

ASEAN Regional Guidelines for Promoting Climate Smart Agriculture (CSA) Practices Volume II



**ASEAN Regional Guidelines
for Promoting Climate Smart Agriculture (CSA)
Practices**

Volume II



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Acronyms

ACIS	Agro-climate Information Services
ADPC	Asian Disaster Preparedness Centre
AGCM	Global atmospheric model
AMAF	ASEAN Ministers of Agriculture and Forestry
AMS	ASEAN member states
AOGCM	Atmosphere–ocean general circulation models
ARCC	Adaptation and Resilience to Climate Change
ASEAN	Association of Southeast Asian Nations
ASEAN-CRN	ASEAN Climate Resilience Network
ASEANCOF	ASEAN Climate Outlook Forum
ATWGARD	ASEAN Technical Working Group of Agriculture and Research Development
BAAC	Bank of Agriculture and Agricultural Cooperation (Thailand)
BMKG	Indonesian Agency for Meteorology, Climatology and Geophysics
BMZ	German Federal Ministry for Economic Cooperation and Development
CCAFS	Climate Change in Agriculture and Food Security
CIAT	Center for International Tropical Agriculture
CFS	Climate Field School
CGIAR	Consortium of International Agricultural Research Centers
CIS	Climate information services
COF	Climate Outlook Forum
CPT	Climate Predictability Tool
CRAFT	CCAFS Regional Agricultural Forecasting Toolbox
CrFS	Climate Resiliency Field School
CSA	Climate Smart Agriculture
CSUF-Ag	Climate Services User Forum for Agriculture
ENACTS	Enhancing National Climate Services
ENSO	El Nino Southern Oscillation
FAO	Food and Agriculture Organization of the United Nations
FARM	Forecast Application for Risk Management
FFS	Farmer Field School

FOR-CC	Forestry and Climate Change
GAP-CC	ASEAN-German Programme on Response to Climate Change
GFCS	Global Framework for Climate Services
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographic Information Systems
GIZ	Deutsche Gessellschaft fur International Zusammenarbeit GmbH
ICT	Information and communication technology
ICM	Integrated crop management
IFAD	International Fund for Agricultural Development
IFS	Integrated Farming Systems
ILM	Integrated landscape management
IPM	Integrated pest management
IPSARD	Institute of Policy and Strategy for Agriculture and Rural Development (Vietnam)
IRI	International Research Institute for Climate and Society
LGU	Local government unit
LI	Lending institutions
MPCI	Multi-Peril Crop Insurance
MRTV	Myanmar Radio and Television
NAIPP	National Agricultural Insurance Pilot Program
NDVI	Normalized Difference Vegetation Index
NMHS	National Meteorological and Hydrological Services
NHMFC	National Hydro-Meteorological Forecasting Centre
PCIC	Philippine Crop Insurance Corporation
PPP	Public private partnership
RCM	Regional Climate Model
RIMES	Regional Integrated Multi-Hazard Early Warning System
RSBSA	Registry System for Basic Sectors in Agriculture
RWAN	Rice Watch and Action Network
SSNM	Site-specific nutrient management
UNISDR	United Nations Office for Disaster Risk Reduction
WMO	World Meteorological Organization

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The chapters represent topics of keen interest to the member states, which also coincided with practices being promoted by development partners and stakeholders in the region. The vast learnings from the concluded USAID Mekong Adaptation and Resilience to Climate Change (ARCC) were freely shared in this volume through the contributions of the Development Alternatives, Incorporated. The technical expertise coming from the Climate Change in Agriculture and Food Security (CCAFS) programme cross-cutting along the CGIAR (Consortium of International Agricultural Research Centers) group, especially the Center for International Tropical Agriculture (CIAT) put together for this volume a very comprehensive chapter on climate information services. The Rice Watch and Action Network (RWAN), not only hosted the ASEAN-CRN's knowledge exchange event in March 2017 but also put together a story from the field.

In short, this volume is a collaboration among CSA experts and project managers on the field within Southeast Asia. This would not have been achieved without the valuable and free contributions of the following institutions and individuals.

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INTRODUCTION

Introduction

The ASEAN Regional Guidelines for Promoting Climate Smart Agriculture (CSA) Practices (now considered as Volume 1) were endorsed by the 37th AMAF in September 2015. The Guidelines were the result of a process initiated by Thailand with its proposal on “Production System Approach for Sustainable Productivity and Enhanced Resilience to Climate Change” to the ATWGARD in 2013. This proposal led to the formation of the ASEAN-CRN, which facilitated the process of coordinated National Studies in collaborating ASEAN Member States (AMS) (Cambodia, Indonesia, Lao PDR, Myanmar, Philippines, Thailand, Vietnam). By 2015, all National Studies have been approved by the focal points of ATWGARD in the respective country and were combined in the Regional Study on the Promotion of Climate Resilience for Food Security in ASEAN.

The process of developing the National Studies entailed assessing climate change impacts on agricultural value chains with high relevance for food security and identifying priority practices to promote resilience in the respective value chains of rice, and maize or cassava. Each practice is documented in terms of its technical requirements as well as institutional and enabling factors necessary for scaling-up. Multi-stakeholder national consultation-workshops were conducted to prioritize and fully document the country-specific CSA practices. Furthermore, through several ASEAN-CRN meetings, AMS identified priority practices for promoting climate resilience in ASEAN and agreed on how to promote the scaling-up of such practices in ASEAN. A number of exchange activities between AMS were facilitated by the ASEAN-CRN to improve the common understanding on prioritized practices.

To synthesize the learnings from the National Studies and the regional prioritization and exchange process, the ASEAN Regional Guidelines for Promoting Climate Smart Agriculture Practices were developed. They outline the background of their development and elaborate on how they align with relevant ASEAN Frameworks and Structures. Furthermore, the role and objectives of the ASEAN-CRN for implementing the Guidelines is laid out. Specifically, it details the principles of regional cooperation to scale-up CSA practices and the role the ASEAN-CRN is playing in that regard.

The 2nd major Chapter of the ASEAN Regional Guidelines for Promoting Climate Smart Agriculture Practices entails the Technical Guidelines on Good Practices. The chapter covers the following five (5) of the previously identified priority practices for promoting climate resilience in ASEAN:

1. Stress-tolerant Maize Varieties,
2. Stress-tolerant Rice Varieties,
3. Agro-insurance using Weather Indices,
4. Alternate Wetting and Drying,
5. Cropping Calendar for Rice and Maize

To advance the implementation of the ASEAN Regional Guidelines for Promoting Climate Smart Agriculture Practices, the ASEAN-CRN in cooperation with development partners facilitated several regional as well as national level activities in the course of the years 2015, 2016 and 2017. Those activities further shaped the

agenda of ASEAN to cooperate on the promotion and scaling-up of CSA practices in the region.

To follow-up on the advancements made on implementing the Guidelines, as well as to cover four (4) additional priority practices for promoting climate resilience in ASEAN which were identified in the studies on Promotion of Climate Resilience for Food Security in ASEAN, the ASEAN-CRN, in cooperation with technical and development partners, drafted a second Volume of the ASEAN Regional Guidelines for Promoting Climate Smart Agriculture Practices. This 2nd Volume complements the Technical Guidelines of the 1st Volume and covers the following four practices in separate chapters:

1. Integrated Farming Systems
2. Rice Shrimp Farming
3. Agricultural Insurance
4. Climate Information Services for Agro-Advisories

The Chapters are based on ongoing or completed projects promoting climate resilience as well as on the outputs of respective ASEAN-CRN events like these following major regional events organized through the ASEAN-CRN:

- ASEAN CRN Workshop on Promoting Climate Smart Agriculture Practices, 26-27 October 2015, Ho Chi Minh City, Vietnam
- First ASEAN-CRN Planning Meeting, 14-15 December, Bali, Indonesia
- Knowledge Exchange Event “Effective Policies for Promoting Crop Insurance to Increase Resilience in ASEAN”, 16-18 August 2016, Ho Chi Minh City, Vietnam,
- Knowledge Exchange Event “Use of Climate Information Services in Agriculture in ASEAN”, 21-23 March 2017, Cebu City, Philippines.

