MAKING THE SMALLHOLDER FARMERS IN SOUTHEAST ASIA CLIMATE SMART - THE CCAFS R4D THRUST

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ABSTRACT

Southeast Asia (SEA) is one of the world's most vulnerable regions to climate change, severely affected by the impacts of climate-related disasters. The UN Food and Agriculture Organization (2017) reported that from 2005 to 2015, USD 14.5 billion worth of crop and livestock production was lost due to natural disasters in Southeast Asia. Millions of people, about 80% of who are smallholder farmers) are constantly at risk due to increased incidence of drought, flooding, and sea level rise. To help minimize the adverse impacts of climate change in agriculture, the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) promotes climate-smart agriculture (CSA) to smallholder farmers as an approach to disaster risk reduction and climate change adaptation. Since its inception in 2013, CCAFS has done various interventions with its partners in Southeast Asia (SEA) in focus countries such as Cambodia, Lao PDR, and Vietnam. Likewise, it also implemented specific projects with partners in Indonesia, Myanmar, and the Philippines. These regional R4D activities contextualized the four CCAFS Flagships: FP1 – Priorities and Policies for CSA; FP2 – Climate-Smart Technologies and Practices; FP3 – Low Emissions Development; and FP4 – Climate Services and Safety Nets in the aforementioned countries. With the goal of ensuring food security amidst climate change in the region, CCAFS SEA works with its partners to integrate climate change adaptation and mitigation in regional and national development plans. To pursue CCAFS' vision for Southeast Asian agriculture, more strategic R4D activities are being carried out with partners to address the following opportunities and challenges in the region: 1) coping with climate change for smallholder farmers; 2) sustaining national and regional food and nutrition security; 3) enhancing

competitiveness in agriculture; and, 4) moving towards regional integration. In addressing the foregoing challenges and opportunities, CCAFS is implementing an integrated R4D approach targeting the region's food baskets (e.g., Mekong River Delta and Basin, Ayeyarwady River Delta and Central Dry Zone of Myanmar, Red River Delta and Central Highlands in Vietnam, and other big river basins). Aside from their strategic importance in the region's economy and food and nutrition security, these areas are also highly vulnerable to the adverse effects of climate change.

Keywords: Southeast Asia, climate change, climate-smart agriculture (CSA)

INTRODUCTION

With their significant impacts and contributions, it is important to study the role of smallholder farmers in agricultural development. Usually associated with a farm size of less than two hectares (FAO 2015), the term smallholder encompasses small-scale farms in terms of social, economic, and spatial indicators (Rigg *et al*, 2015). Globally, it is estimated that 80 percent of the 500 million small farms are managed by smallholders (IFAD 2013). A large majority of them (around 87 percent) are located in Asia, specifically in China, Indonesia, and Vietnam, accounting for 193 million, 17 million, and 10 million, respectively (Rigg *et al*, 2015). With this great number, smallholder farmers are able to provide as much as 80 percent of the food products being consumed in developing countries (IFAD 2013).

In Southeast Asia, smallholders, such as small-scale farmers, pastoralists, forest keepers, and fishers remain as the dominant force in agricultural production. For instance, more than 80 percent of farms in the region are below two hectares (OECD 2017). In the coconut industry, for example, smallholders account for 80-90% of primary coconut production (OECD FAO 2017). While in fisheries and aquaculture, around 90% of fishers and fish farmers globally are smallholders – an estimated 14.5 million; of which 5.4 million are the fish farmers in the region (FAO, 2017c) (OECD 2017).

Regardless of their significant contributions to the region's agricultural development, smallholders still belong to the most marginalized sectors. They are confronted by series of intersecting challenges (IFAD 2013), such as competition for land and water, increase in prices of inputs, the unpredictability of markets, limited access to resources, information, and technology, unavailability of capital and assets, and ecosystem degradation. To worsen their condition, the emergence of climate change in recent decades has made smallholders more vulnerable to various climate-related risks and has experienced negative impacts on agriculture.

Aggravating the current challenges faced by smallholders, climate change has resulted in prolonged droughts, stronger typhoons, the rapid rate of sea level rise, and a higher incidence of pests and diseases. These climate change-related impacts have caused significant declines in production and reduced income (Nwanze and Fan 2016). From 2005 to 2015, approximately USD 14.5 billion of production losses in crop and livestock was recorded in Southeast Asia due to various natural disasters, mostly drought and flooding (FAO 2018). For instance, the recent 2015-2016 El Niño-Southern Oscillation (ENSO) event had overwhelming impacts on various parts of the region. In the Philippines, agricultural losses of almost 557,000 hectares (ha) amounted to USD 325 million (FAO 2017). In Vietnam, a total of 450,000 ha in Central Highlands, South Central Coast, and Mekong River Delta (MRD) were damaged (CCAFS 2016). This trend also shows that most of the impacts of climate-related disasters are particularly being experienced by smallholder farmers (FAO 2018).

Future scenarios will make it even worse for smallholder farmers. Because of climate change, agriculture production in the region will be very risky. It is projected that in 2050s freshwater availability in Southeast Asia, particularly in large river basins, will decrease (IPCC 2007). Furthermore, below are some possible scenarios in crop production, livestock, and fisheries based on various climate projections (Lasco *et al*, 2011):

- There will be a decline in crop production of 2.5% to 10% and 5% to 30% in the 2020s and 2050s compared with 1990 levels, respectively (IPCC 2007);
- Nutritional quality of crops will be affected by hotter temperature and higher atmospheric CO_2 concentration. For instance, the protein and micro-nutrients, iron and zinc contents of rice will decrease (IPCC 2001);
- Changes in temperature, rainfall patterns, and CO_2 concentrations are expected to directly affect the productivity of livestock, availability, and quality of feeds, and occurrence of livestock diseases (Thornton et al 2008); and
- In fisheries, there will be lower productivity, together with an increase in invasive species population and spread of vector-borne diseases (FAO 2008).

