire to all participants.
7. Present certificates and let the head of the research farmer club to summarise the impacts, weaknesses, and steps forward before concluding.

Supplementary material Tool 14:

Facilitation guideline benefits and impact on myself, the community, and the environment?

1. What are the benefits of the climate field lab in this year?
    - for you, as a participant?
    - for other farmers in your community who haven't participated in a climate field lab programme? e.g. How does the village/community as a whole benefit from the climate field school? Do you talk with other farmers in your village about new knowledge you gained? What are the other farmers most interested in?
    - for the environment (e.g. soil health, quantity and quality of water, biodiversity, forest protection, pests and diseases)?
2. What are the weaknesses of the climate field lab in this year/this season? Choose one or more of the questions below or formulate a similar question depending on your programme:

3.a What would you change or improve in the climate field lab if you had one wish free?

3.b What makes you proud of being a research farmer?

3.c Which field research activities would you like to continue?

Tool 14: Evaluation statement of a research farmer in Java

A 45-year old woman farmer from Ciganjeng village explains her learning as follows: "Climate change has caused increased temperatures during night and day, and the number of very hot days has increased." Her major learning from the climate field lab was related to agrometeorology, as she is able to identify the start of the rainy season. According to her, the rainy season sometimes starts earlier, but is more unpredictable. Climate field schools could be improved by providing tools to measure temperature, humidity, and rainfall on her farm. She is particularly proud of being an expert in obtaining satisfying results through healthy rice farming practices. She makes her own solid and liquid organic fertiliser and mixes azolla into it. To break the pest and disease cycle, she will plant onions as second crop after the rice harvest in the future.

Co-research farmer, Mrs. Umi, benefitted from an innovation tested in the climate field lab. Her duck egg production is now more profitable, as she partially substitutes expensive rice bran feed with azolla.

Source: Silke Stöber

Tool 14: Learning effects in Toraja

In Toraja, research farmers from five villages scored the benefits of the climate field schools according to six self-defined clusters. It was organised as a game: the participants ranked the benefits using 20 corn seeds. The six benefit fields were drawn on a DINA4 paper. Each individual research farmer could then denote which benefits are most relevant to them using 20 maize kernels. The graph displays the mean score per benefit cluster per village. Strikingly, most of the 73 research farmers want to create a better future for their children, including improved health and gender equity. In To'Pao and Bua Tarrung, adaptation to climate change was more important than in other villages. Here, farmers need quick and urgent solutions as they suffer from severe impacts of climate change. Bua Tarrung struggles with their cocoa and coffee production due to higher temperatures and humidity. To'Pao has frequent dry spells and generally lacks water for irrigation to compensate for extremely dry conditions.

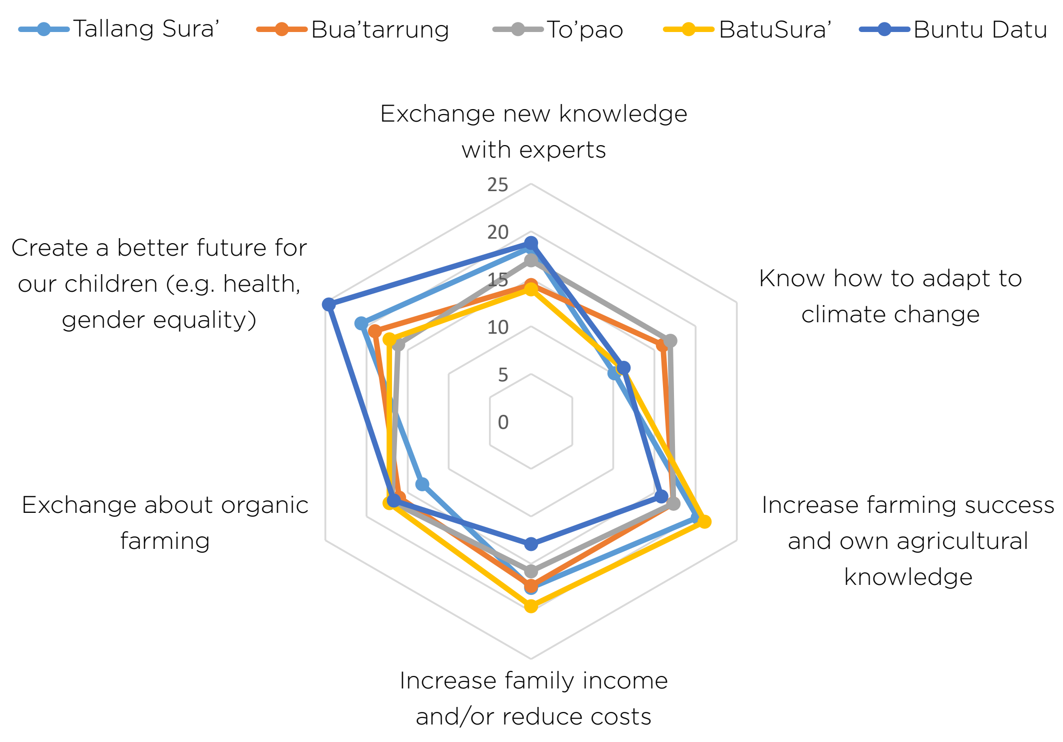


Figure 21 Learning effects in Toraja after two years of co-research (n=73)

Tool 15

Before-after comparison

A before-after comparison show changes over time. It is a very powerful, striking, and easy-to-understand instrument. We can use this comparison to make visible the learning and behavioural changes that have been triggered by the climate field schools.

30 to 45 minutes

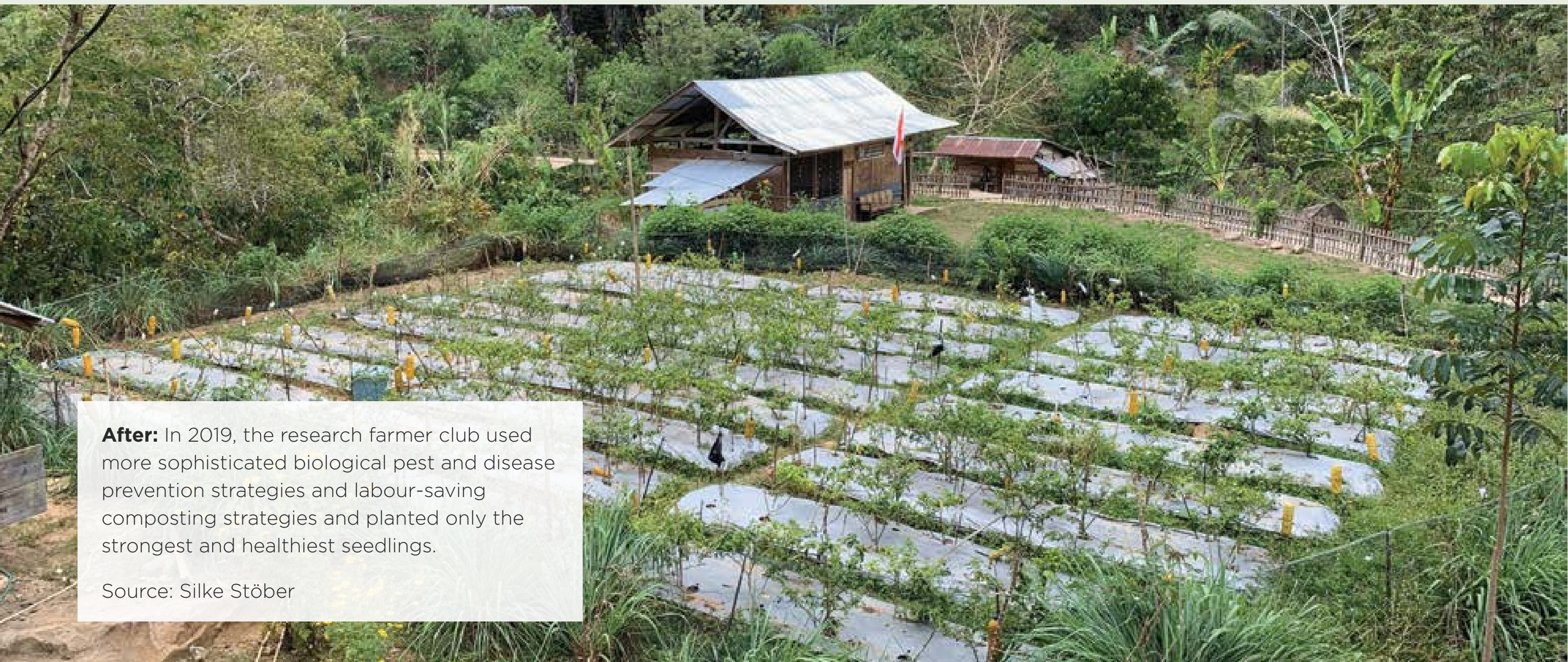
Objective	✔ To compare production, marketing, learning, or management practices before and after the research and training programme ✔ To assess good practices and lessons learnt
Resources	Cards, flipcharts, or brown paper and pens to cluster the previous and new practices
Participants	Research farmers who participated in climate field lab, facilitator
General considerations	✔ This can be organised as an entertaining and fast activity. Ask farmers to quickly call out the new practices that convince them most, are most promising, etc. ✔ The meeting can be combined with a visit of a farmer's field to observe new practices.