The chapters represent topics of keen interest to the member states, which also coincided with practices being promoted by development partners and stakeholders in the region. The vast learnings from the concluded USAID Mekong ARCC were freely shared in this volume through the contributions of the Development Alternatives, Incorporated. The technical expertise coming from the CCAFS programme cross-cutting along the CGIAR (Consortium of International Agricultural Research Centers) group, especially CIAT put together for this volume a very comprehensive chapter on climate information services. RWAN not only hosted the ASEAN-CRN's knowledge exchange event in March 2017 but also put together a story from the field. In short, this volume is a collaboration among CSA experts and project managers on the field within Southeast Asia.

After two years of active regional collaboration on the promotion of resilience in ASEAN through scaling-up CSA practices, the 2nd Volume of the ASEAN Regional Guidelines for Promoting Climate Smart Agriculture Practices is a timely update and complement to the 1st Volume, by focusing on the technical aspects of prioritized CSA practices as well as practice specific regional collaboration agreements.



GENERAL INFORMATION OF RICE FIELD

Name of Farmer:	Phone No. (in City)
Area (ha):	in Village
Block (municipality):	in District
General Location:	in Province
Planting Date:	in Year
Planting Season:	in Season
Planting Method:	in Method
Planting Density:	in Density
Planting Date:	in Date
Planting Season:	in Season
Planting Method:	in Method
Planting Density:	in Density

1 AGRICULTURE INSURANCE

1. Agricultural Insurance

Story from the Field: Agricultural insurance to adapt climate change in Vietnam

The Mekong River Delta is the main rice production area of Vietnam and most farmers in this region rely on rice production to earn their living. However, this region is heavily affected by climate change as well as the up-stream activities along the Mekong River, which together, make their production increasingly risky.

Different measures are used by both the government and farmers to mitigate this situation. The use of agricultural insurance is considered one effective tool to manage risk, to combined with other measures for increasing resilience.

Mr. Nguyen Van Ba is a 62-year old farmer in Thanh Phu district, Ben Tre province who has been growing rice since he was 18 years old. In 2011, his rice field was damaged by extreme salinity intrusion and drought became more and more severe in the following years. Faced with this situation and reduced income from his rice fields, in 2013 Mr. Ba considered to switch from rice to shrimp production, which is potentially more profitable. However, this is a decision that cannot be taken lightly as switching to shrimp farming constitutes a major investment for him and his family. To afford the switch, Mr. Ba would have to mortgage his house to borrow money from the bank and borrow additional money from relatives. Under the most optimistic scenario, he would be able to pay off his loan within 3-4 years. But the case that disaster strikes and he experiences losses in shrimp production due to many possible factors, he would risk to default on the loan, or even go bankrupt.

Faced with this decision, Mr. Ba heard about the National Agricultural Insurance Pilot Program (NAIPP). Staff from the local government as well as an insurance company staff consulted him about the premium support rate, production requirements, the trigger threshold as well as the compensation of the insurance policy available under the program.

After careful consideration, Mr. Ba confidently decided that covered by the agricultural insurance to manage the high risk from switching to shrimp production he would take the decisive step. By joining the NAIPP, Mr. Ba not only received financial support to pay the insurance premium. Staff from local government also visited his pond regularly to monitor his production and provided recommendations on the most appropriate production procedure to reduce production risks. Haven taken this step, Mr. Ba is confident that he is better equipped to meet the increasing challenges of climate change.

While coastal provinces in the Mekong River Delta are affected mostly by salinity intrusion and drought, provinces located up-stream are suffering from heavy rain and disease outbreaks.

Mr. Nguyen Giang Tu and his wife are only 33 years old but they both have more

than 15-year old experience in farming. His family of four is a near-poor household in Tan Hong District, Dong Thap province and their main income comes from the 1.6 ha field where they cultivate 3 crop cycles per year. In the recent years, due to the impacts of abnormal weather condition and diseases outbreaks, Mr. Tu were really worried and afraid that if his field is affected, he will not have enough money for their daily living, especially education costs for their 2 children. To minimize risk, Mr. Tu has to use a lot of seed to deal with the heavy rains. About 300 - 350kg seed/ha were needed while other households can usually do with 200-250kg/ha. He also felt that he needs to use more pesticides and apply them 5-6 times each season, instead of 3-5 times/season as usually common, to deal with the increased occurrence of pests. Mr. Tu was aware that this changes in practice increase the production costs and harm the environment, but he couldn't help doing that concerning the risk of crop losses under the changing conditions.

In 2012, he participated in a village meeting and was introduced to the NAIPP. As his household was near poor, 80% of the premium was subsidized and he only had to pay 20%. This meant paying 333.000 VND (USD14) instead of the actual price of 1.688 million VND (USD74). The subsidy was even increased to a 90% at a later stage, which left him paying USD7.4. Apart from premium support, Mr. Tu also received a guideline on the recommended production procedure according to Ministry of Agricultural and Rural Development standard. The guideline encourages farmers to reduce the amount of seed, fertilizer, pesticide and water as well as certified varieties. It also helps with limiting post-harvest losses.

As his production risks were insured through the NAIPP, Mr. Tu was courageous to follow the suggested procedure, albeit his concern that the new practice might affect his yield. He significantly reduced the amount of seed, fertilizer and pesticide and thereby reduced his production cost. In 2013, heavy rain affected Mr. Tu's field, just a week after sowing and all of seed was damaged. Mr. Tu informed representatives of the insurance company about this loss and two weeks later received compensation. Using this compensation, he could pay off the loan he took to buy seed, which without insurance, he would not be able to pay back until the end of the season which would add significant interest payments.

The NAIPP ended in 2014 after 3 years of implementation, however, it is proved to be an effective measure to insure the production risks that is hampering the scaling-up of CSA models in Vietnam. The Vietnamese government has drafted an official decree on agricultural insurance which is expected to be approved in 2017 and will create a legal framework for the development of agricultural insurance in Vietnam.

1.1. Agriculture Insurance to Promote Climate Resilience in Agriculture

As farmers face increasing agricultural production challenges in the wake of climate change, agricultural insurance through government programs can offer an effective safety net to protect against losses from drought, flooding, erratic rainfall, severe storms and other risks. If unmitigated, smallholder farmers in particular will continue to fight an uphill battle to gain productivity increases, improve their livelihoods and protect their production. As these Regional Guidelines discuss, there are many complementary approaches that can be adopted and implemented to beginning building resilience and mitigating the negative impacts of climate change – agricultural insurance is one layer in the strategy.

The goal of agricultural insurance is to transfer some of the production risks that farmers face to the private insurance sector. In seasons where farmers experience particularly high losses (trigger points can be determined to fit specific situations) by a risk(s) beyond their control, insurance would compensate farmers for some of this loss. This compensation may be used to reduce negative coping strategies (reducing meals, taking children out of school, using poor quality farm inputs the next season, selling livestock, etc.). In return, farmers, or governments on their behalf, pay a premium at the beginning of the season to the insurance company for this protection – greater details on insurance products are given in section 2. National insurance programs can act to reduce the direct costs of relief programs in the event of natural disasters impacting agricultural production – since some of the production risks are insured, the insurance compensation can help support the impacted farmers.

Note that insurance covers *some* of the losses farmer experience from climate risk, ideally agricultural insurance is just one part of a multi-layer, holistic climate risk mitigation strategy. Insurance provides a safety net for events that are beyond the control of a good farmer, but that farmer must take steps to mitigate risks.

