CHAPTER 7

Developing participatory agro-climate advisories for integrated and agroforestry systems

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Summary

Southeast Asian farmers face numerous slow and fast-onset natural hazards that have negative impacts on their livelihoods, and consequently risk slowing their ability to adapt to changing climate patterns. Meanwhile they are also tasked to implement farming practices that help mitigating climate change. One key activity could help farmers' decisions in addressing both challenges: better tailored seasonal weather forecasts combined with participatory development of climate-smart agricultural advice.

The Agro-Climate Information Services for Women and Ethnic Minority Farmers in Southeast Asia project (ACIS) addresses farmers' demand for more actionable climate services in Viet Nam, Lao PDR and Cambodia. Although generally perceived as climate-smart practices, integrated and agroforestry systems are rare in advisories, nor as a strategy to adapt to natural disasters and climate variability. To address this gap, we demonstrate how farmers are involved in co-producing such information, using the example of My Loi, a 'climate-smart village' in Northcentral Viet Nam. The documentation consists of logbooks and notes from three participatory scenario planning meetings, the development of advisories, and in-depth interviews conducted between 2016 and 2018. In short, the timing and content of forecasts and advisories need to be decided with farmers. Regularly updated forecasts over various periods were important for agroforestry systems. Farmers needed information about limiting weather conditions, not the average. When forecasts were uncertain, diversification of species often also meant diversification of risk. Social learning helped farmers observe and document recommendations to build checklists for how to combine trees and crops to minimize negative weather-related impacts.

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1. Introduction

“When ants build up mounds, a storm is coming. When dragon flies fly low, rain is coming”

For thousands of years, farmers’ only means for forecasting weather was to observe the sky and interpret natural phenomena, like flowers, birds and seeds. As climate variability becomes more pronounced and farmers move away from traditional crop varieties, many report that their forecasting skills are no longer valid.

Over the past decade, the technologies for producing and distributing advanced climate information with higher accuracy and at higher spatial resolution has increased rapidly. Such advances remain largely underused, especially among farmers in developing countries, even though climate services for agricultural decision-making can reduce the risk of crop failure and contribute to national food security (Tall et al 2012). As farmers rarely are included in the design of agro-climate information products, their knowledge and needs are poorly addressed. Private companies and public institutions are now trying to fill these gaps (Dorward et al. 2015).

Some farmers obtain weather forecasts, management recommendations and price information via short message services or smartphone apps. Information communication technology also allows them to communicate with suppliers, provide commentary on field observations or correlate satellite data as access insurance (IWMI 2017). There are two short-comings with those approaches. Whereas existing advisories predominantly have been designed for monocultured grain crops and may help farmers plan the more laborious farm work, the main share farmers’ income is from other products, such as cash crops, fruit trees and livestock. Secondly, it misses the tree-crop or crop-crop interaction benefits that could reduce climatic stress in a longer-term time perspective.

Agroforestry, one of a suite of climate-smart agricultural practices (FAO 2013; Rosenstock et al. 2015), has a demonstrated capacity to contribute to adaptation, food security and resilient livelihoods (Simelton et al. 2015) as well as mitigation objectives (Zomer et al. 2016). Agroforestry is mentioned in national adaptation policies and strategies, such as in Viet Nam’s Decision by Ministry of Agriculture and Rural Development QD819/2016/BNN-KHCN on action plan on climate change response and in the Forestry Law of 2017 16/2017/QH14. However, the buffering provided by the interaction of trees and crops does not mean that agroforestry is immune to extreme weather events nor that weather forecasts are less important for such integrated systems.

Funded by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), the Agro-Climate Information Services for Women and Ethnic Minority Farmers in Southeast Asia (ACIS) project has been testing approaches that improve the use of climate services, specifically, so that women and men farmers of different ethnic groups can *access* (available in a variety of designs and formats), *understand* (appropriate language and content) and *use* (appropriate advice, on time) agro-climatic information. This, in turn, is expected to reduce climate-induced crop failures. The project is being implemented together with CARE in five sites in three countries—Ha Tinh and Dien Bien provinces in Viet Nam (2015-2018), Ekxang and Phongsaly province in Lao PDR and Rathanakiri province in Cambodia (2016-2018). It is designed in two main sections, which can be adapted for expansion in different contexts: 1) seasonal weather forecasts; and 2) participatory advisories that incorporate farmers’ knowledge and feedback.

While annual crops typically receive more attention in advisories, in this chapter we draw specifically on the work in My Loi, a CCAFS 'climate-smart village' in Northcentral Viet Nam that was led by ICRAF in collaboration the provincial Farmer's Union. Given the diversity of crops, ACIS was developed for integrated crop and agroforestry systems.

2. The ACIS process and study sites

The ACIS process follows a chronological cycle from developing forecasts and advisories to farmers' learning and feedback. The country and level at which the process is implemented features differing elements.