Steps

1. To finish the season of the Climate Field Labs (e.g. after harvest or before the next season), invite the research farmer club members for an evaluation meeting, preferably close to a farmer's field or demonstration plot
2. Ask the farmer group: Which newly acquired practices are convincing enough to be continued?
3. Make a list of all new practices and the old practices that farmers will no longer use after gaining knowledge via the climate field lab.
4. Structure all new practices in a table or chart, starting from preparing the land, selecting the seed, fertilising the soil, taking care of pests and diseases, pruning, harvesting, storing, selling, and working on the field.

Before: In 2017, only yellow traps were used as pest control strategy.

Source: Silke Stöber



After: In 2019, the research farmer club used more sophisticated biological pest and disease prevention strategies and labour-saving composting strategies and planted only the strongest and healthiest seedlings.

Source: Silke Stöber

Chilli plantations spread all over Toraja and the market demand for chemical-free chillis is high.

Source: Bert Broekhuis

Tool 15: Lessons learnt from a chilli climate field lab in Tallang Sura'

Before chilli climate field lab	After chilli climate field lab
Applied organic fertiliser to the entire row/length of fruit	Put organic fertiliser only into the planting hole
Used biopesticides two to three times during the season (many used fermented recipes)	Used biopesticides more often and try out various recipes with fresh ingredients (not fermented)
Did not use mulching	Mulched chilli plants
Bought or acquired seedlings from other villages	Produced own seedlings including seed priming in onion water (overnight soaking) or hot water to increase germination
Asked somebody to buy the seed at the local market	Farmers bought seeds themselves from an experienced farmer
Used yellow traps	Used yellow trap and other repellent traps, such as lemongrass or marigold, or attractant traps such as corn or tithonia Put lemongrass on top of mulch to protect from ants and caterpillars
Bought chemical pesticides	Saved money as they were no longer buying chemical pesticides
Did not use compost	Made compost and liquid organic fertilisers as a group activity
Farmed independently	Farmed as group: weekly meetings during the season; welcomed new members to learn together
Did not prune branches	Pruned branches to increase productivity

Table 4 Key lessons from a chilli Climate Field Lab

Scaling of processes and results

Scaling is about the wider dissemination of lessons learned and good practices. A distinction can be made between scaling up and scaling out, depending on the level at which the lessons are to be disseminated. With Tool 16, knowledge can be disseminated vertically to other farmers (scaling out). Tool 17 describes how to present important messages on posters in a way that is appropriate for the target group (scaling up, and out). Tool 18 describes an innovative form of dialogue between farmers and policymakers or academia that allows smallholders to present their innovations outside their own community and thus expand their knowledge network (scaling up).

Cristian David has become one of the local experts on pests and disease protection in Buntu Datu, Toraja. He explains how to produce and apply biopesticides, which are most effective when applied fresh, and not fermented as recommended in existing leaflets. When plants are affected, he sprays plants every three days in the early morning with a mixture of one litre of biopesticide and four litres of water. This is effective against white flies and caterpillars. Pheromone traps are employed against fruit flies.

Source: Bert Broekhuis

Tool 16

Sharing farmer wisdom

Farmers' agroecological knowledge continuously develops. Farmers who openly share their innovative planting technique, a new recipe, a new composting technique, or new machinery can be supported in disseminating their local wisdom in the form of a farmer wisdom leaflet. Farmer's knowledge can be supplemented with academic knowledge if the leaflet needs to be enriched.

60 to 120 minutes

Objective	To document, publish, and share good practice leaflets in farmer-friendly language with visual aids
Resources	✔ Inputs and local materials ready on the farm, where the demonstration takes place ✔ Camera or smartphone to take pictures ✔ Academic expert to review the summarised information ✔ Laptop and printer
Participants	Farmer(s) who have invented a new agroecological technique or adapted an existing technique, NGO facilitator
General considerations	✔ Farmers remain the owners of their technology and must be declared as such (authors, inventors, or similar). ✔ Quality check and complementary knowledge should be added by the NGOs or technical experts or universities involved. ✔ Easy-to-read language, clear images, and short, uncomplicated messages should convey the technical information.

Steps

1. Research farmer prepares all the material required for the demonstration of their innovation.
2. Research farmer explains all necessary steps to demonstrate the innovation.
3. Each step is documented in photos and necessary text.
4. Technical information leaflet is produced.
5. Leaflet is shared with technical expert for review.
6. Reviewed leaflet is produced, shared, and tested with farmers who do not yet use the technology.
7. If required, operating instructions and background information is complemented and improved instructions are printed and shared.

Producing biopesticides involves a number of steps, such as collecting leaves and roots and chopping, watering, and pressing them to make an extract. It is most effective when applied fresh.

Source: Silke Stöber

Practical tip

Don't forget, that intellectual property rights also apply to peasant knowledge or farmer's wisdom.

Tool 16: Biopesticides: the last resort in agroecological pest and disease management

The use of biopesticides are one of the agroecological control mechanisms in chemical-free farming. They help to reduce the increased pressure from pests, one of the many negative impacts of climacte change. When made by local materials, they are not as expensive as agrochemicals and are considered less toxic to the environment than agrochemicals. However, production and application of biopesticides may be time-consuming. Some ingredients such as tephrosia might be harmful to beneficial insects such as ladybugs or spiders. Therefore, biopesticides should only be used as a last resort in combination with barrier plants, repellent plants, traps, crop rotation, mixed cropping, and other cultural methods. One of the major learnings in the Climate Field Labs in Toraja was that biopesticides work best when they are unfermented and freshly applied. Farmers experimented with all kinds of local plants and research farmers shared their recipes with other farmers.

Recipes for biopesticides to be used in chilli gardens from Toraja, offered by research farmers from Buntu Datu, To'Pao and Tallang Sura'

Biopesticide – Option 1	Biopesticide – Option 2
1 kg galangal (plant family: Zingiberaceae)	0.25 kg "marvel of Peru" resp. "four o'clock flower" (Mirabilis jalapa)
1 kg ginger (Zingiber officinale)	0.25 kg leaves of soursop resp. "Brazilian paw-paw" (Annona muricate)
1 kg turmeric (Curcuma longa)	0.25 kg leaves of tephrosia (Tephrosia elongata)
0.5 kg leaves of tobacco (genus: Nicotiana)	0.25 kg leaves of tobacco (genus: Nicotiana)
0.5 kg leaves of papaya (Carica papaya)	0.25 kg garden ageratum (Ageratum conyzoides)
1 kg chayote (Sechium edule)	

Table 5 Recipes for biopesticides

How to make biopesticides?

Target pests

Repel / prevent various insects, such as aphids, white flies, caterpillars

Materials


Three leaves of papaya


A handful of lemongrass


One twig of soursop


One twig of red cedar (Toona sureni)


One twig of Tephrosia


A handful of wild basil

+

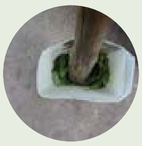

500 ml water

Tools

Machete • Mortar • Bucket • Sieve cloth

Preparation


1. Chop all ingredients with the knife


2. Mash all chopped leaves with pestle


3. Add 500 ml of water, then put it in a sieve cloth and then squeeze


4. filter the liquid, fill it in a sprayer bottle. It is ready to use in a mix of biopesticide to water: 1:4


5. Spray it from under the leaves up and from top to bottom

Mode of action

- ✔ Its distinctive aroma repels pests and prevents attacks
- ✔ Deters the growth / larvae development of insects
- ✔ Inhibits from infestation with disease pathogens

Dosis	1 liter biopesticide on 4 liter of water
Shelf life	< 24 hours
Limitations	Often kills larvae, doesn't kill adult insects, also affects beneficial insect larva
Active compounds	Antifeedant, repellent and oviposition deterrent effects: Papaya: papain (deters caterpillars), carpaine (kills larvae); lemongrass: citral, citronellal, nerol, geraniol (repellent, kills eggs); soursop: annanoin (kills eggs/larvae); red cedar: surenone (repellent, growth inhibitor, antifeedant), Tephrosia: rotenone (antifeedant, kills eggs/larvae); wild basil: eugenol (antifeedant, kills eggs)