- *Base layer: climate knowledge with adapted varieties, choice of crops and cropping patterns.* Farmers now increasingly require an understanding of how shifting climatic patterns will practically impact their fields. Ideally existing extension services can address this with seasonal weather forecasts and respective advice on optimal crops, varieties and planting times. Farmers would select crop varieties better suited for increased temperatures, prolonged drought, water submersion, increased salinity or shorter growing seasons. Planting times and crops can also be adjusted - for example in Indonesia, shifting from rice to corn cultivation in the third season, as over the last years less irrigation water has been available during this season. Other practices to increase resilience on the farm level are covered in these Guidelines. As insurance pays out when losses are experienced, having more resilient farms will reduce the frequency of a needed payout.
- *Second layer: government infrastructure programs addressing climate effects.* This includes improved irrigation systems, damming to reduce flooding, coastal protection against salt water incursion and others.
- *Third layer: community level social safety nets like self-insurance.* Communities, through group saving, may be able to support local farmers

who face one-off losses, wherein the other farmers in the area have a normal season. This would reduce the need for insurance products that isolate individual farmer losses.

- *Forth layer: agricultural insurance underwritten by local insurance companies and reinsured.* In areas with high production losses, insurance can come in to shift this risk to the private insurance sector and farmers receive compensation at these times. Insurance can work as an alternative to emergency relief programs, though in most cases will not completely replace them. Insurance products must be structured to only compensate farmers when the losses are beyond their control, always incentivizing farmers to take best care of their crops (addressing moral hazard concerns).
- *Fifth Layer: government relief programs or catastrophic national or regional insurance* that covers for extreme events that inflict large scale production losses across a wide area.

1.2. Designing Effective Agricultural Insurance Products

As a critical element in a climate risk mitigation strategy, agricultural insurance has numerous design options that can be considered when developing a tailored product to fit the farmer's needs. When developing a crop insurance program or commercial business, one must address product design, distribution channels, farmer socialization and awareness creation, registration, loss assessment and stakeholder coordination strategies.

This section focuses on product design elements and is based off of *Overcoming Challenges Facing National Crop Insurance Programs in Four ASEAN Countries*¹, a paper that also discusses other key elements in insurance programs in greater detail. A step-by-step guide, *10 Phases in Developing a National Crop Insurance Program*, has been published as a Framework Guide by the ASEAN Community, and expands upon the information complementary to this chapter for the actual design and implementation of a national agricultural insurance program.

1.2.1. Generalized Roles of Agricultural Insurance Program Stakeholders

An effective government agricultural insurance program includes the involvement and coordination of a range of stakeholders from the public and private sectors. Each of these actors play important roles, the below description are brief generalizations and may vary depending on the structure of the national program, its goals and the role of the government.

- *National Government* – supports and advocates for agricultural insurance as part of the larger climate resilience strategy, various national level ministries play critical roles.

¹ A. Schrevel, L. Johnson Blair, A. Daniswara. *Overcoming Challenges Facing National Crop Insurance Programs in Four ASEAN Countries*. Working Draft, to be published in 2017. Available upon request from LDJ3@cornell.edu.

- *District and Local Governments* – facilitates farmer awareness and capacity building through Extension Services and other farmer outreach, support and verify loss assessment, liaise with local insurance branches on implementation.
- *Ministry of Agriculture* – may lead the Agricultural Insurance Working Group, ensures products are customized to the actual needs of the farmer end beneficiaries, likely housing government’s implementation team, direct involvement with development partners and insurance companies. Provides objective localized yield data for yield index products and linkages to the national meteorological services for climate data for weather index products.
- *Ministry of Finance* – financial support for the premium subsidy, transferred to the local insurance company upon approval of farmer registration. May take more active role in product design and implementation with Ministry of Agriculture, depends on if there is a government department of insurance.
- *Insurance Regulator* – designs and modifies agricultural insurance regulatory frameworks to create a conducive environment that balances protecting smallholder farmers while also making a commercially-attractive agricultural insurance space for insurers and reinsurers.
- *Distribution Channel Partners* – facilitates access to farmers through established networks. These include banks and microfinance institutions bundling insurance with credit, agri input companies bundling insurance with seed and fertilizer and mobile network operators leveraging mobile networks and mobile money to reach farmers and then generate data sets of farmer locations and planting timing.
- *Local Insurance Companies* – designs and underwrites the program’s insurance products; engages in farmer sales, sign up and registration processes; collects premiums; conducts loss assessment and makes claims payouts.
- *Local and International Reinsurers* – reinsures risk from local insurance companies, spreading the risk over their international portfolios. Ensures that claims can be paid, without bankrupting the local insurance company, even if there are catastrophic losses across the national agricultural insurance program.
- *Development Partners* - technical and/or financial support for the development, piloting and implementation of the program, including how to design customized insurance products (index, indemnity), capacity building for all local stakeholders and best practices on farmer awareness creation.
- *Insurance Intermediary* – may bring expertise on index or indemnity product development, data collection and analysis, marketing and awareness creation, implementation approach and design and claims adjustment.
- *Smallholder Farmers* – target beneficiaries. Involved in the product design to ensure their specific needs are met and the most important risks are mitigated through the insurance. Registers for the insurance product, takes care of their crops, reports claim (indemnity products) and receives compensation in event of covered loss. Provides feedback on product performance and ease of use, advising on improved design and distribution.

1.2.2. Levels of Coverage – Who is Compensated?

The first element to determine is the target farmer customers for the agricultural

insurance, the one directly receiving compensation in the event of significant production losses. The most common approach in South East Asia currently is to compensate individual farmers or local groups at the micro level, though there are other options.

1.2.2.1 Micro – for individual farmers: individual farmers or small farmer groups are insured and receive payouts. Farmers sign up in individually or in groups with premium paid individually to insure specific fields against defined risks. Farmers may insure some select fields or of all of their fields, depending on the structure of the insurance program. When a severe enough loss occurs, caused by a covered risk, the farmer or small group receives compensation from the insurance company. This level of coverage requires significant insurance awareness creation and farmer trainings, substantial registration efforts and loss assessment approaches that can accurately reflect and quantify losses at the individual field level.

1.2.2.2 Meso – for organizations, companies, district programs: a bank, microfinance institution, cooperative or other entities working with farmers and exposed to climate risks can be insured. In East Africa, to aid in distribution, most private sector policies are given at this level. While a bank may insure its lending portfolio, the benefits can be realized at the farmer level. Insurance compensation can be applied to individual outstanding loans. Farmer's production would be insured against relevant risks, and in the case of subsequent production losses caused by insured risks, the insurance would pay out with the compensation applied to outstanding loans. This level would be appropriate for a district government, wherein the government would take out insurance on behalf of the farmers, with insurance compensation passed to farmers either through direct cash, improved climate resilience seed or other farm inputs distributed for free or at a discount, or other approaches to help farmers recover from a poor harvest.

1.2.2.3 Macro – for whole country and regional: at the national or regional level, a government or consortium of governments (like ASEAN) can take out catastrophic insurance that would provide compensation in the event of large scale climate disasters affecting farmers and food production. The African Risk Capacity (ARC) is an organization set up to enable African governments to purchase insurance against selected risks. In the event of a severe event triggering a payout (ideally paid within 2-4 weeks), the country uses the funds for their relief efforts instead of having to pay directly from other government sources or to wait for donors or international aid. For example, in Myanmar when the catastrophic Cyclone Nargis hit in 2008 affecting 2.4 million people, if the government would have had a climate insurance policy covering that specific risk, the substantial insurance payout could have been used in relief and rebuilding efforts with the affected smallholder farmers.