Amidst l these impending threats, the majority of smallholder farmers in Southeast Asia are not equipped with sufficient climate change adaptation strategies. This lack of access to adaptation strategies has made them very vulnerable to present and future climate-related risks (Leary *et al*, 2007 in Lasco *et al*, 2011). During extreme weather events, such as severe droughts,

extreme rainfall and floods, and stronger typhoons, the limited resources and capabilities have resulted in significant loss of livelihood and properties among smallholders. During these times, they are severely affected by higher food prices, as they buy more food than they sell agricultural produce (Vermeulen 2014). To cope with the economic challenges brought by these disasters, they look for off-farm employment opportunities and reduce food consumption (Vermeulen 2014).

With this difficulty of adapting to climate change impacts, the limitations of smallholder further constrain their productivity and resilience (Nwanze and Fan 2016). Because increasing production and income are more of their priority; mitigation activities are also being overlooked. Along with this, smallholder farmers resort to over intensification in agriculture, (IFAD 2013) using technologies and practices like habitat modification, over-extraction of water and nutrients, and use of pesticides, contributing to ecosystem degradation, biodiversity loss, and global warming.

Despite the rapid social and economic development in the Southeast Asian region, smallholders remain to be the largest group dominating the regional agricultural sector (Rigg *et al*, 2015). With this dominance, the focus should be given to smallholders as they are in the front lines of the battle against climate change. To minimize significant losses in production and ensure the food security in the region, the impacts of climate change should be addressed by focusing on productivity improvement and adaptation of the agriculture sector (ADB in Lasco *et al*, 2011). As they also contribute to greenhouse gas (GHG) emissions and environmental degradation, smallholders have strong potential to implement mitigation activities, maintain ecosystem services, and protect biodiversity and natural resources (Nwanze and Fan 2016). By investing in adaptation measures, together with mitigation initiatives, the resilience of smallholder farmers to the various climate shocks can be strengthened.

CLIMATE-SMART AGRICULTURE FOR SMALLHOLDERS

In addressing the challenges being faced by smallholders, a multiple-win solution is highly needed. There is a need for a strategy that will promote high productivity and ensure high income, and at the same time, will address the impacts of climate-related disasters and reduce agriculture's contributions to climate change. With this, a new agricultural paradigm has emerged to tackle the interlinking challenges of climate change, agriculture, and food security.

Climate-smart agriculture (CSA) is defined as an approach that guides actions needed to transform and reorient agricultural systems to effectively support sustainable development and ensure food security in a changing

climate (FAO, 2013). As an approach for developing agricultural strategies in this context, CSA aims to: (1) sustainably increase agricultural productivity and incomes; (2) adapt and build resilience to climate change; and (3) reduce and/or remove greenhouse gas emissions, where possible. Giving emphasis to suitability, the CSA approach helps stakeholders from local to national and international levels, particularly the smallholder farmers, identify agricultural strategies suitable to their local needs and conditions.

In order to address the economic, social, and environmental issues and concerns confronting smallholders, CSA is targeted towards three main goals (FAO, 2013):

- *Productivity*. With the goal of ensuring food and nutritional security, CSA aims to sustainably increase agricultural productivity and incomes from agriculture, without causing negative impacts on the environment. Sustainable intensification, one of the key concepts related to this pillar, underscores raising productivity but at the same time lower emissions per unit of output.
- *Adaptation*. CSA focuses on increasing the ability of smallholder farmers to adapt to climate change in order for them to maintain productivity and protect the ecosystem. It aims to reduce the impacts of short-term risks while building the farmers' capacity and prepare them for long-term stresses.
- *Mitigation*. CSA pushes for technologies and practices that reduce and/or remove GHG emissions for each calorie or kilo of food, fiber, and fuel production. This can be achieved by minimizing deforestation from agriculture and maximizing the potential of soils and trees to carbon sinks and absorbing CO_2 from the atmosphere.

Because smallholder farmers are at the forefront of combating climate change and ensuring food security, it is a must for them to transform agriculture into climate-smart. A variety of CSA technologies and practices (CSA T&Ps) for adoption were identified within seven entry points for CSA (CCAFS, 2018):

1. *Soil management*. To promote soil health and reduce the risk of run-off and soil erosion, CSA interventions range from farm level approaches, such as contour plowing or contour tillage with tied ridges, micro-catchments, and surface mulching, to landscape levels such as land terracing, contour stone bunds or reforestation.
2. *Crop production*. Crop productivity and resilience can be increased through crop varietal selection, plant breeding of higher yielding and stress-tolerant crop varieties, cropping patterns adjustments, crop, and

crop nutrient management, and other ecosystem management approaches.

3. *Water management*. Climate-smart water management practices like supplemental irrigation and rainfall capture aim to reduce or eliminate the risk of crop water stress and yield reduction. Other CSA technologies like alternate wetting and drying, not only save water but also reduce methane emissions.
4. *Livestock management*. CSA Technology and Practices (T&P) can help improve animal health and increase their heat tolerance. CSA can also reduce GHGs by focusing on feed management, enteric fermentation, and manure management.
5. *Forestry and agroforestry*. CSA promotes sustainable forest management through afforestation, reforestation, and agroforestry to increase tree cover and reduce deforestation and increase carbon sequestration.
6. *Capture fisheries and aquaculture*. CSA aims to enhance fisheries and aquaculture productivity and livelihood security by sustainably intensifying production, using better-integrated systems, improving stocks and reducing losses from disease, will increase productivity.
7. *Energy management*. CSA envisions agriculture systems to utilize alternative energy sources such as bioenergy, solar energy, and other renewables such as hydro, geothermal, and other sustainable means of usage of biomass.