Tool 17

Producing people-friendly posters

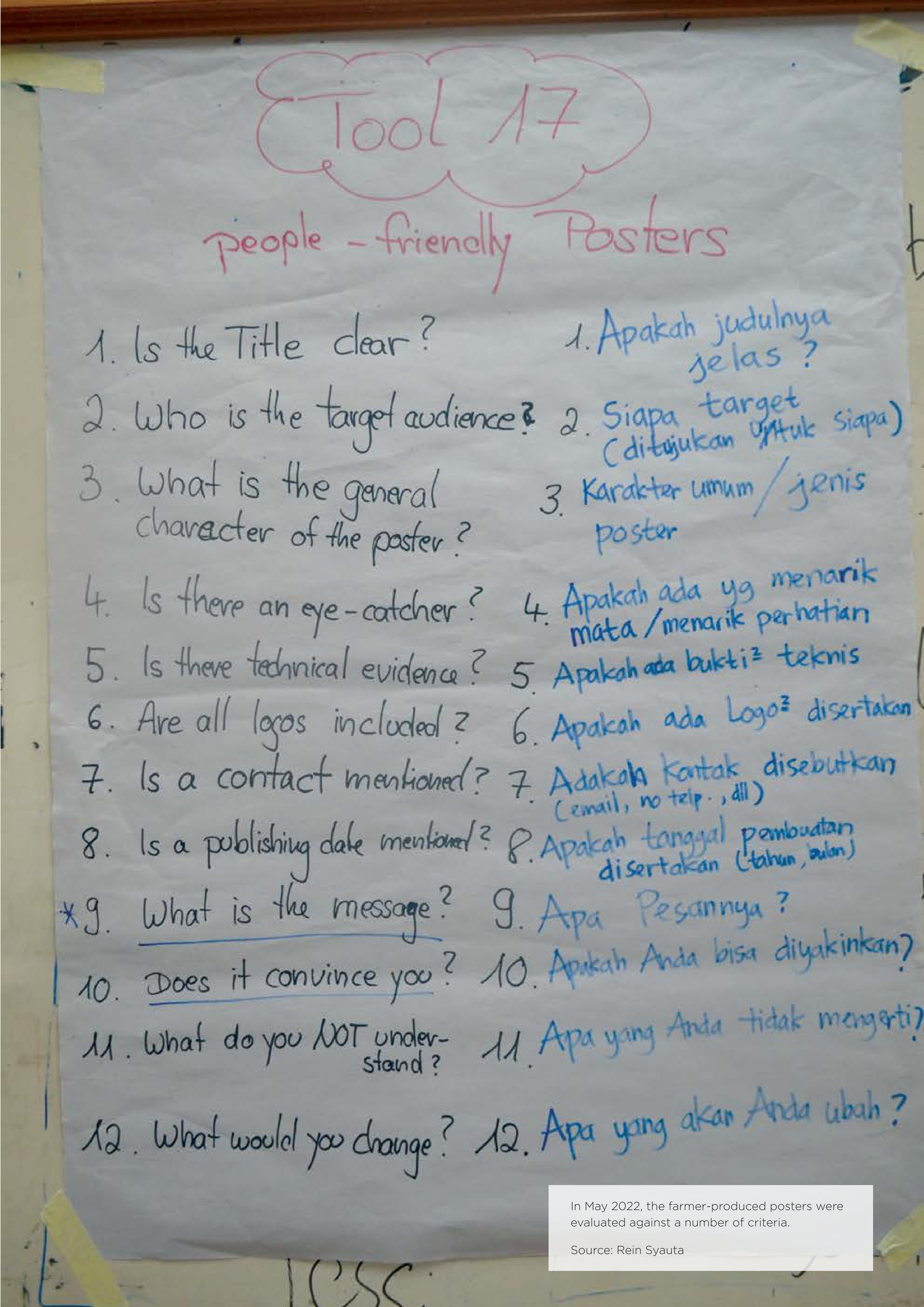
Posters are very popular tools for communications. Relatively cheap to produce and free to display, they offer a wide range of possibilities for disseminating information in a way that is appropriate to the respective audience, be it information for farmers, decision makers, or consumers. Co-creating communications on agroecology with farmers involves participatory processes, ranging from jointly formulating the key topics and messages to validating the poster with both academic experts and farmers or other target groups.

120 minutes

Objective	To create and validate key messages in the form of posters with your target audience
Resources	✔ Pictures ✔ Graphic design expert ✔ Technical results from field research
Participants	Research farmers and NGO and extension staff
General considerations	✔ Posters are good for community signboards, schools, and, when printed as A4 sheets, they can also be used by research farmers to hand over to visitors during farmer-to-farmer demonstrations and field days. ✔ Complex messages should be put into a technical leaflet.

Steps

1. Decide on a general poster topic.
2. Discuss the target audience and the general character of the poster (promotion and raising awareness of a technology, technical information guidance, step-by-step training, advocacy, field day, conference, etc.)
3. Brainstorm with the group a clear poster title to convey the key advantages of the technology, e.g. Healthy soil, healthy plant, healthy people.
4. Select a good "eye catcher" to express your core message (this could be an excellent picture)
5. Provide essential supplementary information required to explain the technology or the process
6. For technical evidence, you may need to include a footnote with sources at the bottom of the poster (small fonts)
7. Have a logo corner or logo bottom line which lists all partners and supporters (e.g. NGO, farmer group, government body, university funding agency)
8. Put a contact address, and/or webpage, barcode, email, telephone number
9. Indicate the month and year or year of publishing
10. Test and validate the poster with a target audience. Asking questions will help verify that the poster adequately captures your intended message. For example, you could ask: What message does the poster convey? Does it convince you ? What do you not understand? What would you like to see changed?
11. Review, print, and share as A4, A3, As, A1, or A0 sized posters on laminated or varnished strong paper, plastic, or fabric depending on where it will be hung, how long it should last, and your budget.



In May 2022, the farmer-produced posters were evaluated against a number of criteria.

Source: Rein Syauta

Tool 17: Stop burning straw poster

Figure 22 Poster Stop burning straw

Tool 18

Elevator demonstration (Farmers go to campus)

Academics and students are often invited to conferences and exchange forums to present their research. Entrepreneurs show their innovative strength at trade fairs. Smallholder farmers, on the other hand, rarely have the opportunity to present their local wisdom and demonstrate their innovative capacity apart from farmer fairs. For mutual appreciation of knowledge systems, the instrument "Elevator demonstrations" has been created. The name was chosen in reference to the "Elevator talks" used in the academic milieu. It can be also called, "Farmers go to campus".

Objective	✔ To link farmer wisdom to scientific knowledge ✔ To provide opportunities for research farmers to present their technologies to academics and the public
Resources	Research farmers, students, university staff, lecturers, other interested farmers
Participants	Research farmers and NGO and extension staff
Time	60 minutes if 15 farmers present. Each farmer has 3 minutes to give their elevator demonstration and one minute for wrap up before going to the next demonstrator. After farmers give their elevator demonstrations, give 30-45 minutes for individual informal discussions in a free exhibition time.

General considerations

- Prepare farmers by doing an elevator demonstration rehearsal. Support their production of posters or leaflets and organize the transport of miniature models, local materials, etc.
- Choose a shady outdoor space where farmers can present their innovations.
- Give the elevator demonstration a prominent place during the academic seminar. Do not run this as an optional or "side event" before or after an academic seminar. Provide a 90-minutes slot before or after lunch.
- Allow farmers to participate in the academic seminar and encourage them to join the discussion.

Steps

1. Invite students, scientists, and farmers to participate in the demonstration/exhibition.
2. Open the demonstration and present the idea of the elevator demonstration. The facilitator invites each research farmer to give the demonstration/speech.
3. Keep the time so each presenter has four minutes. After three minutes, indicate there is one minute left to wrap up.
4. Ask participants of the seminar (e.g. students) to share the most interesting demonstration or take home messages on social media.
5. Invite a representative from the university to honour the demonstration and summarise the TOP TEN lessons learned from farmers.

Practical tip

Select research farmers in such a way that different agroecological technologies or field practices are shown. Give attention to selecting participants of different genders and from different regions.

JAMTANI research farmers demonstrate different organic soil fertility strategies to the Dean of the Faculty of Agriculture at UNPAD (23 October 2018).

Source: Silke Stöber

Concluding remarks Climate Field Labs

The climate crisis is real. It affects many sectors, today we particularly discussed how smallholder farmers need to break out their routine work in order to adapt to climate change. Co-research is a powerful approach to increase adaptive capacities. Research farmers are farmers who design new things, i.e. a) they innovate, b) they do new things (= they take action), and c) they benefit from new things (they create impact). The impact should not only be on-farm, but also off-farm, in the fields of post-harvest management, home industries, and marketing. Farmers who engage in the climate adaptation and agroecology co-research process gain agency, contribute to innovations that can be widely shared, gain independence and increase their adaptive capacity. In order to take part in this innovation cycle farmers should not work alone. They need to cooperate with the penta-helix multi-stakeholder network from: government; academia; media; civil society; and business.

Climate Field Labs are a powerful tool to merge farmers' knowledge with academic knowledge. Meeting regularly in a season to observe growth, productivity parameters, and other criteria as defined by academia and research farmers has strong capacity-building effects and increases adaptive capacities. The labs offer a platform for sharing locally collected climate and agricultural data that can be validated scientifically. All the tools described in this manual have been tried and tested in at least one, or both, project locations. Tools have been validated through dialogues with farmers, with JAMTANI or MPM staff, and with involved scientists from UNHAS and UNPAD. The process of implementing Climate Field Labs differed between both locations, between villages, and between the specific agricultural produce: chilli and rice. If you want to replicate such labs, you definitely need to adapt them to your local conditions.

However, some standards have proven themselves overall. An adequate group size seems to be 10 to 12 farmers. Some groups started with more farmers, which is quite desirable, but they usually had many dropouts. When groups started with less than 10 farmers, it was difficult to manage and maintain the demo plot.

Research farmers are able to create a work schedule and divide tasks and labour; however, they need some guidance on this. If agroecological adaptation efforts are supported by the scientific community with too much delay, research farmers should not despair but feel encouraged to seek their own alternatives and solutions. Meeting regularly for communally producing soil ameliorants, compost, and biopesticides as well as for maintaining their plot is key to success.

Technical challenges in chilli plantations can be greatly reduced by improved planting and crop maintenance techniques. By doing this, chilli yields increased considerably after two seasons. The process of the chilli climate field schools was rated as rather successful. Farmers' knowledge of planting and marketing chilli has much improved. However, challenges with pests and diseases management persist. Here, further support is required. In general, research farmers still lack written materials to support decision making and farming practices. Standard operation procedures on how to take soil samples and how to measure yields and plant height were provided for chilli, but are still lacking for rice.