- *Provincial level:* The process for developing forecasts is different in the three countries. In Viet Nam, a seasonal (updated) forecast is developed by the provincial meteorological bureau, initially with support from national staff. The forecast is forwarded to the provincial agricultural department. The initial dialogues involve representatives from provincial and district Department of Agriculture and Rural Development (DARD) and Department of Natural Resources and Environment (DONRE) offices and farmers to ensure mutual understanding of needs and adjustment of the forecast products.
- *Agro-climatic zone*: The seasonal forecasts and agricultural risks are interpreted in participatory scenario planning (PSP) workshops. The PSP process was developed in Africa (CARE 2015) and adapted for Southeast Asia under ACIS. In Viet Nam, PSP workshops are run with leading farmers and facilitated by a local resource person, for example, a representative of the Farmer's Union (as in Ha Tinh Province), district extension office (as in Dien Bien Province and Ekxang village) or civil society organisation (as in Phongsaly and Rathanakiri), initially with support from project staff. During the workshop, the group examines the seasonal forecast and discusses the probabilities of different outcomes, which results in localized recommendations that incorporate farmers' knowledge. Farmers are encouraged to add their local knowledge to the process of making weather forecasts. The PSPs are done before, during and after the main crop season (usually following the rice calendar). Farmers and facilitators document the process in logbooks and provide reports on forecasting skills and the suitability of agricultural advice to extension and meteorology offices. The local resource person then develops an advisory based on the information. Resource persons can be called in as necessary, for example, from the plant protection department or provincial meteorological bureau.
- *Village level:* Leading farmers and village leaders share advisories to their neighbours, for example, through printed bulletins and public announcements made through village loudspeakers (common throughout Viet Nam). In Ha Tinh Province, the meetings are carried out concomitantly with the four-monthly Community Innovation Fund meetings. In Dien Bien, Rathanakiri and Phongsaly, the Village Savings and Loan Association leader shares the printed bulletins at bi-weekly meetings. The village leaders also share the printed bulletins at village meetings that are organized around events, not on a regular basis.

3. Study site: My Loi Village

My Loi is in the uplands of Ky Son Commune, Ky Anh District, Ha Tinh Province. The annual average temperature is 25°C and average annual rainfall is 2,800 mm, the majority of which falls between August and December, peaking in October. The major threats to food security are periodical flooding and typhoons. During the two most-recent episodes of food insecurity, in 2007 and 2011, villagers depended on food aid.

My Loi has about 820 inhabitants of the approximately 6,000 in the commune. In 2016[1], total village area was 195 ha of 9,036 ha in the commune, of which 140 ha of 6,973 ha was forest and 55 ha of 1,283 ha was agricultural land, primarily, rain-fed. More than half of the commune's agricultural land (895 ha, an increase from 545 ha in 2011 owing to conversion from annual-crop production) was perennial plantations, for example, tea, orange and rubber. Less than 8 ha of the commune's 153 ha of rice fields were irrigated; the remainder were upland or terraced fields.

Forestry, predominantly acacia, eucalyptus and cajaput (*Melaleuca* spp) monocultural plantations, generates about half of the household incomes in My Loi while the other 50% comes from agriculture and other activities (Le et al. 2015). Only a minor portion of the rice fields is used for two crops annually. The main challenges are water shortages (in Spring) and cold spells. The lowlands are used for peanut monoculture (Spring) and mung bean (green bean) or white radish monoculture (Summer) and maize monoculture or maize intercropped with sweet potato (Autumn) and vegetables (Winter). The planting sequence is adjusted to avoid soil evaporation in between the Spring and Summer crops; each season is short and flexible. In terraced fields, cassava is intercropped with solely peanut or peanut with maize. In upland fields,

Figure 33. Location of ACIS project sites in Viet Nam (My Loi climate-smart village in Ha Tinh and Dien Bien provinces), Cambodia (Rathanakiri) and Lao PDR (Ekxang climate-smart village and Phongsaly)

[1] Scheme on restructuring the agricultural sector towards enhancing added value and sustainable development associated with NRD for the period 2016–2020 in Ky Son Commune (Đề án tái cơ cấu ngành theo hướng nâng cao giá trị gia tăng và phát triển bền vững, gắn với xây dựng NTM giai đoạn 2016–2020)

cassava monoculture (Spring to late Autumn/Winter) or intercropped acacia and cassava are grown in the first year or acacia monoculture. Home-gardens are mixed, predominantly with fruit trees (banana, jackfruit, mango, orange, pomelo and lime) and black pepper. My Loi (and Ekxang in Laos) has been a CCAFS climate-smart village project site since 2015, hence differing opportunities to integrate ACIS with CSA.

4. Data

A baseline survey was conducted at the start of the ACIS-project to map and understand farmers' access to weather forecasts and advisories. The survey was done in all sites (Figure 33) during 2016, including 1,333 households. Here we extract questionnaire results from the two sites in Viet Nam, to better highlight within-country similarities and differences (in total n=595 households were interviewed in Ha Tinh and Dien Bien provinces, of which in Ha Tinh 134 women and 142 men (CARE and ICRAF 2016).