Comparing with other agricultural and sustainable development concepts, CSA possesses distinct characteristics which are leaning more towards smallholders (CCAFS, 2018):

1. *Using a landscape approach to promote the maintenance of ecosystem*, CSA is more holistic and integrative in planning and management. CSA directly addresses and systematically includes climate change in the planning and development of sustainable agricultural systems. Being the most vulnerable group to the impacts of climate change, smallholders will benefit from this holistic and integrative approach.
2. *CSA is context-specific*. It looks into the unique interactions of biophysical and socioeconomic and political factors at a specific landscape. Using participatory approaches, it takes into account the unique set of needs and objectives identified by the stakeholders, including smallholder farmers.
3. *The CSA concept is beyond the set of practices or technologies* but can be an integration of multiple interventions at the food system, landscape, value chain, and/or policy level. This can help address the

concerns of smallholder farmers through the development of technologies and practices up to the elaboration of climate change models and scenarios, information technologies, insurance schemes, value chains, and the strengthening of institutional and political enabling environments.

4. *CSA prioritizes the most vulnerable sectors to climate change*, such as the rural poor, women, indigenous peoples, and other marginalized groups. By involving all the stakeholders in decision making, networks of cooperation will be built and appropriate CSA interventions will be identified and successfully implemented.

With the goal of making smallholder farmers' productive and resilient, CSA offers a wide array of options of technologies and practices that can be applied at the farm and field levels. From improved seed varieties to ecological engineering and water-saving technologies, farmers can transform their farms into more sustainable and climate-resilient ones. However, collective action is needed to address the issues of climate change and food security. The widespread adoption of CSA is expected to result in higher agricultural productivity and substantial reduction of GHGs from agricultural activities. In order to achieve significant impacts, scaling up and out of CSA should be done by all the stakeholders at all levels, most importantly by the smallholders.

CCAFS CSA INITIATIVES IN SOUTHEAST ASIA

To give more emphasis to addressing climate change through the promotion of CSA, the CGIAR implemented its research program on Climate Change, Agriculture and Food Security (CCAFS). Led by the International Center for Tropical Agriculture (CIAT), CCAFS brings together the world's best agricultural scientists and climate experts to study and address the interactions, synergies, and trade-offs between climate change, agriculture and food security. The program has been implemented in five regions of the world, such as East Africa, West Africa, Latin America, South Asia, and Southeast Asia.

CCAFS aims to generate evidence and support adoption of CSA policies, practices, and services that will help reduce poverty, increase gender equity, and support sustainable landscapes. Since its inception in Southeast Asia in 2013, CCAFS has envisioned the region to have a stable food supply, with consumers, particularly rural and urban poor having adequate access to food commodities. Giving more focus to smallholders, CCAFS has been working on the promotion of CSA T&Ps to farmers and communities to make them more productive and adapted to climate change. The program also aims to

ensure that institutional, public, and private sector capacities to implement climate change measures are strong and the climate change adaptation and mitigation measures are integrated into regional and national development plans. Through these interventions, CCAFS hopes that these will lead to more resilient agriculture in the region, with a reduced GHG contribution.

The CCAFS in Southeast Asia (CCAFS SEA) program focuses on three countries namely, Cambodia, Lao PDR, and Vietnam because they are among the most vulnerable in the region causing them to have higher developmental intervention needs. Likewise, CCAFS SEA also implemented specific projects with partners in Indonesia, Myanmar, and the Philippines. These regional R4D activities contextualized the four CCAFS Flagships: FP1 – Priorities and Policies for CSA; FP2 – Climate-Smart Technologies and Practices; FP3 – Low Emissions Development; and FP4 – Climate Services and Safety Nets in the aforementioned countries. Moreover, as a regional priority, the Gender and Social Inclusion (GSI) dimensions are integrated into research, planning, and implementation of these interventions. For the past five years, these flagship programs have carried interventions that aimed at improving the various aspects of the lives of the smallholder farmers in the region.

Priorities and Policies for CSA

CCAFS SEA has been helping the countries in the region to establish their decision-support mechanism on agriculture, climate change, and food security policies. Using research-generated data, modeling output, and innovative scenario assessment through collaborative work and partnerships with the regional economic and development bodies, major regional organizations, and concerned national agencies, CCAFS SEA has supported institutions to review and develop policies that will provide an enabling environment for CSA. Here are some of CCAFS SEA's initiatives to mainstream CSA in government policies:

- CCAFS SEA worked with the Ministry of Agriculture and Irrigation (MOAI) of Myanmar in developing Myanmar's Climate-Smart Agriculture Strategy. The document provided a framework to transform the agricultural sector in the context of climate change impacts and socio-economic growth. The strategy envisions the development of technical, policy, and investment conditions to achieve food and nutrition security through climate-resilient and sustainable agriculture (Hom et al, 2015).
- Through IFPRI and the National Economic Development Authority (NEDA) in the Philippines, CCAFS helped establish a decision-

support mechanism on agricultural, climate change and food security policies, that uses newly generated data, modelling output and innovative scenario assessment. The recommendations of the study have been utilized to inform various government agencies (e.g. DBM, Senate AgCom, NEDA) including the formulation of the strategies for the Philippine economic sectors, including agriculture, during the preparation of the Philippine Development Plan 2017-2022 (IFPRI, 2018).

- In Vietnam, CCAFS provided inputs to the country's various commitments to international agreements related to climate change in agriculture (i.e. inputs in the preparation country submissions). In the preparation of Vietnam's National Adaptation Plan in agriculture, CCAFS is providing inputs on potential CSA T&Ps (i.e., AWD) for implementation under the plan and is supporting consultation workshops with relevant government agencies to review the draft plans.
- CCAFS implemented the Policy Information and Response Platform on Climate Change and Rice in ASEAN and its Member Countries (PIRCCA) project which aimed to bridge the gap between science and policy and to establish informal and operational linkages with stakeholders, most especially farmers. The project implemented studies in Myanmar and Vietnam aimed at understanding gender differences on households' perception of climate change, farm-level, and household adaptation strategies, how households build resilience and to what extent climate change related policies can support them. The project also supported the integration of the rice restructuring strategy developed by MARD and IRRI into the rice master plan of Vietnam.
- CCAFS has developed socio-economic and climate scenarios at regional levels as a tool for strategic policy planning and investment decisions. In Cambodia, scenario-guided planning was used in the development of the country's Climate Change Priorities Action Plan that aims at strengthening smallholder farmers' agricultural resilience.