1.2.3. Risks – Covered Causes of Loss

Risks are events that have a negative impact on agricultural production and the subsequent harvest. For example, one of the main agricultural risks experienced is drought; in the event of drought, crops do not receive the necessary rainfall to reach

the expected yield or production level. If a farmer is expecting five tons of rice per hectare, and because of the drought she may only harvest two tons, a 60% loss has occurred. If the rice crop was insured against the risk of drought, in particular against measurable rainfall below a certain threshold, then the insurance policy would compensate the farmer for this shortfall. Climate change has arguably increased the severity of weather-related risks around the world over the past decade. Rainfall related risks, such as drought, erratic timing of the rains (starting on time, then stopping for weeks after planting, or dry spells at key points in crop development), severe storms, hail and floods can have a huge impact on production. Other common risks in ASEAN include pests and diseases that may occur extremely isolated, impacting just one plot in a field. The impacts of climate change - increasing temperatures, erratic rainfall, shifting season timing – can affect pests and diseases by creating more conducive conditions for those preferring warmer temperatures while also influencing the outbreak distribution and life-cycles. The full effects and changes on pests and diseases outbreaks and severity are to be seen.

Insurance is only valuable if it compensates for the risks actually having serious effects on agricultural production, especially risks that the farmers cannot mitigate themselves and that are beyond the control of a farmer applying good practices. Insurance program and product designers need to fully understand what risks target farmers face along with their frequency and severity, when developing mitigation products to build local agricultural resilience. Insurance should not be used to cover risks that can be avoided through employing best practices, having a functional irrigation infrastructure, by applying plant protection products, etc. If an insurance policy was bought that could cover all the possible risks affecting a harvest, it would simply be too expensive and would not encourage farmers to take care of their crops. As stated in Section 1, insurance is one element in a holistic risk mitigation strategy. Farmers' practices and government policy must see climate risk mitigation not as implementing one national insurance program, but rather as building resilience at several levels with farmers and in the agricultural value chain.

1.2.4. Scope of Coverage – How Often the Product Pays

Insurance products can be structured in many ways, including at what loss level the policy would compensate farmers. The frequency and scale of payouts directly impacts the premium rate. A premium rate (a percentage) is the cost the insurance company charges to transfer the risk of loss from the farmer to the insurance company. If the premium rate is 5% to cover a farmer's investment in agricultural inputs worth USD100, the premium paid would be $USD100 \times 5\% = USD5$. This premium rate is ideally based on hard data on the historical occurrence of losses caused by the specific risk(s) being insured, in the specific area, for the specific crop. Reliable data is critical in making these actuarial premium rate calculations. From the insurance company's point of view, the overall premiums charged must be greater than the loss compensation paid out for the company to be financially sustainable in a certain market. There will be some years where large losses are paid, greater than the premiums brought in, but these must be balanced out with years where the premiums are more than the payouts. When looking at the historic loss ratios (premiums paid divided by compensation paid out) for national agricultural insurance programs in ASEAN, insurance products are often underpriced, meaning that in the long run insurance companies lose money on the products – this is not sustainable

and can make agricultural insurance unattractive for private sector insurance companies. This can be mitigated by pricing insurance based on real historical losses, with considerations for expected changes or increases in losses due to climate change and other factors.

From discussions with farmers in Southeast Asia, some farmers start feeling the effects of a poor harvest at 20% below the average yield and others have issues repaying agricultural loans at 50% losses. It is important to understand at what level farmers adopt negative coping strategies. With that understanding policies can be structured so the insurance starts to compensate farmers at or before that level. 'Traditional' products often compensate at losses of 20-70% of expected yield². However, the lower the loss threshold, the more frequent the insurance payouts and the more expensive the premium. It is important to find a balance between cost of the insurance and frequency of payout.

Catastrophic products (insurance covering extreme events that cause severe losses across wide areas), triggering at losses of over 70%¹ for events happening 1 in 10 or 1 in 15 years tend to be substantially less expensive than traditional products. That said, they payout far less frequently and would need to be one element in a more comprehensive risk mitigation strategy.

1.2.5. Index, Indemnity and Hybrid Products – product structure and data source

Agricultural insurance products can broadly fall into two categories – Index-based and Indemnity insurance, with the potential in some cases to hybridize the two.

1.2.5.1 Index Insurance

Index products assess losses based on an external data source for an area (not at the individual farmer level) using proxies for the on-ground-experience and are priced using historical data (ideally 10-30-year time series). There are no field visits to assess claims as the index data (rainfall, yield, temperature, etc.) is inputted into an agronomic model that is designed to equate certain data with a level of crop loss. Index products only work for risks that happen on a large scale, such as drought or a pest infestation affecting the entire district; it does not work for risks occurring in isolated pockets.

With the popular weather index insurance, daily rainfall data is used with an agronomic model designed based on the phases of the crop growth cycle. Based on parameters, it is programmed to reflect that a crop needs a certain amount of rainfall at a certain growth stage and if the rainfall value is lower than that, the crop will have a loss. The magnitude of that loss is based on the severity of the rainfall deficit (or surplus) at a given point in the season; Automated Weather Stations (AWS) or satellite (remote sensing) rainfall data can be used to generate the rainfall data fed into the model. If the model indicates crop losses above a previously determined percentage threshold, all farmers in a certain area would automatically receive a payout, there is no claims process. Since there are no field checks and claims are

² Author's experience.

paid to all farmers in a specific area, there is reduced moral hazard. Moral hazard is when farmers stop taking care of their crop because they know if there is a loss, the insurance will compensate them. This does not occur with index products as the payout is exclusively based on the data collected, not the status of the crop in the farmer's field.

Index products are prone to basis risk - when the insurance product does not payout even though the farmer experiences a substantial production loss. Basis risk occurs when index parameters are not designed properly or due to micro climates – when the farmer experiences significantly different rainfall than recorded by the AWS or the satellite that the index data is derived from. Weather index products also require 10-30 years of daily rainfall data, which can be difficult to obtain in countries without AWS networks, though satellites can be an alternative option. With satellites, the pixel size can be 10x10km or larger, increasing the chances of basis risk as rainfall measurements are averaged over a 100-square kilometer area. Ideally, with smaller pixels sizes and more precise satellite rainfall approximations, reported data will very closely reflect the farmer's experiences so payouts are always made when losses occur.

There are index options beyond weather, including yield index and Normalized Difference Vegetation Index (NDVI). With an area yield index product, yield data is collected at the end of the season by an objective source (usually the government's Ministry of Agriculture or Bureau of Statistics) from a sample of farmers in each area. Using a historical time series of this data, an average yield can be plotted, indicating that the insurance would payout when the reported yield is below a certain threshold. This threshold could be 30% or 70% below the average, or any value chosen. Note, the lower the yield loss used to trigger an insurance payout, the higher the cost of the insurance.

NDVI products depend on satellite imagery and can be used to build an index based on the greenness of area vegetation on the ground (an approximation for the health of the crop). This type of product is used in pastoral areas and less so for field crops. There are promising advances in NDVI technologies, enabling better analysis of the ground images so potential losses can be more clearly evaluated at a more micro level (for an individual field) instead of for a broader area.

1.2.5.2 Indemnity Insurance

With indemnity products, farmers can insure their farms against certain risks (drought, flooding, named pests and diseases, wind storms, volcanic eruptions, etc.) that would decrease their harvest. To date, this is the most common product approach with government programs in Southeast Asia. During registration, farmers need to clearly indicate the specific fields that will be insured, sometimes a challenge if there are unclear government records on land ownership or land ownership deeds. Loss assessment is done at field level (the specific field(s) registered by the farmer for insurance) for a named risk; a representative from the insurance company or from an agent comes to survey the loss and determine if the farmer receives a payout. All claims are individually assessed, which can be a time consuming, expensive and a subjective process. The product pricing of indemnity products should be based on records of historical losses of a particular crop, for a specific

risk, with additional loadings for the costs of implementation, including labor-intensive claims processing. Multi-Peril Crop Insurance (MPCI) is a popular product within indemnity insurance, where farmers can insure against many or all causes of production loss.