The PSP groups in My Loi consist of 43 households (the gender distribution varies 19–25 women and 18–24 men because husbands and wives participate interchangeably), as representatives of four interest groups: home-garden, forestry, intercropping, and livestock, where the former two include integrated tree-crop systems, and the third mainly integrated annual crops. Three advisories evaluated in My Loi were prepared for the summer-autumn season (June–October 2017), during three PSP meetings (June, August and November). The first seasonal forecast was provided as an average for the whole season and distributed prior to the season (pre-PSP). From the second PSP and onwards, monthly updates were provided. Hazards, risks and solutions were participatory made by combining local knowledge and scientific knowledge (from farmers, extension officer, met officer and representative of social organisation) based on different climate scenarios which were built on seasonal forecast information. Findings related to integrated systems were extracted from qualitative documentation from farmers' and facilitator's logbooks, which were evaluated in November 2017. Additional, in-depth, focus-group discussions were held during the PSPs in 2017. The selection process is described in Duong et al. (2016). Gendered similarities and differences in farmers' preferences, understanding of, and benefits from the advisory information were teased out and presented in Duong et al. (2017). Work on evaluating forecast skills is covered elsewhere, for example, Roy et al. (2017). For participatory tools for discussing what trees and crops are suitable for particular extreme events, see Simelton et al. (2013a).

5. Results

Baseline actionability of climate services

At the start of the project there was a one-directional flow of agro-climatic information, biased towards rice. Typically, farmers followed the instructions and did not discuss their interpretations of the information amongst themselves or how to turn the information into farming plans. Neither was farmers' knowledge or feedback incorporated into the design of the advisories. The baseline survey (n=595) for Viet Nam showed the following general and site-specific results:

Availability and accessibility: Seasonal forecasts were prepared at the provincial level, did not reach communes or farmers and were not updated. Daily or 3-day weather forecasts and early warning alerts for storms and floods were disseminated via television and village loudspeakers (over 90% of the interviewed households in both Ha Tinh and Dien Bien said they had access to such forecasts). Advisories were distributed via loudspeaker, extension services and radio and timed for the rice season (between 80–90% of the farmers had access to these). For comparison, in Laos and Cambodia, only half of the respondents had access to forecasts while nearly all received some advice for crops, often via extension, NGOs or village leaders.

Usefulness: Although farmers said the forecasts were useful, the main complaint was that the information was at too low resolution for farm decisions. They depended on seasonal forecasts and advisories that were based on long-term climate averages without seasonal updates or taking into consideration agro-ecological diversity.

Timeliness: Weather forecasts were perceived more-timely than the advisories. This indicates a delay in the translation and distribution, as the information passes between two ministries[2]. Furthermore, the timings of the advisories were primarily determined by the rice season (in some locations the advisories included peanut and livestock), which does not apply to agroforestry or other integrated systems.

Understandable: Women understood the forecasts and advisories equally well (67%) while more men said the forecasts were easier to understand than the advisories (73% versus 64%). Literacy also relates, not only to technical terminology, but also to ethnic languages (three of the five project sites have high shares of peoples whose first language is another than the national language), literacy levels for text and visuals. For example, interpreting information in 'conventional' weather symbols can be cultural, and in Cambodia farmers designed their own icons (Smytzek and Simelton 2018).

Towards a two-directional flow of agro-climate information

Through the ACIS project, more frequent forecasts have been put in place and approaches to provide more spatially relevant forecasts are being tested. One main objective has been to ensure that farmers' needs and knowledge are understood by climate service providers.

First, the relevance of using seasonal weather forecasts in agricultural planning was evident simply by the fact that each average monthly observed temperature in 2016 was at least 0.5 °C higher than the long-term climatological average. Second, after it was emphasised to the authorities that farmers intercropped and used seasonal forecasts to phase crops continuously, they quickly changed the timing of the seasonal forecast for one specific crop (rice) to monthly, updated, 3-monthly forecasts. Also, the range of exposure and uncertainty in forecasts (Roy et al. 2017) helped demonstrate the need for updated, short-term forecasts to provide more details for management that could help farmers adjust their plans. Third, meetings between meteorologists, extension officers and leading farmer allowed farmers to ask questions and request forecast indicators relevant for their agricultural systems. The seasonal forecast was then discussed and interpreted in the PSP groups, where farmers and extension workers combined local and scientific knowledge to prepare advisories for various land uses in particular agro-climatic zones. Daily messages and updates were developed for loudspeakers. After the season, the results of the forecast and advisories were shared with provincial and district forecasters and agricultural officers.

Developing participatory advisories for agroforestry

Discussions with farmers about rating the risk of certain crops against the main hazards during Spring and Autumn resulted in diagrams as shown in Figure 34. The diagram helps better understanding farmers' knowledge and rationalization of

[2]As is common in many countries, meteorological data is produced by the Ministry of Environment and the agricultural advice by the Ministry of Agriculture. In Viet Nam and Laos, these correspond to the Ministry of Natural Resources and Environment (MONRE) and Ministry of Agriculture and Rural Development (MARD).

their tree and crop selection. This is further documented in Table 25. The process of creating Figure 34 also helps reveal potential adaptation gaps that need to be addressed. In particular, it can highlight underuse of the protective functions of multi-strata systems.