In Java, the exposure to climate change is rather high. Combined with very low soil health, rice farming becomes very difficult and can be financially unrewarding for farmers. Testing stress-tolerant varieties is only part of the solution. Apart from planting stress-tolerant varieties and practising sustainable soil management, more rigorous adaptation measures are required. For example, infrastructure is needed to control the impacts of extreme droughts, floods. Soil ameliorants to successfully deal with salinisation, iron toxicity, and drought, are other innovations still to be tested. More investment is required if the region wants to continue to use the land for rice cultivation. In this regard, the envisaged cooperation with the local meteorological office is a promising step. Climate variables and their effect on soil and yield shall be closely monitored and discussed with local government offices.

Advanced research farmers have also criticised Climate Field Labs for their monotony. The learning effect of monitoring growth parameters was not high enough. Therefore, co-research in Climate Field Labs should perhaps be limited to two seasons. A closer connection between the Climate Field Labs and promising new innovations and expert knowledge would certainly be a solution. This cannot be done by a farmer organisation or NGO alone. Future close collaboration with universities is essential to analyse the effect of advanced technologies, such as the use of biochar, fermented azolla, green-blue algae, or seed priming.

"Petani peneliti kuat – petani organik sehat" (Research farmers are strong; organic farmers are healthy) is JAMTANI's slogan often recited at meetings. The slogan motivates smallholder farmers to continue to develop their farms and keeps the spirit of the co-research approach alive.

Source: Rein Syauta

Mr. Kustiwa Adinata, Director of JAMTANI, facilitates the research farmers' elevator demonstrations which took place as part of the Farmer Goes to Campus event on 24 May 2022 at UNPAD Bandung.

Source: Silke Stöber

5. Co-creation of knowledge products

Publishing together to share good practices and lessons learned is key for moving forward. For quality assurance and respecting intellectual property rights, the project team (farmers, NGO and scientists) understand each other as co-researchers. Joint publications are one output. A range of good practice notes, technical leaflets, fact sheets and manuals, videos, posters, and academic journals have been produced. All products that have been published between 2018 and 2021 are listed below. For further information please contact the lead author institution of the respective product.

Topic	Type of publication	Target group	Lead author/ more information
Azolla	Fact sheet (Bahasa)	Advocacy at national regional level	JAMTANI
Floating paddy	Fact sheet (Bahasa)	Advocacy at national regional level	JAMTANI
Climate resilient rice production	Fact sheet (Bahasa)	Advocacy at national regional level	JAMTANI
Climate Field School	Fact sheet (English and Bahasa)	Advocacy at (inter) national level	JAMTANI
How to make biopesticides	Fact sheet on local wisdom (Bahasa)	Smallholder Capacity Building	MPM
Organic chilli production	Good practice note (Bahasa and English)	Advocacy at national and regional level	SLE
Organic rice production and marketing	Good practice note (English)	Advocacy at national and regional level	SLE
Preferensi petani terhadap keragaan padi (Oryza sativa) unggul untuk lahan sawah di wilayah Pangandaran dan Cilacap	Indonesian Journal	Academic	UNPAD
Efektivitas Pelatihan Analisis Sederhana Kesehatan Tanah Sawah Melalui Metode Sekolah Lapang Petani	Indonesian Journal	Academic	UNPAD
Climate field schools to increase farmers' adaptive capacity to climate change in the southern coastline of Java	International Journal	Academic	UNPAD
Performance of local rice varieties under various organic soil fertility strategies in Toraja, Indonesia	International Journal	Academic	UNHAS
Empowering upland farmers to become more resilient towards climate change – experiences from Toraja, Indonesia	International Journal	Academic	UNHAS
Growth of Rice (Oryza sativa) Varieties: Mendawak, Inpari 34, Ciherang, and Bangir In Ciganjeng Village, Pangandaran District	International Journal	Academic	UNPAD
Selection of Five Rice Varieties (Oryza sativa) Under Salinity Stress in Climate Field Schools	International Journal	Academic	UNPAD
Improving the Climate Resilience of Rice Farming in Flood-Prone Areas through Azolla Biofertilizer and Saline-Tolerant Varieties	International Journal	Academic	UNPAD

Topic	Type of publication	Target group	Lead author/ more information
Growth and production of indigenous Katokkon chilies of Toraja (Capsicum chinense jacq) in various organic Tithonia compost compositions	International Journal	Academic	UNHAS
Climate Resilient Sustainable Agriculture for Restoring the Soil Health and Increasing Rice Productivity as Adaptation Strategy to Climate Change in Indonesia	International Journal	Academic	UNPAD
The potential of Climate Field Schools to boost small-scale farmers' adaptation capacity	International Journal	Academic	SLE
Nutritional Assessment of Indonesian Chilli Landraces (Capsicum chinense Jaqc.)	International Journal	Academic	SLE
Smallholder Farmers' Challenges of Coping with COVID-19 Containments: Insights from two food regions in Indonesia	International Journal	Academic	SLE
Performance of rice paddy varieties under various organic soil fertility strategies	International Journal	Academic	UNPAD
Is Green Manure (Azolla pinnata and Sesbania rostrata) a Climate-Resilient Strategy for Rice Farming?	International Journal	Academic	UNPAD
Sesbania rostrata	Poster	Advocacy at national and regional level	JAMTANI
Azolla	Poster	Smallholder Capacity Building	JAMTANI
Pests, diseases and natural enemies of rice plants	Poster	Smallholder Capacity Building	JAMTANI
Propagation of media for biological agents	Poster	Smallholder Capacity Building	JAMTANI
Stop burning straw	Poster	Advocacy at national and regional level	JAMTANI
Chilli production	Poster	Advocacy at national and regional level	MPM
Local rice varieties	Poster	Advocacy at national and regional level	MPM
Farmer-led research	Poster	Advocacy at national and regional level	JAMTANI
From farmer field schools to climate field labs	Poster (conference)	Academic	SLE
How to propagate and use azolla	Technical manual (Bahasa)	Smallholder Capacity Building	JAMTANI

Topic	Type of publication	Target group	Lead author/ more information
Farmer field school	Technical manual (Bahasa)	Smallholder Capacity Building	JAMTANI
Onion and System of rice intensification	Technical manual (Bahasa)	Smallholder Capacity Building	JAMTANI
Homegardens and home industry	Technical manual (Bahasa)	Smallholder Capacity Building	JAMTANI
Pests and diseases in rice fields	Technical manual (Bahasa)	Smallholder Capacity Building	JAMTANI
Farmer field school on soil ecology	Technical manual (Bahasa)	Smallholder Capacity Building	JAMTANI
Smallholder integration into rice value chains	Video (Bahasa and English)	Advocacy at (inter) national level	JAMTANI
Climate village concept	Video (Bahasa and English) https://en.penamasmotivator.org/kegiatan-lhp-criip	Advocacy at national level	MPM
Mendawak rice variety and climate field schools	Video (Bahasa and English) https://jamtani.or.id/public/berita/28/peningkatan-produksi-lahan-asin-dengan-varietas-mendawak	Advocacy at national level	JAMTANI
Farmers voices: Farmer field labs – Research farmers in practice	Video (English) https://www.youtube.com/watch?v=D-PXk7zwgmY	Advocacy at international level	SLE
Climate Field labs Indonesia	Video (simple show) (Bahasa and English) https://www.youtube.com/watch?v=s24-Q5Tq-Hk	Advocacy at (inter) national level	SLE
Smallholder farmers and their efforts to market their organic products in global and regional value chains	Video https://www.youtube.com/watch?v=ZelpEH9Liyw	Advocacy at (inter) national level	SLE
Climate village concept	Webinar Link https://www.youtube.com/watch?v=c-UgS5rdEpg	Advocacy at (inter) national level	MPM

Annexes

Annex 1: Factsheets

Factsheet 1: Rice cultivation as a driver of climate change

The non-CO_2 greenhouse gas emissions, methane (CH_4) and nitrous oxide (N_2O), have a much higher potential to drive global warming than CO_2. Rice cultivation is estimated to account for 6% of the total non-CO_2 emissions worldwide and therefore holds potential to reduce non-CO_2 emissions. Indonesia is one of the six major rice-producing countries in the world and is, therefore, a hot spot for mitigation actions and adaptation.

Methane and nitrous oxide from rice paddies

Through inundation of rice paddy fields, soil organic matter decomposes. This decomposition creates an anaerobic environment in the soil and water, causing methane emissions. Farmers typically raise their yields by applying synthetic fertilisers which influence the N_2O emissions from the soil. As demand for rice increases, more forests are converted to paddy, thus reducing the land under forest and other carbon sinks.

Mitigation practices

Soil and water management and flooding practices in rice production can mitigate the impacts of climate change. The System of Rice Intensification (SRI) is one widely promoted methane-abatement technology. As it features intermittent flooding and drying of fields, it breaks the anaerobic conditions in the paddy and, therefore, less methane is released. However, the benefits of lower methane production through limiting flooding may be offset by nitrous oxide emissions created in the dry, aerobic period. Crop residue incorporation has a high potential to abate this, as many farmers still burn their rice straw after harvest. Furthermore, no-tillage, direct seeding, low-emitting varieties, and integrated fertiliser application (use of organic fertiliser to build up soil organic matter) can reduce emissions. In the CRAIIP project, the partners concentrate on organic farming to demonstrate yield potentials and soil fertility improvements through the use of green manure, compost, and micro-organisms.