Moral hazard can be a challenge with indemnity products, as a farmer may have a pest outbreak that could be resolved with expensive pesticides, but the farmer decides to let the crop suffer as they know there will be an insurance payout. Ground assessments throughout the season can partly mitigate this - if the insurance assessor sees there is an infestation that should be able to be mitigated through pesticides, they can require that farmers treat the field, otherwise they would not receive an insurance payout if the treatment is unsuccessful. This can be a challenging situation to enforce and moral hazard is an on-going problem. Loss assessments being subjective can also cause challenges, as the assessor directly determines if the farmer receives compensation.

1.2.6. Insurance Subsidies – Making Premiums Affordable

Affordability is a key challenge with agricultural insurance products for smallholder farmers with minimal resources. Across ASEAN, all government-supported national crop insurance programs include a direct premium subsidy, ranging from 60% in Vietnam for near poor farmers, 80% in Indonesia for all target smallholders to 100% for certain crops in the Philippines. A premium subsidy is when the government pays part of the market premium cost charged by the insurance company to make the remaining premium cost more affordable to farmers. Realistic financials and budgetary planning is critical with subsidies as the financial commitment can grow exponentially as program scale from pilots with tens of thousands of farmers to full programs reaching millions of farmers across the country. Close collaboration between the relevant Ministries with the Ministry of Finance is necessary. Phase out of the premium subsidy is often a long-term exit strategy, but this needs to be handled strategically in ways so farmers do not feel the full cost of the insurance abruptly. Innovative distribution strategies, bundling insurance products with credit or inputs can act to decrease the farmer's adverse reaction to paying insurance premiums.

1.2.7. Other Critical Implementation Decisions

For all product design and implementation factors, it is critical that those developing the agricultural insurance program fully understand the profile and needs of the farmers who will be benefiting. Even though the developers likely work directly with local farmers, conducting scientific and structured data collection with target farmer beneficiaries, local and national stakeholders, as well as program implementers is vital. From these interactions, the developers must also distill the potential challenges that may face implementation and take steps to proactively mitigate. Understanding the four implementation decisions below will help make the final product both better suited to the risks facing target farmers while also meeting farmer expectations. A more detailed analysis and discussion of these factors and critical

decisions points surrounding them can be found in *Overcoming Challenges Facing National Crop Insurance Programs in Four ASEAN Countries*³.

1.2.7.1 Matching Product Type to Risk Profile

Insurance products are only valuable to farmers when they compensate farmers for the most challenging production risks at the right time, risks that just destroyed a significant portion of the crop. During the initial research stage and review of historical production data per insured crop for the target area, developers of insurance programs should pay close attention to the types of risks actually causing significant losses, their frequency and on what scale (individual field, whole district) they occur. It is likely that the risks will not be homogeneous across the country, some areas may face flooding as their greats risk while others experience pest and diseases with more severity and frequency. Either a broad national policy can be created that covers all risks experienced in all areas, or more tailored (including customized premium pricing) products at a province level may be appropriate.

The most relevant risks can dictate the insurance product structure – indemnity or index-based. As a general rule, if losses are very isolated, affected only a few farmers or fields, then indemnity products would be better for compensating the farmers experiencing the losses than index products. If drought, erratic rainfall, flooding, etc. are the main risks that impact a whole district when they occur, then an index product may be a more efficient fit. However, for both product structures, the data availability for local insurance companies underwriting the products as well as international reinsurers to price the products is critical. For index products, they would require a 10-30-year time series on daily rainfall or area yields. For indemnity products, a detailed breakdown on percentage losses each season and ideally their specific cause is needed. This quality data requirement should not be underestimated and the collection of which would ideally be done at the very beginning of the product development process.

1.2.7.2 Importance of Farmer Education and Awareness Creation

Agricultural insurance is a foreign concept to the vast majority of ASEAN smallholder farmers. While they may be adopting risk mitigation strategies to combat climate change, the concept of formally paying to transfer agricultural risk to the private sector is a new. As such, it takes considerable time, effort, organization and follow up to ensure farmers understand the product they are purchasing (or required to sign up for) and have appropriate expectations of what the insurance can and cannot offer.

In the farmer trainings, it is important to cover, with a consistent message, what value the insurance product actually has for the farmer. Why should the farmer buy the product? What need does the product fulfill and how is an insurance payout preferable to their current risk mitigation strategy in the event of a lost harvest?

³ A. Schrevel, L. Johnson Blair, A. Daniswara. *Overcoming Challenges Facing National Crop Insurance Programs in Four ASEAN Countries*. Working Draft, to be published in 2017. Available upon request from LDJ3@cornell.edu.

Outreach must be tailored to the information needs and understanding level of the target farmers. Steps to develop this outreach may include:

- a. Creation of training manuals and training of field staff to conduct awareness creation.
- b. Designing socializing, communication, marketing and training materials for farmers.
- c. Establish a training hierarchy down to villages to ensure communication.
- d. Implement trainings and follow up trainings at farmer group levels.
- e. Conducting quality verifications on trainings conducted and survey select trained farmers.

1.2.7.3 Developing Viable Distribution Channels

Effectively reaching farmers with a well-designed insurance product is essential for creating impact. Identifying and developing distribution channels is an often overlooked and underestimated step in the program design process, though without these channels, it becomes challenging and time consuming to reach farmers. Most of the current ASEAN agricultural insurance programs distribute the insurance to farmers through already established farmer groups. This is a popular approach, though requires farmers to already be organized in groups, a large ground presence of staff to train farmer groups sometimes through repeat visits, and assurances that when payouts are made through the group that the funds actually reach the correct farmer.

Products can also be sold directly to individual farmers, with no aggregation by farmer groups at all. This is even more challenging unless those farmers can be reached through bundling the insurance with other products or services. Another distribution channel leveraging private sector aggregation is with linking insurance to agricultural credit. This can be a mutually beneficial arrangement for both the credit institution and the farmer. In the case of a poor season, the farmer risk default or having to sell off assets to make the payment; the bank could face huge defaults on the portfolio or have to conduct expensive, time consuming and unpopular repossession on farmer assets. With insurance, the payout can go directly to the bank and be applied against the outstanding loan so the farmer and bank do not have to worry about default. Increasing access to credit in rural areas is a key development point for many emerging market governments, linking credit with the agricultural insurance can reduce the risk for banks and MFIs to enter the market, while encouraging farmers to take the products.

1.2.7.4 Developing Effective Loss Assessment

Farmers and governments create and take up agricultural insurance policies for one main reason, to be compensated in the event that a certain loss takes place. Loss assessment and the subsequent claims payment remain two of the most important steps in the entire process, and often the most difficult. During the farmer training and registration process, farmers must understand what specific losses are covered and how to report a claim.

For index products, there is no farmer-reported claims process, as the loss

assessment is exclusively based on proxy data (weather, yield, NDVI, others). With indemnity products, farmers typically report claims directly to the insurance company or to intermediate field staff, depending on the chosen structure in the government program. Objectively assessing the cause and scope of the loss can be challenging. Disagreements can arise between the insurance loss adjuster and the farmer when quantifying the amount of the loss and the cause of loss. Since most insurance policies only trigger a payout after a certain percentage of loss, farmers may disagree if they feel the percentage loss concluded by the assessor is too low. This can be exacerbated by the subjective nature of some losses assessment, relying on visual inspection of a field. In some policies, pest damage is covered by the insurance, but only if it is caused by a certain type of pest. It can be challenged when doing loss assessment to determine if the loss was covered by the pest named in the insurance cover or by an uncovered pest. Such considerations should be taken when deciding the risks covered in the policy, thinking forward on what damage can be differentiated at the field level. Clear steps must be created and communicated on how objective assessment will be done, with conflict resolution procedures established.