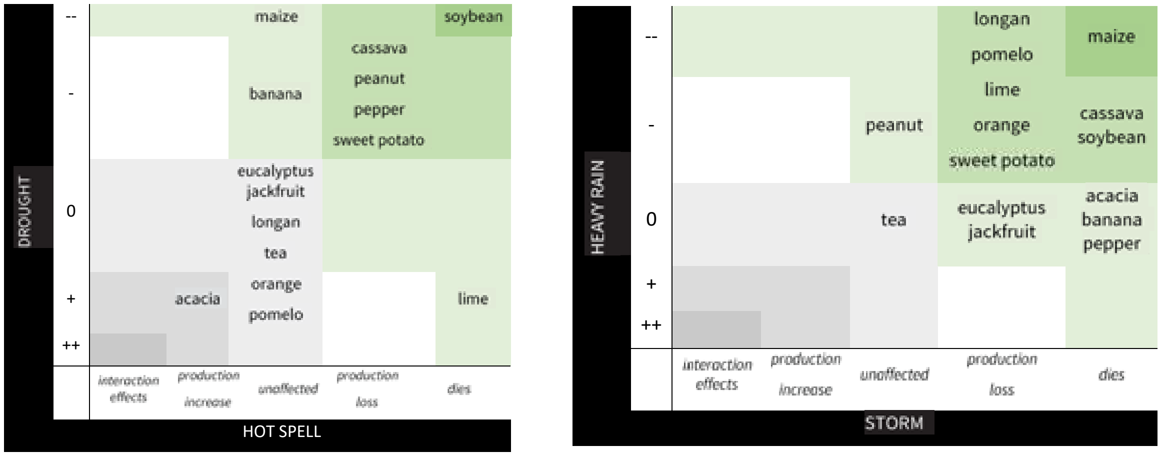

Figure 34. Suitability of, and risk associated with, agroforestry crops and trees during droughts and hot spells in Spring-Summer (top) and heavy rains and storms during Autumn (bottom). (the signs – to ++ on the y-axis correspond to the impacts on the x-axis). Source: focus-group discussions in My Loi, 2011.

Farmers' checklist

In preparing and disseminating the advisories, there was a trade-off between the level of detail and amount of information that farmers could absorb, both text and visual elements (Duong et al. 2017). One remaining step towards incorporating climate-smart advice is acknowledging the role of poly-cultural systems as adaptation options. Considering the potential information overload in agroforestry advisories, farmers in My Loi suggested assembling their observations and experience from past years into a checklist. After one year of testing they had a draft with actions that they could revise according to the forecasts (Table 25).

The farmers' checklist was created through facilitated discussions, focusing around farmers' observations of tree and crop interactions (Table 26). In the PSP workshops, farmers were encouraged to talk about how they adapted the farming calendar with annual crops and how they paired crops and trees to reduce risks (in effect, this meant detailing the benefit of ecosystem functions). Farmers related adaptation functions to the shape of canopy and root systems, flexibility of trunk and branches, quality and amount of leaves, and nitrogen-fixing species (acacia, legumes) on poor soils. A range of local strategies, especially for drought management, were collected. To minimize soil evaporation and soil erosion, some intercropped peanut and/or bean with cassava. The benefits of compost and mulching with rice straw and palm leaves were applicable for many plants, for example, orange, ginger and pepper, and made it easy to introduce new species and practices that can be components of agroforestry systems (for example, vermiculture, Guinea grass, *Arachis pintoi*, seasonal vegetables).

BOX. EXTREME EVENTS AND FARMERS' OBSERVATIONS OF TREE-CROP BENEFITS

The impacts of recent extreme weather events served for demonstrating opportunities for intercropping and timing.

- April 2015: The first tornado hits My Loi. Acacia trees were among the worst affected (Le and Simelton 2015).
- May 2015: Three rainy days totaling 13 mm (compared to the long-term average of 164 mm), and five days with temperatures above 38 ˚C. This greatly reduced monocultural peanut and cassava yields while intercropped fields had lesser losses.
- February 2016: Temperatures dipped to 10 ˚C. The highest observed temperature in the same month was 34 ˚C.
- October 2016: On the 14th and 15th, 474 mm and 207 mm of rainfall, respectively, and another 330 mm on the 30th.
- September 2017: On the 15th, typhoon Doksuri hits Ky Son Commune. Among the most damaged were 3-year-old acacia monocultural plantations and older, unpruned fruit trees.