Climate-smart technologies and practices

Under this flagship, various initiatives have been done to engage stakeholders in identifying and addressing the technological priorities and related concerns of farmers, particularly the smallholders. CCAFS SEA has implemented research for development (R4D) interventions, using participatory action research, to build the capacity of local communities and

local governments in upscaling CSA through the Climate-Smart Village (CSV) approach.

CCAFS came up with the CSV concept to generate evidence on the effectiveness of CSA. Being implemented in Asia, Africa, and Latin America, the CSV approach aims "to generate evidence at local scales of what CSA options work best, where, why, and how, and use this evidence to draw out lessons for policymakers, agricultural development practitioners, and investors from local to global levels" (Aggarwal *et al*, 2018). As venues for site-specific research, CSV sites under CCAFS represent different agro-ecologies with specific climate risks and socio-political elements. The different situations among these CSVs provide comparison and diversity of context that will be very useful in developing solutions to anticipated future impacts of climate change. Specifically, the CSV approach aims to: evaluate CSA options for productivity, adaptation, and mitigation; develop solutions for future climate change impacts; learn the factors affecting adoption; and identify effective socially-inclusive and integrative financial and policy tools (Aggarwal *et al*, 2018). Major components of a typical CSV approach are practices, technologies, climate information services, insurance, institutions, policies, and finance (Aggarwal *et al*, 2018).

Introduced by CCAFS in 2015, CSVs were established in the region to serve as models of climate-resilient communities and field laboratories of CSA T&Ps. CCAFS SEA established seven CSVs in the region, including Ma, My Loi, and Tra Hat in Vietnam; Phailom and Ekxang in Laos; Rohal Suong in Cambodia; and Guinayangan in the Philippines. Through the leadership of the various centers such as CIAT, the World Agroforestry Centre (ICRAF), the International Rice Research Institute (IRRI), and the International Insititute for Rural Reconstruction (IIRR), the CSVs have served as a multisectoral platform for testing the technological and institutional options for climate change adaptation and mitigation in agriculture. The CSVs in Southeast Asia has served the convergence points of different interventions that are implemented by CCAFS-funded projects, other CGIAR projects, and other development projects that operate in the villages.

In the span of three years, CCAFS SEA, through the CSV implementation, has produced significant outputs and outcomes (Bonilla-Findji and Bui 2017):

1. *Ma CSV*. CSA T&Ps were introduced in Ma CSV, such as the improved cookstove for generating bioenergy and biochar, techniques for crop residue and animal manure management, System of Rice Intensification, and intercropping on sloping lands. CCAFS SEA, together with its partners, also implemented participatory land-use

planning (PLUP) with the involvement of villagers and stakeholders. Capacity-building and engagement activities were also done, such as engaging innovative farmers and local governments in roving workshops; and organizing the Photovoice to capture climate change issues from farmers' point of view. Ma CSV serves as the learning site for CSA in Yen Bai province and nearby communities.

2. *My Loi CSV*. Through participatory CSA testing and evaluation, My Loi CSV successfully developed scalable CSA T&Ps, such as orange-based agroforestry systems, black pepper home gardens, acacia-based agroforestry systems, and vermiculture. Several CSA T&Ps tested in My Loi CSV were selected for scaling and incorporated in the commune development plan, New Rural Development plan, and district farmer union and DARD programs. In terms of climate information services, farmers in My Loi CSV were able to: build a simple meteorological station that generates more accurate weather forecasts; and produce forecasts and agro-advisories using participatory scenario planning. In the village, CCAFS also studied the implementation of the Community Innovation Fund (CIF) ─ a loan allowing farmer interest groups to implement CSA initiatives in their communities (Le *et al*, 2018). Participatory communication and social engagement activities were also conducted, such as Photovoice, engaging youth in art and climate change activities, technology exhibits, and trade fairs.
3. *Tra Hat CSV*. Pest Smart interventions such as ecological engineering (EE), extension services through Plant Clinic, and education and awareness raising activities were implemented in Tra Hat CSV (Sivapragasm *et al*, 2017). Rice cultivars grown have been assessed in the village to identify 'entry points' for disseminating improved varieties to specific locations and seasons. Other CSA T&Ps were also introduced to the farmers like using rice straw for mushroom production and gasifier stoves.
4. *Rohal Suong CSV*. Benefiting more than 100 households, CSA T&Ps were implemented in Rohal Suong CSV, such as climate-stress tolerant rice varieties, community-managed water storage ponds, and pest smart agriculture. These CSA T&Ps were also selected as priorities for scaling out in several neighboring communities. In Cambodia, Rohal Suong CSV has been selected as a demonstration site of the International Fund for Agricultural Development -funded ASPIRE project.
5. *Phailom*. To address the water scarcity during the dry season, a model to design cost-effective roof-top rainwater harvesting system was developed in the CSV. This simple decision support tool that can be

adapted to the various conditions of Southeast Asia has been promoted, and its guidelines have been distributed to farmers in Lao CSVs. The promotion of the effective use of community ponds for aquaculture and irrigation was also done. Furthermore, community-based seed system was implemented through seed fairs, farmer field schools, and information campaigns. Photovoice was also conducted in Phailom CSV to increase and deepen the farmers' understanding of local climate change issues, the concept of CSA, and the viable options.