1.3. Status of Agriculture Insurance in ASEAN

Agricultural insurance has been used as a risk mitigation tool in Southeast Asia for the past decades, launching in 1970 in Thailand⁴ and 1981 in the Philippines.⁵ The history is varied across the region, with currently three of the ten countries operating national crop insurance programs and five others either considering launching or have a paused national program. **Table 1** gives a brief overview of the status of agricultural insurance in each country, including products offer, next steps and the main focal institutions for the government insurance program implementation. Countries that have been operating programs for decades have experienced and overcome a range of challenges related to risks to insurance, product structure, effective distribution channels and strategies on loss assessment. This section provides a brief discussion on the current programs in Thailand, the Philippines and Indonesia; as well as potential plans for the countries considering building new national crop insurance programs.

Table 1. Status of Agricultural Insurance in ASEAN.

AMS	Status of Agricultural Insurance	Products Offered	Next Steps	Focal Institution
BR	None		No plans know	
CA	No national program, NGO pilot program	Rice (Indemnity for drought, flooding) in	Considering a national program	General Directorate of Agriculture, Ministry of

⁴ Monthip S., Akarapon H. Improving the Agricultural Insurance Program To Enhance Resilience To Climate Change In Thailand. National Research Council of Thailand. Office of Agricultural Economics.

⁵ Cajucom, Norman. "Philippines: National Crop Insurance Program Update." ASEAN-CRN Conference on Effective Policies for Promoting Agriculture Climate Insurance to Increase Resilience in ASEAN, 17 Aug 2016, Hotel Majestic, Ho Chi Minh City, Vietnam. Conference Presentation.

AMS	Status of Agricultural Insurance	Products Offered	Next Steps	Focal Institution
		NGO program		Agriculture Forestry and Fisheries (MAFF)
ID	Ongoing, launched in 2015 and scaling to national coverage. Private agricultural with limited offering.	Rice (Indemnity, Multi-Peril). Commercial: plantation covers	Continue scaling, cover additional crops and livestock, explore index products	Ministry of Agriculture, PT Jasindo (insurer)
LA	No national program		Considering a national program	Ministry of Agriculture and Forestry (MAF)
MA	No national program. Limited private commercial insurance	Commercial: plantation crops (rubber, oil palm, coconut, fruit, cocoa)		
MM	No national program		Considering a national program	
PH	Ongoing, long running and scaled programs and products since 1981. Extensive commercial agricultural products available.	Indemnity/Multi-Peril for rice, corn, high-value crops, livestock, aqua-culture; Piloting weather index insurance. Commercial: non-crop agricultural assets, credit and life term insurance.	Assessing how to scale index products, improved structures for indemnity and distribution channels; develop new insurance products; insurance capacity; enhance insurer PPPs.	The Philippine Crop Insurance Corporation (PCIC)
SG	None		No plans	
TH	Ongoing, initially launched in 1970s, has evolved through several initiatives.	Rice (Indemnity - scaled, Weather Index - pilot).	Assessing how to scale index products, improved structures for indemnity, new distribution channels, climate studies.	Department of Insurance, Ministry of Commerce
VN	On hold, previously launched in 1982 and 2011-2014.	Rice (Yield Index, losses from a range of named risks), livestock, rice and aquaculture (indemnity).	Reviewing challenges with previous program, new governmental decrees under review for a new agricultural insurance program.	Ministry of Agriculture and Rural Development (MARD) and Ministry of Finance

1.3.1. Selected Country Climate Insurance Updates

1.3.1.1 *The Philippines*⁶

The Philippines first launched government crop insurance in 1981 with the creation of the Philippine Crop Insurance Corporation (PCIC), a government-owned insurance company specializing in providing agricultural insurance solutions. Through this public private partnership (PPP), the government supports agricultural insurance through a premium subsidy; PCIC develops, distributes and underwrites policies; and then the risk is reinsured locally and internationally. PCIC has expanded from covering rice and maize crops against natural calamities (drought, flood, typhoon, tornado, volcanic eruption) and for pests and diseases to now offering a range of products also for livestock, aquaculture, non-crop agricultural assets, high-value crops, as well as credit and life term insurance for farmers and fisherfolk. The agricultural insurance products are structured as both indemnity/MPCI and to a lesser extent, weather index insurance (rainfall index in pilot areas) for selected varieties of rice and corn. These products and risk expansions were based on feedback and demand from the agricultural community. Over the past 35 years, the National Crop Insurance Program has covered 7,630,750 farmers cultivating 8,905,119 hectares and 4,360,734 livestock, with 1,194,932 farmers insured in 2015 alone.

To support smallholder farmers, national food security and poverty alleviation policies, the National Government subsidizes 100% of the premium for rice, corn, high-value crops, aquaculture, livestock and non-crop agricultural assets of subsistence farmers and fisherfolk listed under the Registry System for Basic Sectors in Agriculture (RSBSA) issued by the Department of Budget and Management (DBM). The government also supports fully subsidies for subsistence farmers and fisherfolk beneficiaries of several other programs. PCIC also provides partial premium subsidy for subsistence rice and corn farmers not listed under RSBSA (on average 54% - see table 2 for representative breakdown of the premium between farmers, lending institutions (LI), and the government). Premium rates for rice and corn covers are variable per region, per season and per risk classification⁷ and reflect the extent of the cover and the frequency of risks inflicting losses on production. Most products have the sum insured (the value of the farm investment or property that farmers protect with the insurance, the value of the indemnity is calculated based on what the farmer would theoretically receive from the insurance company as compensation in case of a total loss) based on the cost of production inputs or the production loan + 20% (the additional 20% is optional). For example, a farmer can take a production loan for USD100, insure the loan with a sum insured of USD120, for a total premium of USD120 * 10.81% for MPCI cover (natural disaster and pests & diseases perils) or USD120 * 7.95% for natural disaster cover.

⁶ Cajucom, Norman. "Philippines: National Crop Insurance Program Update." ASEAN-CRN Conference on Effective Policies for Promoting Agriculture Climate Insurance to Increase Resilience in ASEAN, 17 Aug 2016, Hotel Majestic, Ho Chi Minh City, Vietnam. Conference Presentation.

⁷ Cajucom, Norman. Philippine Crop Insurance Corporation, The Philippines. Personal Interview. 15 Nov 2016.

Table 2. Premium Breakdown for Rice Insurance in The Philippines.

Particulars	Premium Share			
	Multi-Risk Cover		Natural Disaster Cover	
	Premium (%)	% Share in Total Premium	Premium (%)	% Share in Total Premium
Farmer Share	2.91	26.92	2.23	28.05
LI Share	2.00	18.50	1.50	18.87
Govt. Share	5.90	54.58	4.22	53.08
Total	10.81	100	7.95	100

Source: PCIC Presentation

From experiences in the Philippines, the most effective distribution channels are value chain partners, such as lending institutions (e.g., rural banks, microfinance institutions, input suppliers) that bundle insurance with agricultural loans, local government units (LGUs), farmer cooperatives and organizations, other government institutions and private sector involved in agri-fishery-forestry activities. Through these channels, farmers, fisherfolk and other stakeholders can individually access the insurance or apply as groups.

1.3.1.2 Indonesia⁸

After several years of limited scale agricultural insurance pilots, the Asuransi Usaha Tani Padi (AUTP) was launched in 2015, by the Ministry of Agriculture, Jasindo (state owned insurer) and reinsurance partners to build rural agricultural climate resilience. The program focuses on smallholder rice farmers cultivating less than 5 hectares and is highly subsidized with government paying 80% of the flat rate 3% premium. The program sets an insurable value per acre reflecting the costs of production at USD450, with total insurance premium of $USD450 \times 0.03 = USD13.5$, of which $USD13.5 \times 0.2 = USD2.7$ is paid by the farmer. The farmers and area covered have drastically increased from 3,000 ha in the 2013 pilot to 293,000 hectares insured mid-2016. The risks covered by the indemnity product were expanded to include additional pests and diseases as farmers experienced uncovered losses to the original ten pests & disease, in addition to drought, flooding and other climate conditions.