Harvesting before rain fell reduced damage and, although fields were flooded, saved Autumn crop failures both in 2016 and 2017. A limited area of Autumn-Winter crops (sweet potato, maize) near flood plains were lost in 2016. While monocultural maize near a river were swept away, intercropped maize and sweet potato in adjacent fields were less affected. Here, the sweet potato stabilized the soil into micro-terraces that supported the maize. Yields from agroforestry systems were less affected by heavy rain and drought, as the canopy protected sub-canopy crops from rainfall and reduced wind speeds. The 'mac' trees reduced storm and rainfall impact on recently planted pepper seedlings compared to pepper grown on cement poles (September 2017).

The discussions contextualized why 'farmers' practice' may go against 'extension recommendations'. While short-rotation annual crops are recommended as an adaptation strategy, from a farmers' perspective the same may be said for some perennials. For example, by following the recommended spacing for acacia timber trees (2 x 2 m for 8 years) trees are exposed to longer and higher risk than by spacing for pulp (1 x 1 m for 4 years). In the two most-recent storm events, monocultural acacias were badly damaged.

In some cases, facilitators (extension workers or project staff) helped with recommendations or explained why some methods might have worked and others did not.

Table 25. Extract from farmers' checklist of preventive measures for agroforestry systems and recommendations for advisories in Autumn 2016; inconclusive examples from My Loi

<table>
<tr><th rowspan="2">Applies mainly to
FORECAST PERIOD</th><th colspan="4">In the case of…</th></tr>
<tr><th>Drought
SPRING–SUMMER</th><th>Hot spell
SPRING–SUMMER</th><th>Heavy rain, flooding
AUTUMN</th><th>Cold spell
WINTER</th></tr>
<tr><td>Things to think about

What can I do?

What can I plant?

What tree-crop interactions can I make better use of?</td><td colspan="4">Do I have enough information?
• How does this season's/year's forecast compare with the same time in the previous year? (Important for making annual planting selection)
• How does this year's forecast compare to the inter-annual variability of many years? (For selecting perennials, the extreme inter-annual ranges are good indications for what microclimatic situations trees are intended to ameliorate, for example, shade, heavy rain, soil evaporation)

How can I use annual crops to reduce the risk of crop failure?
• Are seedlings at risk?
• Does the weather event interfere with the time for planting, flowering, harvesting or the following crop? Can I change the planting dates? Can I change the annual crop variety or species?
• How can I best avoid wasting time and money on replanting and agro-inputs?

How can I use (existing or add) perennial crops/trees to reduce the risk of crop failure?
• When (what growth stage) are fruit trees particularly sensitive to which weather stress?
• Where should I introduce what types of trees? What combinations of trees (canopy shape, root system, natural pest and disease control) and crops go well together?
• How can I select different trees or varieties to spread harvest times?

How can I use natural resources and inputs more efficiently?
• Use biological pest/disease control.
• Time with weather (forecast): spray pesticide on a cloudy day (not in direct sunshine or before rainfall); irrigate early in the morning or late afternoon (avails stressing plants with rapid change in soil temperature).</td></tr>
<tr><td rowspan="2">General</td><td colspan="2">Increase soil water-use efficiency:
add (vermi-)compost before planting crops/trees; mulch with rice straw or leaves; plant cover crops; no minimum tillage</td><td rowspan="2">Keep seeds dry
Clear ditches
Reduce damage from falling objects: prune, cut damaged branches, thin-out leaves
stabilize plants: cover tree bases/ roots with soil; use supporting trees or pillars to firm up sensitive plants (e.g. sugarcane); plant wind breaks (e.g. bamboo).</td><td rowspan="2">Monitor minimum temperatures to take action (especially for seedlings and livestock)</td></tr>
<tr><td>Avoid planting trees during extended droughts</td><td>Regulate micro-climate (reduce temperature difference):
plant shade trees; grow ginger in bags under shade; monitor maximum temperatures to take action</td></tr>
</table>

Bean or cassava intercropped with peanut-bean and/or maize in rotation	After the peanut harvest, plant bean while soil remains moist from previous crop	Plant beans in time to harvest before the heavy rains start Prevent rotting disease e.g. rhizoctonia solani in peanut: add lime before rains and on a sunny day after 3-4 days of continuous light rain. Hill up plants and provide good drainage Remove infected plants, add lime on the soil to kill fungus	Add ash or mulch with rice husk and cover topsoil, to maintain soil temperature	
Maize intercropped with sweet potato	Avoid planting when soil is crust and temperature is too high (38-40°C for 3 days continuously) Irrigate	Adjust farming calendar to avoid planting during heavy rain, flooding and storm conditions Clear ditches to ensure drainage	Add ash or mulch with rice husk to maintain soil temperature	
Black pepper with Mac tree *(Wrightia annamensis)*	Mulch with rice straw, palm leaves or another crop residue Drip irrigation	Cover the soil around young pepper seedlings (1-2 year-old) with palm leaves Use live supporting trees (e.g., Mac tree) for pepper instead of cement pillars to create micro-climate temperature under trees and reduce heat during hot spells period. Cementitious materials absorb heat and drain quickly, making the column hot and dry (up to 45°C during the dry season)	Prevent rotting diseases: prune branches, runner shoots, and leaves near the soil, branches should be at 10-15 cm from topsoil; remove dead and sickplants; add lime (see cassava-peanut) to avoid Phytophthora fungus and nematodes, which may cause root- rot, and quick or slow wilt diseases on pepper	Irrigate in the morning to avoid frost damage, if possible Plant wind shield trees, e.g., bamboo and jackfruit trees can minimize cold humid wind directly on the pepper plant