6. *Ekxang CSV*. Pest Smart initiative in Ekxang CSV has boosted the confidence of farmers, especially women, and increased their capacity to mitigate upcoming pest outbreaks. A complementary training program was also conducted to increase the capability of extension workers to manage plant clinics effectively and engage a large group of farmers. The CSV has also the venue for demonstrating and disseminating new climate-resilient rice varieties and promoting groundwater use for irrigation.
7. *Guinayangan*. Unlike the other CSVs, Guinayangan is not a village but a municipality located in the Philippines. It is composed of 54 barangays in coastal and mountainous areas and it is known for rice and coconut production. Various CSA T&Ps have been successfully implemented in Guinayangan, such as drought-resilient crop varieties, short-cycle tilapia-raising, community-based seed production, and impoundment systems to improve water supply (IIRR 2017). Guinayangan was also successful in promoting watershed management, community savings for sustaining environmental services, coastal bio-shield (planting mangroves as a natural barrier for tsunamis and storm surges), and scaling out of alternative pig feed production. The Guinayangan model is a good example of how an operative multi-stakeholder approach, which involves the local government units, national government agencies, non-governmental organizations, and smallholder farmers, will work. The knowledge-generated in Guinayangan is being used in the implementation of the Philippine government's Adaptation and Mitigation Initiative in Agriculture project to effectively scale out CSA to the whole country and develop sub- and national CSA frameworks.

As a venue for knowledge-sharing on CSV implementation, CCAFS has conducted the CSV roving workshop. Using experiential and on-site learning approaches, the workshop specifically aims to: enhance the participants' knowledge of CSA T&Ps; facilitate sharing of knowledge and experiences on CSA T&Ps among farmers and CSV support teams, and demonstrate community-based CSA approaches that are successful. Farmers from the

seven Southeast Asian CSVs first attended the roving workshop in the municipality of Guinayangan, Philippines last September 2015. The succeeding workshops were held in Vietnam and Cambodia, in May 2016 and August 2017, respectively.

Recently, together with the IIRR and International Development Research Center(IDRC), four new CSVs were established in the different agro-ecological zones of Myanmar, namely: Ma Sein village in Bogale (delta), Htee Pu village in Nyaung-Oo (dry zone), Kyaung Taung village in Nyaung Shwe (uplands), and Sakthal village in Hakha (hilly) (Barbon *et al*, 2017). Through these new CSVs, the scaling out of CSA T&Ps will be done using community-based adaptation strategies. A potential solution to food security and nutrition challenges in the country, the CSVs will serve as learning platforms for scaling-out CSA at the township level.

Low emissions development

A study conducted by CCAFS found that out that smallholder farmers are responsible for approximately 5% of global GHG emissions, including 32% from the agriculture sector and 29% from the agriculture-driven land-use change (Vermeulen and Wollenberg 2017). With this CCAFS R4D agenda on low emissions development (LED) also focuses on options for smallholders to reduce GHG emissions and increase carbon sequestration in their respective agricultural systems. Adoption of low-emissions agriculture provides an opportunity for more efficient use of agricultural inputs, which in turn, may provide immediate economic benefits for smallholders (Vermeulen and Wollenberg 2017).

CCAFS SEA has supported national efforts to reduce GHG emissions in the various agricultural systems by supporting the development of approaches and strategies for scaling mitigation technologies and quantification procedure/protocol guidelines. Some of the project highlights are:

1. The AWD technology, developed by IRRI and its partners, addresses the twin problems of adaptation and mitigation through efficient water management (Richards and Sander 2014). This water-saving approach enables farmers to save up on irrigation water by up to 30% and reduces methane emissions by 30-70% without a yield penalty. Through the Mitigation Options to Reduce Methane Emission in Paddy Rice project, CCAFS promoted the outscaling of the AWD technology in Vietnam, through the support of national plans with suitability maps.

2. CCAFS also funded various researches to inform Vietnam's LED plans, such as: the analysis of the costs, incentives and economic returns of the two low emission options (AWD and Mid-season Drainage) for rice; the climatic suitability mapping in MRD to promote AWD+ outscaling; the GHG emission measurements in rice fields in Central Vietnam under continuous flooding and AWD treatments; and the estimation of GHG emission in ruminants in three sub-agro-ecological zones of Ba Vi Province.
3. In Indonesia, CCAFS investigated the global warming potential of current farming practices of dairy farms in Lembang district, West-Java. The research found out that an average dairy farm in Lembang emits 33 ton CO_2e per year, which is equal to 1.9 kg CO_2e per kg fat and protein corrected milk (FPCM), a unit of measurement that allows comparison of the carbon footprint of dairy products (De Vries *et al*, 2017). Using scenario analysis, CCAFS identified several improved feeding and manure management practices (i.e., maize silage feeding, improved manure management through reducing the amount of discharged manure and adding roughage in the diet) that have potential to reduce emissions from dairy farms in Lembang.
4. Through organizing consultation workshops, the program has also supported the development of a regional support system (e.g., clearing house) for a more effective Nationally Appropriate Mitigation Action (NAMA) implementation of among the Southeast Asian countries.
5. In the preparation of Vietnam's INDC before COP 21 in Paris, studies such as those conducted by IFPRI and IRRI on the effectiveness of various agricultural mitigation options were important in helping determine the emission reduction targets in agriculture. Simulation models and scenario outputs were shared to determine AgINDC emission reduction targets. MARD also requested CCAFS to support the national consultation prior to the submission of the agriculture INDC in 2015 After Vietnam submitted its INDC, MARD sought to review INDC for the crop, livestock, forestry, and aquaculture options, and develop an implementation plan. A study also found out the very low awareness of the stakeholders, including farmers, on climate change mitigation measures and NDC. CCAFS recommended the government to conduct information campaigns on GHG emission reduction stated in the NDC plan among farmers, government officials, and other stakeholders (Trung *et al*., 2017).
6. CCAFS also provided inputs in Vietnam's membership in the Climate and Clean Air Coalition (CCAC) in 2017.