More information can be found on SRI-Rice ONLINE, which is maintained by the SRI International Network and Resources Center (SRI-Rice) at Cornell University http://sri.ciifad.cornell.edu/ and SRI articles, e.g. Hasanah et al. (2017).

Factsheet 2: Impact of climate change on rice production

- Increased temperatures are a source of sterility. Tillers, for example, develop well between 25 and 31°C. Temperatures higher than 33°C reduce tillering (Pandey et al., 2010).
- Extreme temperatures (>35°C) for only a few hours during flowering can cause complete spikelet sterility and reduced grain filling while ripening (Laborte et al., 2012).
- Increasing nighttime temperatures pose a risk for the rice plant during flowering phase. A 1°C nighttime temperature rise in the dry growing season leads to a rice yield decline by 10% (Peng et al., 2004).
- Drought has damaging effects on rice plants. Stomata closure due to water stress or spikelet sterility due to low air moisture content and increasing air temperatures are some of the causes. Water-saving rice production systems such as alternate wetting and drying in SRI should operate safely. For example, until one week after transplanting, the seedling needs to be 80% covered with water (Korres et al., 2016).
- In coastal areas, sea level rise causes flooding and increases soil salinity. This damages crops throughout their growth cycle. Salinity increases the transpiration demands, which accumulates the salt content (Pandey et al., 2010).
- Salinity also affects soil microbial activity and soil fertility, through reduced N mineralization and enzyme activity (Wichern et al., 2020).
- Rice fields flooded by excess rainfall can result in long-lasting submergence of the rice canopy. A rice field flooded for two weeks would damage almost the entire harvest.
- High rainfall with strong winds provides conditions for bacteria to multiply and enter the leaf, e.g. bacterial leaf blight (*Xanthomonas oryzae pv. oryzae*). The lesions expand and turn yellowish and the leaf dries up. Bacterial leaf blight is one of the most serious rice diseases with yield losses as high as 70%.
- Late planting, frequent showers, overcast skies, and warm weather promote the development of blast (*Magnaporthe grisea*). Blast can cause serious losses.

More practical information on rice production can be found in the Rice Knowledge Bank (RKB) of the International Rice Research Institute (IRRI). It is a digital information service that provides solutions, particularly for small-scale farmers: http://www.knowledgebank.irri.org.

Factsheet 3: Impact of climate change on chilli pepper production

Extremely high temperatures, drought, and heavy rains are major constraints for chilli growth and production (Lee et al., 2018).

- High temperatures (>30°C) can negatively affect seed germination. Seeds germinate best at 25–30°C. Optimal growth temperatures are between 18 and 30°C.
- When daytime temperatures are above 34°C or night temperatures are below 21°C for an extended period of time, more flower buds drop and less fruits will develop (Erickson & Markhart, 2002).
- High temperatures lead to rapid plant maturation which reduces the yield. The fruit set also decreases when the plants are exposed to high temperatures.
- The quality and quantity of pollen is influenced by high temperatures. Empty grains and/or clumped and small pollen can be the result. Chilli plants that are pollinated with such pollen tend to carry malformed or seedless fruits (Lee et al., 2018).
- An increase in temperature to 35°C leads to earlier flowering (of 6 days) and a delay in fruiting by around 27 days (Garruña-Hernández et al., 2012).
- High precipitation or over irrigation can result in lower yields because the moist soil causes less root development, more diseases, and nutrient leaching (Akinbile & Yusoff, 2011).

More information on chilli and many other crops and their agronomic requirements can be found on Infonet, a channel of the Biovision Farmer Communication Programme (FCP). It gives farmers, trainers, students, and extension workers quick access to up-to-date agricultural information and related topics: https://infonet-biovision.org/PlantHealth/Crops/Peppers.

Chilli is an indispensable part of Indonesian cuisine. A meal without chilli is simply not delicious. Climate extremes repeatedly cause productivity and harvest losses. As aconsequence price spikes of chilli are often observed. Further research is needed to develop adapted chilli varieties and climate-resilient cultivation systems.

Source: Silke Stöber

Annex 2: Glossary on-farm trials (academic language)

Term	Description
Data	Information that you collect in an experiment is called data. The data can have two different natures: a) quantitative (numerical, e.g., number of productive rice tillers) or b) qualitative (evaluative, based on judgements, e.g., excellent, good, fair, poor taste of rice variety).
Treatment	A treatment is a practice that you want to investigate. An on-farm experiment often compares one or more new practices with what the farmers presently do. The latter is called control or farmer practice. For example, in the experiment you may want to compare: a) the yield from a common variety of rice with the yield of a new stress-tolerant variety; b) soil health or yield with azolla-enriched compost and farmer-style compost; or 3) the yield of chilli peppers with or without liquid fertiliser.
Factor	In more complex trials, you would compare treatments that have two factors, also called sub-treatments, e.g. the growth of different rice varieties (factor 1) is tested for different green manure treatments (factor 2).
Block	A block is the basic unit of an experiment. A block contains two (or more) different treatments in a side-by-side comparison. There are differences between complete block or split-block design. In a split-block design, two factors are used, of which the complicated factor that needs more land is the whole-block factor, e.g. irrigation practice or soil fertility practice, and the other easy to split factor, e.g. variety, the sub-block factor.
Plot	A plot is an area of specific size in which the treatment is applied. The project's rice variety plots are 5 m long and 40 cm wide. For chilli peppers, each treatment consist of 5 plants covering an area of 40 cm x 2 m.
Buffer row	In order to protect the treatments from the impact of neighbouring treatments, buffer rows or specific separation materials can be used. In the paddy fields, between the green manure treatments, a ditch was constructed 50 cm high in order to avoid water mixture of the different sub-treatments.
Replication	Each treatment is replicated multiple times on several plots. By replication, you are more likely to obtain robust results. Replications can be done in the same demonstration field or under similar conditions in other farmers' fields (inter-farm comparisons) or even in other villages (inter-village comparisons). Replications can be also done in time, when you repeat the same treatment in two or more seasons.
Randomisation	If all treatments and replications are included in one demonstration plot, the location of different treatments and replications are chosen by chance, such as by the lucky draw.

	In addition to replication, randomization is also important for addressing the problem of field variability, reducing experimental error, and determining the true effect of the treatments you are comparing. Replications should be arranged randomly within the field. Or, in the case of a blocked experimental design, treatment plots must be arranged randomly within each block. If you have three treatments, for example, you cannot place those treatments in the same left-to-right sequence within each block. They must be arranged in a random order. This can be done using the flip of a coin, drawing numbers from a hat, or using a random number generator for each block.
Screening trial	When practices are not replicated in multiple plots but only at one plot at the same time, it is called a screening trial. When you want to compare a larger number of varieties in an exploratory way, a screening trial would also suffice. Farmers can make simple observation about whether varieties are promising for markets, climate, and management practices. You can also use the screening to assess whether a variety would be suitable for a replicated trial.
Mean	The mean is the average value in a data set. The mean is the sum of all measured data points, which is divided by the number of data points. If you have three data points of 23 cm, 24 cm, and 28 cm, you would sum up 23+24+28 and divide it by 3, which gives a mean of 25 cm.
Variance	The variance in a observation data collection describes the extent to which the high and low values differ from the mean value.
Standard deviation	The standard deviation is the square root of the variance and is more easy to understand than the variance. If the mean number of productive tillers per rice plant is 10 and the standard deviation is 2 productive tillers, the data is clustered more closely around the mean compared to a standard deviation of 4 productive tillers.
Variation Coefficient	The variation coefficient is the ratio (in percent) of the standard deviation to the mean. The higher the coefficient of variation, the greater the level of spreading around the mean. It allows us to compare the variation of results from different samples, e.g. two varieties.

Research farmers and scientists from UNPAD and UNHAS conduct randomised mutifactorial field trials in rice and chilli in several villages of Java and Toraja, Sulawesi, here a rice demonstration plot in BatuSura village in October 2019.

Source: Bert Broekhuis

Annex 3: Glossary on-farm trials (farmer language) and trial sheet

For distribution and/or display in a climate field school meeting

Glossary on-farm trials (farmer language)

Definition	Term
The question you want to have answered by the experiment is the	Research question
The area where you do the different tests is the	Plot
The area where you arrange the tests in the field physically is called	Block
Which factors do you need to combine to build your test area?	Treatment
The issues you wish to test exactly are called	Factor
What kind of information do you need to collect to compare the results of the experiment?	Data, test criteria
What is my reference for evaluation the information from the test?	Control field, farmer practice
How do you make sure that the results of one block are not incidentally?	Randomisation and replication

On-farm trial sheet

Block	First replication	Plot 1		
		Plot 2		
Block	Second replication	Plot 3		
		Plot 4		
Block	Third replication	Plot 5		
		Plot 6		