Orange and pomelo-based systems	Suitable cover crops: legumes, vegetables, *Arachis pintoi* Mulch with straw or palm leaves Drip irrigation Water harvesting pond	Cover the soil around young trees and seedlings with palm leaves as mulch	Ensure well-drained soil Remove broken and shooting branches Prepare terraces for fruit crops (e.g., citrus, guava, and banana) on steep slopes to prevent nutrient and top soil losses due to heavy rain Plant strips of grass or pineapple to prevent soil loss	Irrigate in the morning to avoid frost damage Spray flower stimulants to stimulate timing of orange flower (ask extension for advice)
Tea	Plant shade tree *(Senna siamia)* Intercrop tea with maize in the first year Mulch with rice straw and leguminous residue		Drain well Prune trees before	Irrigate in the morning to avoid frost damage, if possible

Farmers' general recommendations for agroforestry advisories

When preparing advisories for agroforestry systems we observed a few differences with respect to annual crops, which need to be taken into consideration.

For reference climate (weather): For annual crops, farmers preferred to compare the current year's forecast with the previous year's weather. However, for planting new perennials, the range of historical inter-annual variability is important (frequency and intensity) and to avoid planting during the most intense drought. Knowing the phase of the El Niño–Southern Oscillation is a good first indicator.

For the forecast: First, to time the advisory for monocultural rice makes little sense for upland farming systems. Farmers preferred receiving continuously updated forecasts. Second, similarly for annual crops, farmers need to know the limiting factors not monthly or seasonal averages, for example, minimum (Winter) and maximum (Summer) temperatures and risk of drought (dry days) and floods.

During the Participatory Scenario Planning: In the original PSP approach, farmers prepared for all forecast scenarios except those with low probabilities. Especially for agroforestry systems, farmers often noted that different scenarios meant the same risk or they prepared the same way, regardless of the risk level. So, 1) they preferred only the scenario with highest probability and focused on different 'what if' scenarios of the exposure, for example, depending on the timing and intensity of the event, how might certain crops be affected and how to avoid this; and 2) instead of repeating, the farmers assembled a list of general actions (Table 25). The PSP workshops provided opportunities to learn adaptation strategies from natural disasters (Box, Table 26).

For the advisories: Many general recommendations are the same for agroforestry as other types of advisories: the information needs to be clear, detailed (what treatment, how much, when) and avoid complicated terms and abbreviations as this creates barriers to farmers who are not part of developing the advisory. Specific climate-smart practices should be added and, for agroforestry in particular, farmers appreciated icons to illustrate plant growth and tree-crop canopy/root interaction effects and for complementing technical terms. However, icons should complement rather than replace words. The advisories should be tested with female and male farmers outside the PSP groups before using widely. Figure 35 exemplifies a modified agroforestry advisory based on two years of testing.

Table 26. Extracts of adaptation measures and farmers' observations discussed in the Participatory Scenario Planning (PSP) meetings for the Autumn season 2017

Pre-PSP in May 2017	Mid-PSP in August 2017	Post-PSP in November 2017
Forecast for the season: • dry in June (less rain in 2017 compared to 2016) • days with heavy rain (>50 mm) in August to October (2-4 days per month) • heavy rain and storm possible in September and October **Drought and storm preparedness recommendations:** avoid planting during the dry period; harvesting of annual crops should be done before the storm; strengthen and prune long-term trees; ensure good drainage and prevent root diseases. • crops: after the peanut harvest, plant bean while soil remains moist from previous crop; choose short-term and short crop or varieties; intercrop peanut and cassava • mulch orange, ginger, pepper with rice straw and palm leaves • plant or make use of shade trees and cover crops (Guinea grass, arachis pintoi, seasonal vegetables) • add compost to improve soil water-holding capacity and soften the soil • clear ditches to ensure good drainage • prevent rotting diseases and reduce damage from falling tree parts: prune branches, runner shoots, and leaves near the soil. Branches should be at 10-15 cm from topsoil; remove dead and damaged plants; add lime to avoid fungus and nematodes, which may cause root diseases. • Keep updating weather forecast to take action.	**Farmers' actions:** • update weather forecast • used short-term crops/ varieties • used various types of compost: pig, chicken and cattle manure, vermicompost, green manure (peanut leaves) • used drip irrigation for orange and pepper • mulched • planted cover crops under orange • add lime into the soil before planting **Farmers' observations:** Households who had established drip irrigation for pepper and orange said it saved water, compared to sprinkler irrigation and tubes, and reduced pests spreading via sprinkled water between canopies. **Forecast for next phase:** Actively follow weather forecast, prepare for rain. Extension workers advised on nitrogen and lime application for acid soils to minimize nitrogen overuse. Postpone planting maize and sweet potato (Autumn – Winter season) if high probability of heavy rain and storm.	**Farmers' views on the comparatively low impact of a flood in October:** • prune trees to cut damaged branches, and thin out leaves • deep-root trees were largely unaffected (Mac trees, jackfruit) • tea was less affected by the storm • most lowland crops had already been harvested • unharvested crops were planted at higher elevations (e.g. ginger, cassava) • Intercropped maize and sweet potato were less damaged than monocultures. Maize and sweet potato has supporting benefits to storms • Farmers who used compost that decomposed more than previously, noted more effective nutrient and pest control and reduced weeds. **Forecast for the following season:** Winter is forecasted to be colder than last year. Farmers planned to follow weather forecasts for planting vegetables and crops (planting date may be later than last year), add ash or mulch with rice husk on topsoil to maintain soil temperature.