Insurance products are currently distributed to farmer groups, wherein individual farmers must register and pay for the insurance, with Jasindo and local government extension offices conducting registration and awareness creation. Farmers individually indicate the plots and areas they wish to insure, paying the premium through a group bank transfer. With indemnity products, loss assessment is done at the field level by Jasindo loss assessors or external partners. There have been challenges with loss assessment due to manpower demands and being able to accurately approximate if there is a 75%+ loss in the field. The insurance only pays out if the plot shows a 75%+ loss. Without government land records referring to exact maps, it is challenging to determine what plot is insured by an individual, and

⁸ Plenary Presentations and Discussion. ASEAN-CRN Conference on Effective Policies for Promoting Agriculture Climate Insurance to Increase Resilience in ASEAN, 17 Aug 2016, Hotel Majestic, Ho Chi Minh City, Vietnam.

that the field with the loss is actually the one insured. Farmers may not insure all of their fields, only selected plots.

The government is looking at expanding the coverage to additional food security crops, high value crops and livestock; also, investigating the feasibility of weather index insurance coverage for key risks impacting production in larger geographic areas. For initial ease of implementation, a flat national premium rate was used, though in the future variable rates by province (actuarially calculated) may be used to better reflect different risk levels in different provinces.

1.3.1.3 Thailand⁹

Agricultural insurance has experienced a number of evolving initiatives in Thailand since first launch in 1970, with a mix of PPPs, government-sponsored programs and private sector offerings. In 2011, the current Thailand National Rice Insurance Program launched as an indemnity product focused on smallholder rice producers, largely distributed linked to agricultural credit offered by Bank of Agriculture and Agricultural Cooperation (BAAC) and Local Extension Officers (registration, farmer education). The Thai General Insurance Association (TGIA) leads a pool of 17 insurers underwriting the products, with the premium rates by area set by the government at USD17.85 per ha (average, significant range based on risk level) to insure a value of USD198 for all perils apart from pests and diseases. An additional pest and disease cover can be purchased. A government subsidy of 60% is available to all farmers, with an additional subsidy paid by BAAC on insured loans for those accessing insurance through rural credit.

Due to high implementation and losses assessments costs with the rice insurance programs - including frustrations regarding requiring an area to be declared a disaster area to trigger a payout - Thailand has investigated weather index insurance as an alternative product structure. From 2009-2015, the Thai government and World Bank piloted weather index insurance for rice crops, however faced challenges with basis risk, inaccurate payouts, and barriers to scale due to data requirements. Index insurance products are based on historical time series of data, in particular for Thailand the rainfall data was from AWS. The government is also pursuing research studies on climate factors and how they could impact the implementation of tailored agricultural insurance and seeks regional ASEAN collaboration on climate risk mitigation.

1.3.2. Countries without Ongoing National Programs¹⁰

At the ASEAN-CRN Knowledge Exchange Event on *Effective Policies for Promoting Agriculture Climate Insurance to Increase Resilience in ASEAN* held in Ho Chi Minh City in August 2016, eight ASEAN country representative teams come to understand

⁹ Monthip S., Akarapon H. Improving the Agricultural Insurance Program To Enhance Resilience To Climate Change In Thailand. National Research Council of Thailand. Office of Agricultural Economics

⁹ Rattanayod, Busaraporn. "Thailand National Rice Insurance Program." ASEAN-CRN Conference on Effective Policies for Promoting Agriculture Climate Insurance to Increase Resilience in ASEAN, 17 Aug 2016, Hotel Majestic, Ho Chi Minh City, Vietnam. Conference Presentation.

¹⁰ Interactive Group Work. ASEAN-CRN Conference on Effective Policies for Promoting Agriculture Climate Insurance to Increase Resilience in ASEAN, 17 Aug 2016, Hotel Majestic, Ho Chi Minh City, Vietnam. Conference Presentation.

the status of agricultural climate risk mitigation, learn from successes and challenges, and then map out the next step plans for each of their countries. Myanmar, Lao and Cambodia embraced the challenge to employ the *10 Phases in Developing a National Crop Insurance Program* to design the next steps their countries will pursue over the next year.

1.3.2.1 Myanmar

- Communicate the learnings and plans conceived at the ASEAN-CRN Agri-Insurance Workshop to the Ministry of Agriculture through small meetings with relevant stakeholders involved with crops, livestock and irrigation.
- Collect relevant data (crop and weather) and design an insurance pilot program for implementation, following the 10 Phases Guide. Syngenta Foundation for Sustainable Agriculture will be a technical knowledge partner and assists in dry runs.
- Plan a pilot project through an interactive process with various stakeholders. Roll out that pilot over the next three years.

1.3.2.2 Laos

- Brief key policy makers (including Ministry of Agriculture and Forestry) about agricultural insurance to build foundational understanding of the concept.
- Develop a National Working Group, including representatives from agriculture (Department of Agriculture, National Agriculture and Forestry Research Institute, Planning, Extension, Land), finance (Ministry of Finance, Bank of Laos, Agriculture Promotion Bank, Policy Bank), and the private sector (General Insurance Company).
- Conduct capacity building within Lao and participate in regional knowledge workshops, especially exchanges with Vietnam, Thailand and Cambodia to share learnings and program development progress.
- Develop a proposal for an agricultural insurance pilot program, including data collection, farmer and stakeholder survey, pilot site selection and assessment, technical experts, budgeting, potential donors or development partners for funding (ASEAN, GIZ, Food and Agriculture Organization (FAO), ASEAN-CRN), policy maker presentations with discussions and approval, and other needs for setting-up agri-insurance system. Present this to policy makers for approval.
- Implement an agricultural insurance pilot project.

1.3.2.3 Cambodia

- Secure financial support from development programs (potentially ADB's funded Rice-SDP project) in order to design and develop a national crop insurance program.
- Conduct a feasibility study on the need for rice insurance. Build on the learnings and experiences from the current NGO pilot insurance project.
- Implement a pilot project through a PPP and develop an Agri-Insurance Policy Framework. Potentially focus on piloting weather index crop insurance.
- Participate in capacity building, exchange trips and regional knowledge

workshops with all stakeholders.

1.4. Potential for Regional Collaboration on Agriculture Insurance in ASEAN

The very nature of the Association of Southeast Asian Nations provides a platform for countries to share knowledge, experiences, successes and failure on a range of topics facing the region, including how to use agricultural insurance as an effective climate risk mitigation tool for farmers. The regional trade dynamic provides a degree of interconnectedness on food security, severe production shocks in one country would affect the surrounding nations too. Looking across the region, many countries face similarly diverse climate and agricultural production risks and a largely smallholder farmer based with limited understanding of insurance products. While approaches would need to be tailored to each country's particular risk profile, data (weather, yield) availability, government objectives and private sector capabilities (lending, insurance, input distribution), many successful and failed attempts in one country would likely be highly beneficial for surrounding countries. While miss-steps do occur sometimes in product design and program implementation, the goal of ASEAN regional collaboration would be to reduce their frequency or severity, or if challenges do occur, having a sounding board on ways to make beneficially improvements to create real resilience for farmers. Countries with new programs can learn from their neighbors who have already implemented programs, building on success and learning from challenges.

Those directly involved in designing, implementing and governing agricultural insurance programs across ASEAN can utilize the ASEAN-CRN and resources to better understand best practices and discuss solutions to challenges facing their respective countries. ASEAN-CRN has a robust role to play as agricultural insurance and other climate mitigation initiatives take more priority within each country, bringing more emphasis on regional coordinating and learning on best practices and successful approaches. The goal will be to create actionable and implementable information that will create local impacts in each country. Such initiatives this platform supports include:

- *Regional knowledge exchange events and workshops*, like the one held in Ho Chi Minh City, Vietnam in August 2016, where in representative teams from eight countries discussed the progress, challenges and ideas in an open and goal oriented setting.
- *Regional collaboration through the ASEAN Insurance Council*, investigate how as a regional block the community to establish catastrophic insurance against severe climate risks impacting multiple countries. Risk pooling and regional reinsurance may be possible given commitment from the member countries.
- *Multi-country field visits and dialog* are already undertaken between countries with young agricultural insurance programs to those with decades of experience, such as the Philippines and Thailand. Newer programs and countries that are in the process of developing agricultural insurance products

have much to gain from visiting successful programs to learn approaches that work, and to understand better what approaches have been less successful in the past.