Annex 4: Standard operational procedures for chilli

Stages	Time
Preparing the land Clear the land of weeds and other green wastes, conduct minimum soil tillage, and form planting beds for the trial plots. The beds should be 5 m x 1 m and 30 cm high. There should be 30 cm between beds.	Week 1
Sowing and transplanting seeds Soak seeds in warm water (around 50°C) mixed with shallot extract for 12 hours. Prepare the growing media from a mixture of soil and buffalo manure mixed with ashes at a ratio of 1:1. The seed nursery should be in a shady area and needs regular watering to keep it moist. After 5 weeks (or when the seedlings have 7-8 leaves), select healthy and strong seedlings for transplanting.	Weeks 1 to 6
Applying compost Tithonia compost should be applied to the plant beds 2 weeks before transplanting to allow the compost and soil to mix and decompose properly before seedlings are transplanted into it. The compost should be applied in each planting line at a rate of 20 kg / bed.	Week 4
Mulching Mulching is done after compost application. In a Climate Field Lab natural mulches are supported. However, due to the high occurrence of pests, the local university recommended the use of reflective silver black plastic mulch that deters pests, and which was provided by MPM. The installation of silver black plastic mulch should be done on a sunny day, so the plastic mulch can be stretched and attached perfectly. After installation, the plastic is punctured for planting holes with a spacing of 60 x 60 cm.	Week 4
Planting Seedlings (5 weeks old, 7-8 leaves) are ready for planting in the field. Planting is done in the morning. Water is provided immediately, as water is essential for plants during their growth.	Week 6

Caring for plants Intensive **watering** is necessary after planting, in the morning or in the evening. After flowering, watering can be done every two days, adjusted to environmental conditions. Water is only added to the punched out planting holes until the soil is soaked. There are two types of **pruning**: shoot and bud pruning. Shoot topping is done 28 days after planting. It aims at encouraging the plant to produce a lot of branches, as the shoots are trimmed off. Once a branch is well formed, prune buds twice: once between 15 and 30 days after planting. Without bud pruning, chilli grows more slowly. **Pest and disease control** is carried out using plant-based biopesticides that do not leave harmful residues and are environmentally friendly. Sprayed in the morning or evening twice a week, or as necessary. Apart from that, insect traps can be installed to control for fruit flies, aphids, and white flies. Yellow traps can be installed at 100 cm height and modified Steiner traps petrogenol protect against fruit fly. The petrogenol needs to be replaced every month. **Liquid organic fertilisers** should be applied twice a week in the morning or evening. To make liquid organic fertilizer, mix 1 liter of organic fertiliser with 5 liters of water and watering it into the root zone near the plant to avoid direct contact with the plant stems.	Weeks 6 to 20
Harvesting A solid fruit of red color indicates ripeness. Harvesting is done by picking fruits with their stems in order to keep the *Katokkon* chilli fresh for longer. Harvest in the morning when the fruit's weight is in an optimal condition due to accumulation of nutrients and other substances at night with less evaporation. Harvesting can be done over four to six months, usually one to two times per week.	Weeks 20 to 28

Ms. Dorkas, one of the research farmers in To'pao village, tried a lot of things before they could successfully grow the local chill variety. Developing standard operational procedures was crucial for them to keep pests and diseases away from their chilli plants. By now they are well known in the region for their good quality chilli.

Source: Rein Syauta

Annex 5: Observation sheets for selected parameters

During the climate field labs, certain parameters were observed and recorded once a week according to a standardised protocol. Two example sheets, one for chilli, one for rice, are presented here.

Chilli

Observation sheet Chilli																								
Village: TO'PAO																								
PARAMETER: Height (in cm)																								
NO.	Variety	Treat-ment	Observa-tion date	Plant sample 1. repetition							Plant sample 2. repetition							Plant sample 3. repetition						
				1	2	3	4	5	6	Ø	1	2	3	4	5	6	Ø	1	2	3	4	5	6	Ø
		P1																						
		P1																						
		P1																						
		P1																						
		P1																						
		P2																						
		P2																						
		P2																						
		P2																						
		P2																						
		P3																						
		P3																						
		P3																						
		P3																						
		P3																						

Observation sheet Chilli																								
Village: TO'PAO																								
PARAMETER: Height (in cm)																								
NO.	Variety	Treat-ment	Observa-tion date	Plant sample 1. repetition							Plant sample 2. repetition							Plant sample 3. repetition						
				1	2	3	4	5	6	Ø	1	2	3	4	5	6	Ø	1	2	3	4	5	6	Ø
		P1																						
		P1																						
		P1																						
		P1																						
		P1																						
		P2																						
		P2																						
		P2																						
		P2																						
		P2																						
		P3																						
		P3																						
		P3																						
		P3																						
		P3																						

Rice

Village	Ciganjeng	Observation date:	03.01.2018, 57 days after planting		
Treatment	Po. farmer style compost	Repetition	1st		
Variety Mendawak					
Sample	Height (in cm)	Number of tillers	Pests	Diseases	Natural enemies
1	69	35			
2	71	26	1 rat attack		
3	77	29		virus: dwarf growth/leaf roll	
4	66	28			
5	70	32			
Sum	353	150			
Average	70,6	30			
Variety Bangir					
Sample	Height (in cm)	Number of tillers	Pests	Diseases	Natural enemies
1	78	23			
2	85	23			
3	76	22			
4	74	24	1 rat attack		
5	79	34			
Sum	392	126			
Average	78,4	25,5			
Variety Ciherang					
Sample	Height (in cm)	Number of tillers	Pests	Diseases	Natural enemies
1	72	26			
2	75	23			2 coccinella
3	77	22	1 rat attack		
4	72	25			
5	72	24			
Sum	368	120			
Average	73,6	24			
Variety Ciherang					
Sample	Height (in cm)	Number of tillers	Pests	Diseases	Natural enemies
1	78	23			
2	85	23			
3	76	22			
4	74	24	1 rat attack		
5	79	34			
Sum	392	126			
Average	78,4	25,2			

Summary sheet of weekly observation in climate field school

Day and date:
Research site/location:
Environmental conditions: Temperature: Soil condition: Humidity: Soil pH: Weather: Weed prevalence:
Activity description:
Results: Height (in cm) Number of tillers: The tallest variety: Most tillers: The biggest increase: The largest growth:
Evaluation of results:

Research Farmer 1:	Research Farmer 2:
....	....

Summary sheet of weekly observation in climate field school in Java

Summary sheet of weekly observation in climate field school in Java

Day and date: Wednesday, 3-1-2018

Activities: Agro eco system observation

Research site/location: Village Ciganjeng, Padaherang, Pangandaran

Environmental conditions:

Temperature: max. 44°C ; min. 31.4°C

Soil condition: non-flooded, intermittent

Humidity: max. 59 % ; min. 23 %

Soil pH: 5.93

Weather: bright sunlight

Weed prevalence: 30 %

Activity description:

1. Agro eco system observation, plant height and tillering
2. Calculation of percentages, sums and averages
3. Testing of soil health parameters.

Results:

Height (in cm)

Varieties	this week	last week	change
1. Mendawak	73.4	69	4.4
2. Bangir	82.4	81.4	1.0
3. Ciherang	77.1	73.4	3.7
4. Inpari 34	89.6	83.4	6.2

The tallest variety: Inpari 34: 89.6

The biggest increase: Inpari 34: 6.2

Number of Tillers

Varieties	this week	last week	change
1. Mendawak	33.9	38.1	4.2
2. Bangir	27.2	29.8	2.6
3. Ciherang	25.3	28.3	3
4. Inpari 34	29.4	34.8	5.4

Most tillers: Mendawak 33.9

The largest growth: Bangir 2.6

Evaluation of results:

1. Weeds: P0: 30% – P1: 30% – P2: 20% – P3: 10% – P4: 65% ; average: 31%
2. Rat attack: P0: 15 stems – P1: 0 – P2: 1 stem – P3: 0 – P4: 4 stems.
3. Rice seed bugs:
4. Tillering rate reduced.

Next steps:

1. Weeding & embankment weeding on 4-1-2018
2. Use biological pest control (urine of humans + sheep) against rats, and yellow trap against rice seed bug.
3. Use bio fertilizer (Azolla + rabbit urine + banana peel, 3 l./tank / per treatment plot with hand sprayer.

Research Farmer 1:	Research Farmer 2:
[illegible]	[illegible]

Annex 6: Climate diary learning journal

A photocopiable resource for Tool 6:

Year:	Week Ending date	Sunday			
Rainfall (Number of Days)	Heavy				
	Light				
	Dry				
Daytime Temperature (Number of Days)	Hot				
	Normal				
	Cool				
Night-time Temperature (Number of Nights)	Warm				
	Normal				
	Cold				

Monthly Report on farming
Observations on my field: 1st week: 2nd week: 3rd week: 4th week:
Activities /Steps Taken:
Plans for Next Month:

Annex 7: Good agroecological practices

Azolla

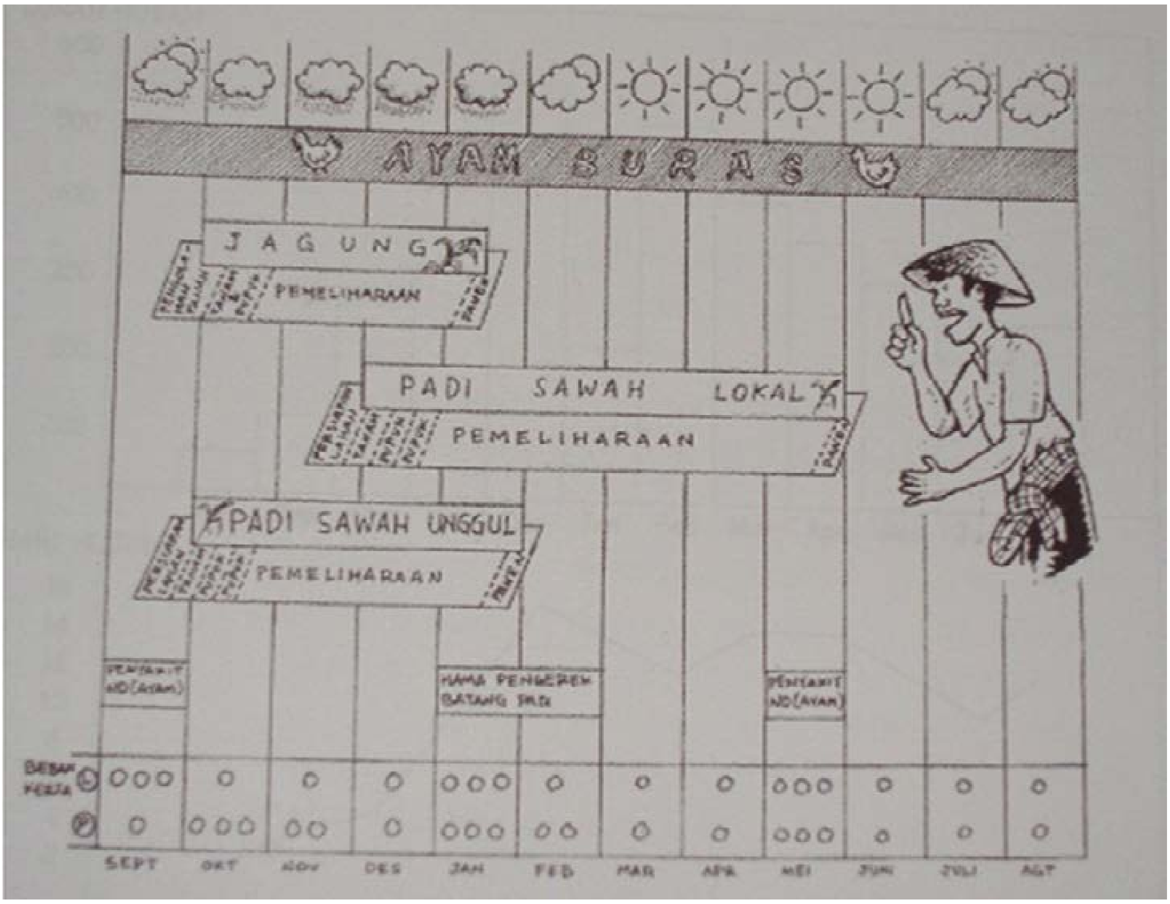
Biochar production

Mixed cropping

Shade nets

Agroforestry

Cropping calendar



Farmer field school

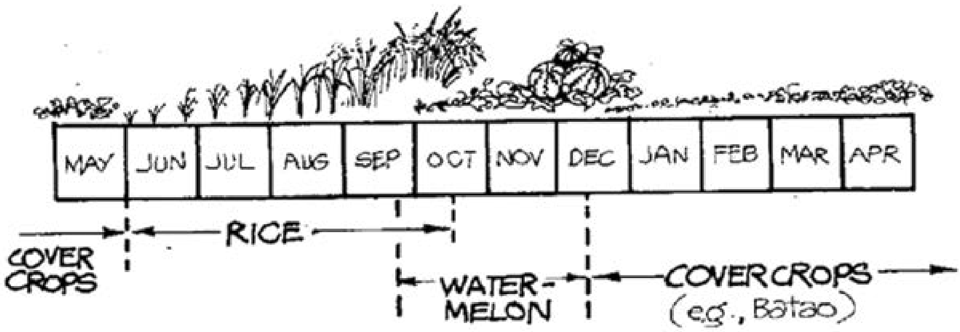
Biological pest and disease control

Stress tolerant crop variety

Barrier plants (insect control)

Compost

Crop rotation



Direct marketing

Floating fields

Home industry

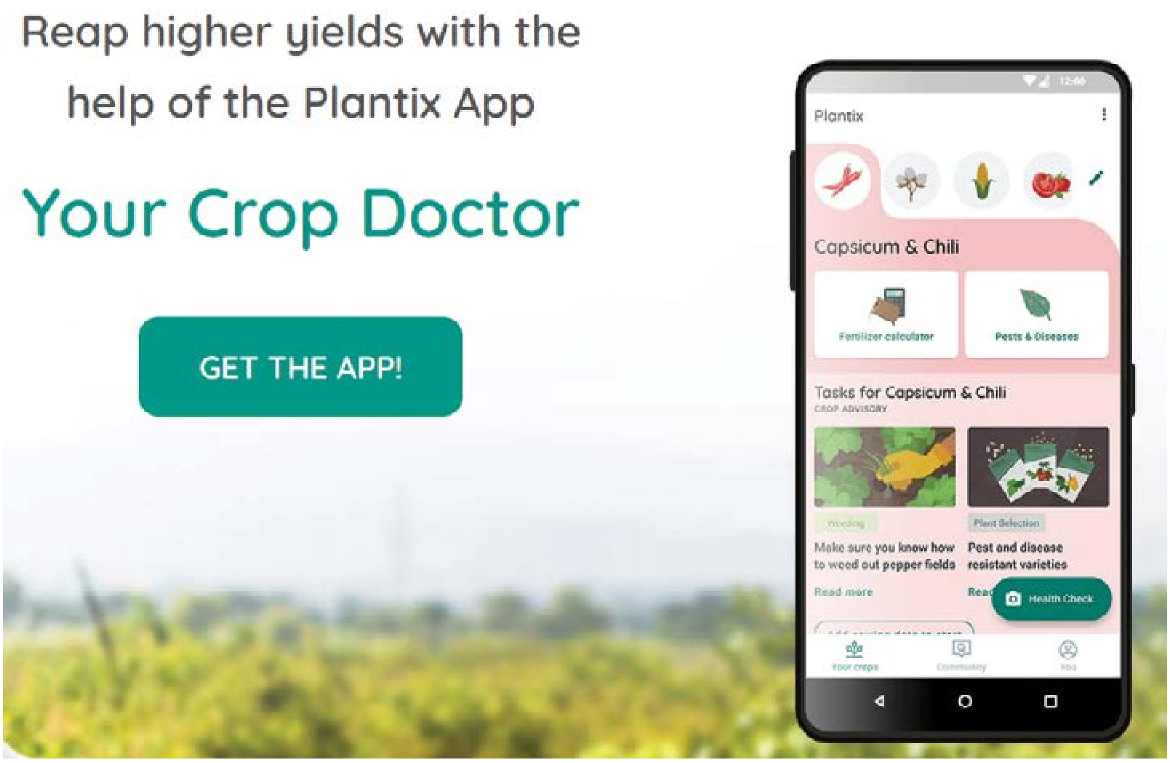
Symbiotic techniques

Organic farming

Mulching

Integrated rice duck fish azolla compost farming

Apps / books to control pests and diseases



Vermicompost

Annex 8: Bibliography

Akinbile, C.O. & Yusoff, M.S. (2011). Growth, Yield and Water use Pattern of Chilli Pepper under Different Irrigation Scheduling and Management. *Asian Journal of Agricultural Research,* 5 (2): 154-163.

Ardiansyah, M., Rafiuddin, A., Jadmiko, S. D., & Boer, R. (2017). Assessment of the impact of climate change and land cover change on landslide in Tana Toraja district. *IOP Conference Series: Earth and Environmental Science, 149.*

Chepkoech, W., Mungai, N. W., Stöber, S., Bett, H. K., & Lotze-Campen, H. (2018). Farmers' perspectives Impact of climate change on African indigenous vegetable production in Kenya. *International Journal of Climate Change Strategies and Management, 10*(4), 551-579.

Colls, A., Ash, N., & Ikkala, N. (2009). *Ecosystem-based Adaptation: a natural response to climate change.* IUCN.

Davis, K., Bohn, A., Franzel, S., Blum, M., Rieckmann, U., Raj, S., Ernst, N. (2018). *What Works in Rural Advisory Services? - Global Good Practice Notes.* Lausanne, Switzerland: GFRAS.

Erickson, A.N. & Markhart, A.H. (2002). Flower developmental stage and organ sensitivity of bell pepper (Capsicum annuum L.) to elevated temperature. *Plant, Cell and Environment 25*(1): 123-130.

FAO. (1997). Climatic impacts of warm El Nino events (April-September) [infographic]. FAO Factfile. http://www.fao.org/english/newsroom/factfile/FF9717-E.HTM

Frison, E., Jeremy, C., & Hodgkin, T. (2011). Agricultural Biodiversity Is Essential for a Sustainable Improvement in Food and Nutrition Security. *Sustainability*. 3. 10.3390/su3010238.

Garruña-Hernández, R., Orellana, R., Larque-Saavedra, A., & Canto, A. (2014). Understanding the Physiological Responses of a Tropical Crop (Capsicum chinense Jacq.) at High Temperature. *PLOS ONE 9*(11): e111402.

Habtezion, S. (2016). *Gender and Climate Change. Overview of linkages between gender and climate change*, United Nations Development Programme, UNDP.

Hasanah, N.A.I., Setiawan, B.I., Mizoguchi, M., Sands, G.R., Arif, C., & Widodo, S. (2017). Triangle graphs development for estimating methane and nitrous oxide gases emission from the system of rice intensification (SRI). *Journal of Environmental Science and Technology, 10*(4), 206-214.

HLPE. (2019). *Agroecological and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition.* Rome, Italy.

Hollburg, M., & Stöber, S. (2021). The potential of Climate Field Schools to boost small-scale farmers'adaptation. *IOP Conf. Ser.: Earth Environ. Sci.* 748 012032.