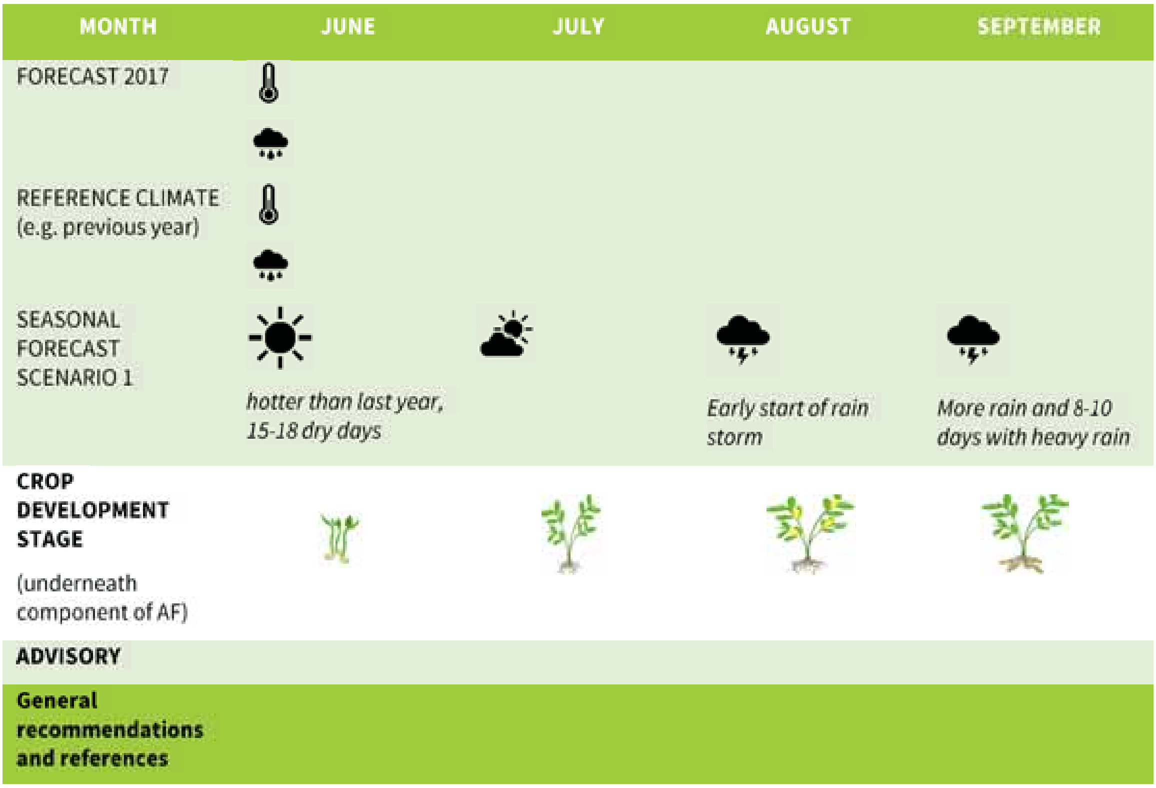

Figure 35. Example of advisory design

6. Discussion and recommendations

The ACIS project offers a unique opportunity to incorporate agroforestry in climate services and, thus, support the implementation of national adaptation strategies in local land-use plans. At farm level, preparedness and better planning frees labour and resources from recovery operations to invest in more productive work.

At local level, a regular and close dialogue between forecast suppliers (DONRE), agricultural planners (DARD) and farmers' representatives helps deliver actionable information. For example, farmers' feedback helped adjust the timing of forecasts to crop seasons and the type of information provided. The usefulness of two-way communication for disseminating forecasts to farmers, for example, by meeting extension workers or through farmers' climate field schools, has been proven to enable farmers to seek clarification on questions (Patt et al. 2005; Sala et al. 2016). The dialogues help clarify what meteorologists, extension workers and farmers mean, for example, when they talk about 'normal' weather, to better understand the different perspectives of meteorological, agronomic and technical droughts (Simelton et al. 2013b) or explaining probability and uncertainty to avoid raising false expectation that forecasts are 'predictions'. To meet farmers' expectations of which situations can be 'adapted' to meet both market- and weather-related challenges and what problems can be solved, the advisories can strive for 'no regret' options for short- and long-term solutions (farmers testing different options). Diversification can be considered a no-regret option because it spreads risk over the year, in contrast to 'not knowing what to do' even when there are strategies available.