Climate services and safety nets

In Southeast Asia, particularly in countries like Vietnam, Cambodia, and Lao PDR, relevant government agencies provide seasonal forecasts, agro-advisories, and other climate services that to some extent can be utilized during crop seasons. National and community-based mass media such as television, radio, and village loudspeakers serve as platforms where these services are delivered to the people. However, not everyone, most especially the resource-deficient smallholders, can easily access these platforms, let alone climate services (Simelton *et al*, 2018). Moreover, there are discrepancies between accessible and preferred platforms, which implies that climate services are being delivered in formats that do not necessarily fit the needs or preferences of the target end-users, particularly smallholder farmers.

To address this gap, CCAFS has implemented research activities on climate services and safety nets to understand and act on agro-meteorological information needs of various stakeholders and their support network. By developing innovative ways by harnessing modern and traditional information and communication technologies, CCAFS aims to provide early warning systems for various climate-related risks and to establish effective on-farm delivery systems for climate information and products. Together with local and international partners, CCAFS SEA has conducted the development of effective climate information and advisory services for farmers and climate-informed safety net interventions.

In many countries, men farmers can access agro-climatic information more easily, which constrains women's participation in decision making at various levels. To enable women farmers, ethnic minority farmers, and agricultural planners to better anticipate and respond to risks and opportunities from changes in weather patterns, CCAFS SEA implemented the Agro-Climate Information Services for women and ethnic minority farmers in Southeast Asia (ACIS) project. Led by ICRAF and CARE International, the project provides practical agro-climatic information and guidance, with particular attention given to the unique gendered aspects of disseminating this information, in Vietnam, Lao PDR, and Cambodia from 2015 to 2018. For the past three years, ACIS has helped the smallholder farmers through the: development and distribution of participatory agroadvisories in 89 villages in the three priority countries; improvement of community weather stations; downscaling of seasonal forecasts; and capacity development, particularly for the women and youth.

Another climate-risk information system successfully developed by CCAFS SEA, the Climate-Smart Maps and Adaptation Plans (CS-MAP) was adopted in the 13 provinces of MRD to promote sustainable rice production (Son *et al*, 2018). CS-MAP, a highly participatory approach, engages experts

from the national and local levels to identify climate-related risks; determine potential affected areas and their risk levels using technical, infrastructure and topographic data, and local knowledge; assess and improve proposed adaptive measures; and develop integrated adaptation plans for rice production from regional to provincial levels. Using the CS-MAP methodology, risk maps for flooding, drought and salinity intrusion and corresponding monthly adaptive cropping schedule, both for normal and severe years were developed for the whole MRD. Through a resolution, MARD adopted the CS-MAP for rice production management in the region, with six provinces already operationalizing the methodology.

In rural areas, radio is still an effective channel to disseminate information. In 2015, CCAFS together with the Philippine Federation of Rural Broadcasters (PFRB) implemented a radio campaign called "Climate Change i-Broadkas Mo" (Cruz *et al*, 2016). The campaign mobilizes rural communities to advocate principles and the practice of CSA. A set of 156 interviews and 165 scripts in local languages were prepared and distributed to 153 rural broadcasters. These were aired in at least 78 radio stations nationwide, reaching about 2 million listeners, mostly smallholder farmers. An offshoot of the radio campaign, a school-on-the-air (SOA) project on climate-smart agriculture (CSA) was conceptualized and implemented in Cagayan Valley, Philippines from February to March 2018. Spearheaded by the Philippine Department of Agriculture (DA)—through its Regional Field Office 2 (DA-RFO2)—together with PFRB, the Philippine Agriculture Journalists, Philippine Rice Research Institute, CCAFS SEA and 12 partner agencies, 60 modules on CSA T&Ps were shared with more than 10,000 initial farmer-learners in the major rice producing provinces in the region. This approach will be outscaled in other regions in partnership with the Agricultural Training Institute (ATI) and State Universities and Colleges (SUCs).

Gender and social inclusion

Women and children are the most vulnerable groups to the impacts of climate change. This makes gender and social analysis a very critical aspect in understanding the various socioeconomic factors affecting agriculture and climate change. Thus, gender equality and social inclusion (including the youth) cut across all the R4D activities of CCAFS – from CSA to climate risk management, LED, and policies and institutions. Through participatory methodologies, CCAFS SEA has engaged women and the youth in various research activities and community interventions. With the goal of harnessing their capabilities and increasing their participation in decision-making,

CCAFS SEA has successfully implemented various projects across the region.

Previously discussed under the flagship programs, it is evident that gender issues and other related social concerns are being addressed by CCAFS. At the policy level, CCAFS's recommendations focus on addressing gender disparities and social differentiation to ensure gender equality, improved welfare, and adaptive capacity to climate change. Aside from increasing women and the youth's participation in CSA research, efforts have been done to study the gender dimension and social implications of various CSA interventions. Moreover, in improving climate information services in the region, CCAFS SEA has put women and other marginalized groups in the forefront, like what has been done in the ACIS project.

Studies were also done by CCAFS to ensure that rural women benefit from its contribution to poverty reduction, enhanced environmental resilience, and improved food security, human health and nutrition. CCAFS SEA's R4D activities on gender resulted to: improved knowledge on perception of climate change risks, effects on and changing gender roles, and labour distribution by gender in rice production; understanding barriers and constraints faced by men and women in CSA adoption; and identification of enabling factors that could enhance adoption and scaling out of CSA by men and women.

With a 50-60 year average age of farmers across the region, there is an urgent imperative to engage the youth in agriculture. Rising up to this challenge, the Philippine Rice Research Institute, together with CCAFS SEA, pursued an Infomediary Campaign to cultivate the interest of young people in rice farming (Manalo *et al*, 2015). In the campaign, high school students were tapped to serve as information providers on climate-smart agriculture for rice (CSA4Rice) to farming communities. Aside from the basics of rice farming and climate change, they were taught how to access platforms to get agricultural information, which they could pass on to the larger farming communities. From 2012-2016, the campaign involved over 200 high schools nationwide, of which 81 are vocational high schools.