IPCC (Intergovernmental Panel on Climate Change). (2014). Asia. In: Climate *Change 2014 – Impacts, Adaptation and Vulnerability: Part B: Regional Aspects: Working Group II Contribution to the IPCC Fifth Assessment Report* (pp. 1327-1370). Cambridge University Press. doi:10.1017/CBO9781107415386.004

IPCC (Intergovernmental Panel on Climate Change). (2019). H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, E. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.): technical Summary. In: *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate* [H.- O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.

Javadi, T., & Han, D. (2015). *Clearing the Diplomatic Haze: Indonesia's Tense Ties with Singapore and Malaysia.*

Kaimuddin & Ulfa, F & Stöber, Silke & Ramba, T & Iswoyo, Hari & Dermawan, Rahmansyah & Sjam, S & Yassi, A & Fatmawati. (2021). Growth and production of indigenous Katokkon chilies of Toraja (Capsicum chinense jacq) in various organic Tithonia compost compositions. *IOP Conference Series: Earth and Environmental Science.* 870. 012045. 10.1088/1755-1315/870/1/012045.

Korres, N., Norsworthy, J.K., Burgos, N., & Oosterhuis, D. (2016). Temperature and drought impacts on rice production: An agronomic perspective regarding short- and long-term adaptation measures. Water Resources and Rural Development. 9. 10.1016/j.wrr.2016.10.001.

Laborte, A., Nelson, A., Jagadish, K., Aunario, J., Sparks, A., Ye, C., & Redoña, E. (2012). Rice feels the heat. Rice Today. 11. 30-31.

Magnan, A. (2014). Avoiding maladaptation to climate change: towards guiding principles, S.A.P.I.EN.S [Online], 7.1, 2014. URL : http://journals.openedition.org/sapiens/1680

Margono, B.A., Potapov, P.V., Turubanova, S., Stolle, F., & Hansen, M.C. (2014). Primary forest cover loss in Indonesia over 2000–2012. *Nature Climate Change* (4) 730–735. https://doi.org/10.1038/nclimate2277

Ministry of Agriculture Indonesia. (2013). *Foundation Module Climate Field Schools.* Directorate of Crop Production, Jakarta.

Ministry of Foreign Affairs of the Netherlands. (2018). *Climate Change Profile: Indonesia.*

Olhoff, A., Puig, D., Bee, S., Dickson, B., & Alverson, K. (Eds.) (2016). *The Adaptation Finance Gap Report.* United Nations Environment Programme.

Pandey, S., Byerlee, D., Dawe, D., Dobermann, A., Mohanty, S., Rozelle, S. and Hardy, B. (editors). (2010). Rice in the global economy: strategic research and policy issues for food security. Los Baños (Philippines): International Rice Research Institute. 477 p.

Peng, S., Huang, J., Sheehy, J. E., Laza, R. C., Visperas, R. M., Zhong, X., Centeno, G. S., & Cassman, K. G. (2004). Rice yields decline with higher night temperatures from global warming, in: *PNAS,* 101 (27) 9971-9975.

Prayoga, MK, Rostini. N, Setiawati, MR, Simarmata, T, Stoeber, S, Adinata, K (2018). Preferensi petani terhadap keragaan padi (Oryza sativa) unggul untuklahan sawah di wilayah Pangandaran dan Cilacap, in: *Jurnal Kultivasi* Vol. 17 (1) Maret 2018.

Prayoga, MK, Rostini. N, Setiawati, MR, Simarmata, T, Stoeber, S, Adinata, K (2018). Growth of rice (Oryza sativa) varieties: Mendawak, Inpari 34, Ciherang, and Bangir in Ciganjeng village, Pangandaran district. Jurnal Biodjati, 3 (2) 126-131.

Republic of Indonesia. (2013). *National Action Plan for Climate Change Adaptation (RAN-API) Synthesis Report.* https://zerosugar.files.wordpress.com/2014/08/ran-api_synthesis_report_2013.pdf

Republic of Indonesia. (2016). *First Nationally Determined Contribution. Contribution: Republic of Indonesia.*

Ritchie, H. & Roser, M. (2017). “CO_2 and Greenhouse Gas Emissions”. Published online at OurWorldInData.org. Retrieved from: ‘https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions’ [Online Resource]

Salahuddin, M. (2014). Challenges for the UNFCCC in Indonesia’s Decentralisation. *Indonesia Law Review, 4*(1).

Lee, SG, Kim, SK, Lee, HJ, Lee, HS, Lee, JH (2018). Impact of moderate and extreme climate change scenarios on growth, morphological features, photosynthesis, and fruit production of hot pepper. *Ecol Evol.* 2018; 8: 197– 206. https://doi.org/10.1002/ece3.3647

Simarmata, T., Hersanti, Turmuktini, T., Fitriatin, B. N., & Setiawati, M. R. (2016). Sa. *Hayati Journal of Biosciences, 23*, 181-184.

Suryana, A. (2019). *Fertilizer Subsidies and Retail Price Policies to support Food and Nutrition Security in Indonesia*. Taipei, Taiwan.

UNEP/IUCN (United Nations Environment Programme and International Union for Conservation of Nature (2021). Nature-based solutions for climate change mitigation. Nairobi and Gland.

USAID (2012). Indonesia Climate Vulnerability Profile. United States Agency International Development.

Wichern, F., Islam, M. R., Hemkemeyer, M., Watson, C., & Joergensen, R. G. (2020). Organic Amendments Alleviate Salinity Effects on Soil Microorganisms and Mineralisation Processes in Aerobic and Anaerobic Paddy Rice Soils. *Frontiers in Sustainable Food Systems, 4*(30). doi:10.3389/fsufs.2020.00030

Winarto, Y. & Stigter, C. J. (2016). Incremental learning and gradual changes: “Science field shops” as an educational approach to coping better with climate change in agriculture” Natural Resources Management: Concepts, Methodologies, Tools, and Applications. pp.1454-1487.

World Bank and ADB (2021). Climate Risk Profile: Indonesia. The World Bank Group and Asian Development Bank.

Yi, B. L. (2016). Southeast Asian fires emitted most carbon since 1997: scientists. https://www.reuters.com/article/us-indonesia-haze/southeast-asian-fires-emitted-most-carbon-since-1997-scientists-idUSKCN0ZE210

About the authors

Kustiwa Adinata was born 1970 in a farming family in Java, Indonesia. He has been a practicing farmer since 1990. He graduated from the Faculty of Agriculture of Padjadjaran University in 2012. His fields of expertise are andragogy, ecological farming, and farmer-to-farmer training. He is the founder of IPPHTI, an Indonesian national association of farmers with more than two million members. Since 2011, he has been a project manager for various climate change adaptation and mitigation projects, such as the Climate Adaptation Project (CALP), the Climate-Resilient Agriculture Investigation and Innovation project (CRAIIP), and the Climate Change Adaptation, Mitigation, and Disaster Risk Reduction Project. In 2018, he founded the Indonesia Peasant Community Organisation (JAMTANI). He has co-authored more than 14 scientific publications on the following topics: climate change adaptation, floating paddy field cultivation, stress-tolerant paddy seed, climate-friendly products, and the impact of COVID-19 on food security. He also wrote a book titled “Practical assessment of soil ecology to promote climate resilient agriculture”.

Silke Stöber was born in 1966 in Germany. Since childhood she has been exposed to the livelihood plights of smallholder farmers and fisher folks in the Global South as her parents worked in development cooperation. She holds a PhD in agriculture from Humboldt-Universität zu Berlin and has more than 30 years of development and research experience, particularly in Southeast Asia and sub-Saharan Africa. Since 2014, she has been affiliated with the Centre for Rural Development (SLE) at Humboldt-Universität zu Berlin. Her areas of interest are climate-resilient food and agriculture, climate change adaptation, rural development, food security, and agricultural economics. Silke’s research and teaching interest is driven by real-world problems, particularly those that smallholder farming families face. Co-research with farmers and rural communities in science–practice partnerships is one of the main vehicles of her academic work. Between 2017 and 2019, she was the Climate-Resilient Agriculture Investigation and Innovation Project’s scientific advisor.

Tandu Ramba was born in 1966 in a farming family in Toraja, Indonesia. He graduated from the Faculty of Animal Husbandry of Hasanuddin University, Makassar in 1991. His area of expertise is in the socio-economics of animal husbandry. In 2012, he joined a local NGO known as the “Toraja Church Motivator Training and Development Centre” which is called now the “Motivator Community Development Foundation” (MPM). After undergoing a series of practical training, he became the main facilitator in the implementation of MPM’s Climate Field Schools, which includes climate change adaptation, mitigation and disaster risk reduction. He is also project manager in a number of other projects at MPM in collaboration with Bread for the World, Germany such as: the Climate Adaptation Learning Project (CALP), the Climate-Resilient Agriculture Investigation and Innovation project (CRAIIP), and a broader Climate Change Adaptation, Mitigation and Disaster Risk Reduction Project.

Notes

Between heavy rain and sea level rise

Co-research with smallholder farmers in Indonesia
A manual for the Climate Field Lab approach

"Co-research is a more radical form of action research. It includes overcoming structural power relations between academic and community researchers. This is an important, but often not easy undertaking. The manual shows us ways and many tools on how to actually do co-research in the field of climate change adaptation with small-scale farmers. It literally invites you to try out co-research yourself."

Dr Nicole Paganini
Programme Lead – Urban Food Futures
TMG Research gGmbH