The PSPs create enabling conditions for combining farmers' knowledge with scientific knowledge for climate services. Forecasts based on traditional knowledge should be respected; we cannot expect the same detail as from a meteorologist's forecast, however, both should be objectively scrutinized. For example, in August 2017, farmers had many indicators of an Autumn without major storm events—jackfruits grew on branches rather than trunks, bamboo expanded and grew straight, and 'vespa' bees were not hiding below ground—but then typhoon Doksuri hit. We point out that indigenous knowledge may vary and does not mean that all farmers agree. For example, in Dien Bien, only half of the PSP farmers believed that chestnut was a good indicator of rainfall while the other half had no opinion. It may also be that farmers believe that weather is decided by gods and, thus, adapting or planning makes no difference. Nevertheless, the PSPs help monitor indigenous knowledge, forecasting techniques and encourage better understanding rather than disqualifying farmers' indicators. Specifically, the process has helped farmers with planning (timing their farming calendars), receive updated information, and learning how to monitor and reflect on actions taken in response to information. Moreover, new opportunities arose to provide feedback to provincial authorities, such as the meteorological and agricultural departments.

Given the bottlenecks for agroforestry development in Viet Nam (Simelton et al. 2016), particularly related to institutional, human and technical capacity, there are challenges for expanding the use of better forecasting services as described here. One challenge with agroforestry compared to monocultural crops is that farmers may have diverse combinations of crops and trees, which would result in lengthy advisories.

There is certainly a trade-off involved in how much information to introduce in both the PSP and the advisory. We expect that when advisories can be accessed online, such 'information overload' can be more easily managed. Specifically, to fast-track actionable climate services specifically for agroforestry, the following is needed.

Capacity development

In all three countries, we encountered communication gaps between meteorology and agronomy.

- *Training*: Few agricultural extension officers were trained in integrated farming systems and agro-meteorology. As a result, extension workers were not familiar enough with weather forecasting to know what to ask for. Conversely, meteorological staff were not trained in agro-meteorology and were largely unaware of what farmers or extension workers needed to know and when they needed to know it.
- *Farmers' needs*: For the development of seasonal forecasts, it is important to first understand farmers' priority crops and avoid assuming that rice alone determines the timing of seasonal forecasts. Moreover, crop and variety selection depend not only on the weather to come but also on how it was in the previous season (delayed, early, dry, wet etc). Mutual understanding can be formed through farmers' field schools running over longer periods, for example, in the ACIS project sites in Cambodia rain gauges were used for school education that will create a new generation of young farmers with a basic understanding of weather monitoring.

Climate-smart advisories

- Advisories can be improved immediately by introducing climate-smart practices and practices with demonstrated benefits of making better use of existing perennials in, for example, upland fields, home-gardens or as windbreaks in neighbouring fields. However, what, when and how to plant needs to be specific to local contexts (Duong et al. 2016).

- *Adding value to standing trees*: Farmers alone typically rationalized what crops to add to standing trees usually by their provisioning services while in the PSP groups they discussed regulating functions to match the need for animal feed, mulch, compost or green manure, or natural pest control. The loan groups discussed 10-year business plans, reducing the risks associated with monocultures by adopting mixed species' stands with mixed ages and selective felling. This calls for clear guidelines and intentions from government support programs. To cover the establishment gap, additional income could be generated from bee hives and shade-tolerant species, such as medicinal plants, ginger and lemongrass.
- *Adding value by species selection*: Canopy and root structures need to be considered when prioritising multi-strata and sub-canopy species in relation to their regulating functions. For example, knowing the likely frequency of natural disasters can help when considering a light canopy to provide shade to Spring crops or a dense canopy to ameliorate rainfall intensity for Autumn crops.
- *Land-use planning*: When deciding which perennials to plant where, planners need to consider a range of climate risks over several years and the frequency and intensity of such events (hazard mapping and hazard history). For example, strong trees as windbreaks can be planted closer to houses and animals and trees that break more easily further away, for example, acacia. Learning can be facilitated by evaluating post-disaster damage. For example, after recent storm and flood events in in 2017 and 2018 the team joined the disaster evaluation teams to also point out 'good practices', where the damage was less.

Viet Nam's plan to join the Framework for Climate Services (GCFS) could lead to more practical and useful forecasts being of benefit to farmers throughout the nation. This would connect to the National Adaptation Strategy, which acknowledges the importance of climate-smart agriculture, and could support Nationally Determined Contributions to reduce greenhouse-gas emissions and mitigate climate change. We stress the importance of offering services that are feasible for smallholders with mixed farming systems in complex upland terrain.

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