OUTLOOK FOR SOUTHEAST ASIA

With the goal of ensuring food security amidst climate change in the region, CCAFS SEA is working with its partners, not only to improve the well-being of smallholder farmers but also to integrate climate change adaptation and mitigation in regional and national development plans. To pursue CCAFS' vision for Southeast Asian agriculture, more strategic R4D activities are being carried out to address the following opportunities and challenges in the region:

1. *Coping with climate change*. To cope with extreme weather events and changing climatic conditions, CCAFS will focus on scaling up and out CSA technologies and practices in its priority countries that will help cope with drought, flooding, salinity intrusion, rainfall variability, heat stress, and cold spells. Better access to climate information services such as early warning, seasonal forecast, and risk mapping will also be intensified to help farmers make informed decisions, manage risks, take advantage of favorable climate conditions, and adapt to climate change. Moreover, development of climate index-based crop insurance will be further evaluated as a major risk mitigation strategy, especially for smallholder farmers in the region. It is noted that crop insurance for small holders in the region is highly subsidized or non-existent because of the high risk to extreme events of many of the countries.
2. *Sustaining national and regional food and nutrition security*. The current goal of CCAFS is to catalyze positive change towards CSA, and resilient, low emission food systems and landscapes, with emphasis on improving food and nutrition security. To ensure that the Southeast Asians, most especially the smallholders and their families, will be food- and nutrition-secure, agriculture must withstand the effects of climate change and adequately produce nutritious food for human health.
3. *Enhancing competitiveness in agriculture*. With an increasing role of Southeast Asia in the global agro-food trade, there is a need to elevate the quality of its products to meet international standards through more efficient and productive technologies and practices. Smallholder farmers should be equipped with proper skills and resources to increase not only their productivity but also their competitiveness. Towards this, bigger investments in agriculture R4D are needed to foster sustainable and more competitive agriculture in the region.
4. *Towards a regional integration*. As part of the establishment of the ASEAN Economic Community in 2015, the integration of agriculture initiatives across the region will be very crucial in addressing the impacts of climate change. There is a need for stronger regional collaboration and coordination in planning and implementing mitigation and adaptation activities. Along with this, the smallholders and the role they play should be a major consideration in harmonizing agro-economic policies, production systems, and value chains.

In addressing the foregoing challenges and opportunities, CCAFS SEA will implement an integrated R4D approach targeting the region's food baskets (e.g., Mekong River Delta and Basin, Ayeyarwady River Delta and Central Dry Zone of Myanmar, Chao Phraya River Basin in Thailand, Red River Delta and Central Highlands in Vietnam, and the big river basins in Indonesia and Philippines). Aside from their strategic importance in the region's economy and food and nutrition security, these areas are also highly vulnerable to the adverse effects of climate change (Fig. 1). To have a more integrated set of activities and interventions, CCAFS will converge the activities of its four R4D flagships in the CSVs.

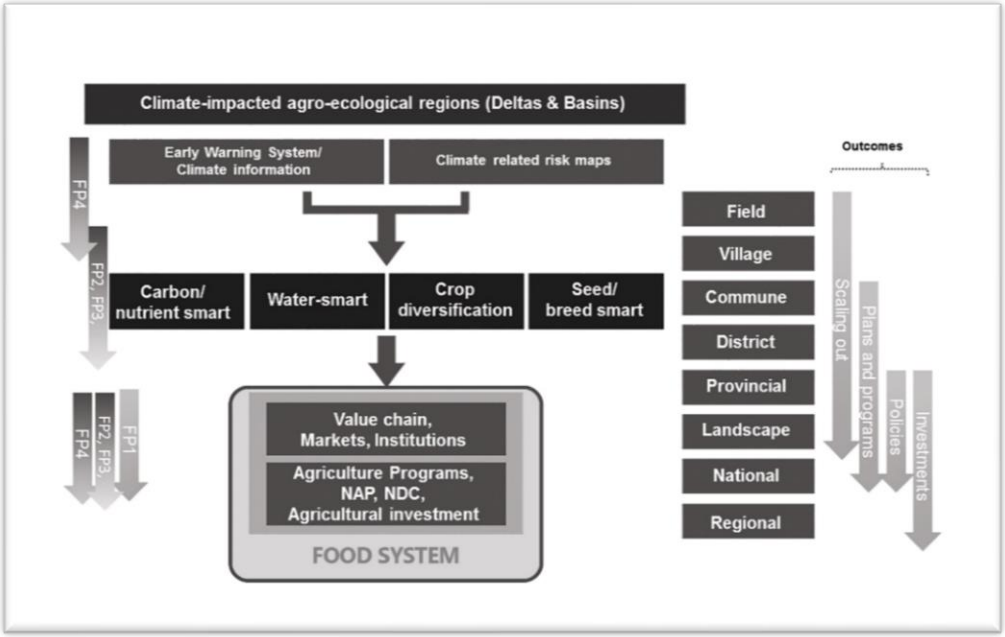

Fig. 1. CCAFS program framework for Southeast Asia.

An illustrative case could be pursued at the Mekong River Basin addressing major impacts of climate change in the area. The FP4 (Climate Services and Safety Nets) project will provide climate services to FP2 (Climate- Smart Technologies and Practices) or FP3 (Low Emissions Development), project interventions ensuring their effectiveness, and FP1 (Priorities and Policies for CSA) will look at the broader impact of the interventions on food systems and determine policy requirement to support upscaling of FP2, FP3, and FP4 interventions.

By refocusing its R4D framework and revisiting its research approaches, CCAFS SEA has identified its new set of targets and priorities starting in 2019:

1. *Priorities and Policies for CSA*. Supporting policy formulation, CCAFS SEA will evaluate the impact of climate change and the effect of various CSA interventions in the broader context of food systems at different levels in the region. The research will be done on the effect of various CSA interventions in the food system in relation to the synergies and trade-offs in health, environment, and economic outcomes. CCAFS SEA aims to continue providing policy recommendations at the ASEAN and national levels and in supporting the countries in the implementation of their NAP and NDC.
2. *Climate-Smart Technologies and Practices*. Under this flagship, the goal is to improve the adaptation and resilience of smallholders for Southeast Asia in the large rainfed and flood/drought-prone areas which are also the most vulnerable to the impacts of ENSO. CCAFS SEA will tests, evaluate, and most importantly, link emerging evidence to influence investment and scaling out. Priority will be given to testing and evaluation of transformative technologies and business models that will include components on drought and flooding risk mapping, innovative technologies, and arrangements for water management, including solar irrigation, stress tolerant crop seed systems, crop diversification, agroforestry, and climate advisory services. Targeting women and minorities, CCAFS will introduce gender-sensitive CSA options and business models that will sustain and upscale the interventions. With the presence of CSVs in these areas, the preferred geographic targets for these interventions are the Mekong basin (Cambodia and Laos), Central Coast of Vietnam, and/or the Central Dry Zone in Myanmar.
3. *Low Emissions Development*. The goal of the project is to reduce GHG emission in major rice production areas in the region, particularly the big river deltas such as Mekong River Delta (Vietnam), Chao Phraya River Basin, and Ayeyarwady River Delta (Myanmar), CCAFS SEA will develop the evidence base and tools that will allow rapid mainstreaming and upscaling of LED technologies that will help the target countries attain their GHG emission reduction targets. Also, CCAFS will continue to develop feasible low-emission strategies for Indonesian smallholder dairy farmers that will: sustainably increase farm productivity of smallholder dairy farmers, while reducing greenhouse gas emissions; improve resource use efficiency, and increase farmer income.
4. *Climate Services and Safety Nets*. Supporting the operationalization of climate information services across vulnerable areas in Southeast Asia, the program's priority areas of research include adaptability of the Enhancing National Climate Services (ENACTS) approach to SEA,

enhancements to seasonal drought prediction, delta region hydrology/salinity risk mapping, and early warning. CCAFS will also move towards integrating climate information services in all of its flagship projects and activities. Aside from improving the accessibility of decision-makers and farmers to climate information services, developing climate index-based crop insurance as a major risk mitigation strategy for smallholder farmers will be another CCAFS SEA's priority.

SUMMARY

Despite their huge number, smallholder farmers still belong to the marginalized sectors in Southeast Asia. With limited access to technology, resources, and information, smallholders have become highly vulnerable to climate change and its impacts. To address production challenges and achieve adaptation and mitigation, CSA is an approach that smallholder farmers can adopt for more sustainable agriculture. CGIAR, through CCAFS, has done various R4D on climate change to help uplift the capacities of smallholders to cope with climate change. CCAFS has successfully promoted CSA through its various interventions through its flagship programs on priorities and policies for CSA, climate-smart technologies and practices, LED, and climate services and safety nets, and gender and social inclusion. As the challenges posed by climate change intensify, CCAFS will continue to support Southeast Asia in helping its smallholder farmers cope with climate change; sustaining national and regional food and nutrition security; enhancing its competitiveness in agriculture, and strengthening the regional integration.

From this experience of promoting CSA, CCAFS SEA is recommending strategic actions to make smallholders in Southeast Asia more climate-smart:

1. *From CSVs to Deltas/Basins - The need for a holistic or integrated approach*. Integrated management of landscapes is important to support food production, maintain ecosystem services, and improve the livelihood of smallholder farmers. Through a more holistic approach, the interlinking relationships of the biological elements (e.g., water resources, agriculture, and biodiversity) and other related factors (e.g., political, socio-economic, and cultural) in the landscape are understood and taken into consideration. Using integrated planning and management strategies, factors like the varying stakeholders' interests, synergies, and trade-offs among different land use can be identified and harmonized. Through this, the concerns of the smallholders will not be neglected from the planning up to the

implementation of any CSA intervention. Moreover, to effectively scale CSA, it is important to study and invest in all the enabling factors, such as policies and institutional arrangements, stakeholder involvement and gender considerations, infrastructure, insurance schemes, and weather information and advisory services.

2. *Practical and innovative - Developing location-, time-, and risk-specific options*. To have a more targeted response system to climate-related risks, the establishment of a comprehensive early warning system is a prerequisite. Using geographical information system and information and communication technology, the system could identify the spatial distribution and levels of potential impacts. Through risk maps, information related to climatic pattern, topography, hydrology, cropping system, crop calendar, infrastructure (e.g., roads, dykes, canals, sluices), vulnerability (e.g., including poverty and ethnic groups), risks (flood, drought, saline intrusion) and recommended actions (e.g., crop calendar adjustment, planting tolerant varieties) should be consolidated. Furthermore, a strategic communication platform should also be in place to provide timely alerts and advisories to well defined affected areas. This location-, time-, and risk-specific system will allow more effective preparation of contingency actions. The development and implementation of this mechanism should be with the involvement of all the disciplines and stakeholders from various sectors, particularly the smallholders (i.e. CS-MAP implemented in Vietnam).
3. *Mainstreaming CSA in programs and/investment plans*. To effectively scale CSA, most especially among smallholder farmers, the creation and implementation of appropriate policies integrating CSA into national programs and investments are necessary. It should not be treated as a standalone program or investment plan. CSA should be integrated into the national and regional strategies and plans including the NAPs, NDCs, and NAMAs, and in the agriculture and food security plans included in national development and poverty reduction strategies. This can be done through: capacity building of policymakers, institutions and relevant stakeholders; developing and promoting decision support tools; providing evidence for CSA scaling; and strengthening partnerships and implementing collaborative activities with relevant government and private institutions.

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