- *Information exchanges, platforms and a joint, curated database to share best practices and materials on:*
 - Farmer training and awareness creation standard operating procedures and training materials with specific content on socializing on insurance
 - How to use remote sensing and satellite technologies, including specific data sources, analyses techniques and referred public and private partners
 - Strategies on reducing program implementation costs
 - Effective information sharing on natural disaster and extreme weather events among AMS
 - Structuring effective PPPs to develop and implement insurance program, including how to best align incentives and responsibilities. This includes on the government side, coordinating from national to local level, insurance companies, private sector CSR interests, and the donor and development partner communities.
 - Drafting policy reforms and parliamentary orders relevant to creating agricultural insurance programs and institutional frameworks.

- *Insurance product development collaboration in small groups and on knowledge exchange platforms related to:*
 - Broadly how to develop Weather Index-based Insurance (WIBI) and Area-based Yield Index Insurance (ARBY) products
 - Designing index insurance parameters and structures to accurately reflect losses experienced from risks that can be reflected in remote sensing or weather data
 - Loss assessment procedures for index and traditional products
 - Trainings on gathering, preparing and analyzing agricultural data for model inputs and calibration for index products and premium calculations

- *Strategic collaborations on relationships with development partners*, including international collaborations for technical support and financial grants for program design and pilots. ASEAN countries could build on successful approaches, applications and planning from neighbors to reduce replication of work and create more value from the development partners' previous investments in agricultural insurance.

- *Utilizing the 10 Phases in Developing a National Crop Insurance Program* as a technical guide across countries to improve their agricultural insurance programs or starting a new one. This could be structured as a multi-country interactive effort wherein countries forming programs (Myanmar, Cambodia, Malaysia and Laos) would have a small representative team simultaneously go through a structured process on national program development, ideally

supported by development partners. The country representatives would have regular dialog along with field meetings to jointly discuss critically aspects (loss assessment, product design, subsidy, registration, farmer training, etc.) of the insurance development, mutually collaborating and learning from successful and unsuccessful approaches alike.



2 INTEGRATED FARMING SYSTEMS

2. Integrated Farming Systems

Story from the Field: Integrated Farming Systems in the Lower Mekong Basin

In the remote areas of central Cambodia, prolonged drought, variable rainfall, higher temperatures and more severe and frequent storms, leave farmers increasingly vulnerable to the impacts of climate change. With limited economic opportunities, farmers in the region often migrate to nearby provinces or countries like Thailand to find work on mono-crop plantations or in construction. Tek Chan, a smallholder farmer who lives in Svay District, Kampong Thom Province, faced declining returns from his rice crop, which grown in the regions notoriously sandy soils, requires a dependable water supply. Forced to begin selling his labor to nearby plantations for a low wage, Tek Chan followed the guidance of his village chief to attend a farmer field school to learn about integrated farming systems (IFS). The IFS model focused on strategies to optimize small plots of land by incorporating complementary production systems on his land, such as small-scale horticulture, fish and frog ponds, and sustainable household pig or chicken/duck rearing. Beyond diversifying household income streams, the IFS approach requires a clear water use efficiency strategy and reduces input costs by using the waste of one system as the input to another (such as placing chickens in a contained area and using droppings for fertilizer).

After receiving the IFS training, Tek Chan converted his small land holding from a rice production regime to an integrated system that included, a vegetable garden with homemade naturally-sourced pesticides, a small rice plot, ducks and chickens with netting for waste collection and a household aquaculture regime raising frogs. Through land use planning and diversification, he can now earn a sustainable living from his land and no longer has to leave his family to work on the plantation.

*Across the Lower Mekong Basin (LMB), farmers like Tek Chan face ever-increasing climate extremes—higher average temperatures, extended dry seasons, more frequent and intense storm events, and increasingly variable conditions. The USAID-funded Mekong ARCC project worked with communities in ‘hotspot’ provinces across the basin, such as Kampong Thom, to implement **Integrated Farming System** activities to diversify income streams while incorporating production systems that helped achieve balance in the agro-ecological systems of the farming landscapes.*

*For example, in the Pa Tueng Sub District in Thailand’s mountainous northern province, Chiang Rai, the project introduced **agroforestry** systems to augment the community’s reliance on upland rice and maize, two crops highly vulnerable to the region’s shifting climate patterns. The tree crop selected – Assam tea – has a high heat tolerance (up to 35 degrees C), grows well under the shade of perennial fruit trees, and was known to perform well in local soils at an altitude of 1,000 meters above sea level. The tea plants require relatively low labor and fertilizer inputs, have a productive life of over 40 years, and offer near year-round production that supplements incomes from annuals like rice and corn. Further, Assam tea fits into the IFS category by the co-benefits it provides, such as hillside erosion control and soil quality enhancement for intercropped perennial fruit trees. Importantly, strong market demand for Assam tea—particularly from China—made the crop attractive*

to farmers.

*In the remote village of Ban Kouanesam, in Nakai District of Lao PDR, the project supported installation of **household-level fishponds** to raise *Clarias* sp. (catfish) and *Rana rugulosa* (common lowland frog). With natural fisheries in the area facing declining productivity due to drought and other non-climate factors, the fishponds helped to supplement the nutritional needs (protein) and income streams of community farmers. As an IFS technique, the inputs for the ponds were primarily termites – available on community forest land – that were used as fish food, while elements of the locally consumed fish waste could be put back to use in household compost or as feed for livestock.*

*In Kok Klang Village of Thailand's Isaan region, the USAID Mekong ARCC team introduced an **improved system of small-scale household pig production**. The climate friendly method consisted of raising pigs on a bio-mattress or compost bed that was inoculated with microorganisms to enhance the decomposition of the pig wastes and to create clean compost for application to home gardens, crop fields or for sale as alternative income. In this model, farmers located pens ideally near fruit trees (as an easy food source for pigs), away from hillsides to prevent water from pooling in the pen but near water sources to draw on for on demand taps. The new system eliminated foul odors emanating from the pigpens; reduced water wastage by eliminating the need to flush wastes from the pigpens, and by installing taps connected to household ponds that deliver drinking water only on demand; and reduced the likelihood of diseases by keeping water and feed cleaner. The pig production model is suitable for IFS as it encourages resource use efficiency in terms of both water and composting, whereby the output of the pigpen system can be used as an input for on-farm agricultural systems.*

2.1. Integrated Farming Systems to Promote Climate Resilience in Agriculture

Integrated farming is not a new concept; however, its relevance has been elevated recently as a central strategy in climate smart agriculture. The increasing variability in hydrological regimes and temperature extremes simply increases the need for agro-ecological diversity as a resilience strategy. Beyond the multiple benefits discussed above, IFS builds resilience to a shifting climate in the following ways.

2.1.1. Widening the productivity threshold

All livestock and natural species thrive in specific thermoneutral zones; crops are most productive in a 'comfort zone' where temperature, rainfall, and soil conditions create a favorable growing environment. Climate change can mean that crops face conditions outside of their comfort zone – higher maximum temperatures, prolonged number of days without rainfall, etc. – causing reduced harvest or even total crop failure. An integrated farming system involves understanding agro-ecological zones – both trends and forecasts – and selecting crop varieties that complement one another and can thrive in a wider band of climate variability (temperature and rainfall).

For example, in India, farmers are integrating native crops like millet, which can tolerate temperatures of more than 46 degrees C (115 F), into fields where they grow rice and wheat—crops that cannot tolerate temperatures over 38 degrees C (100 F). Identifying comfort zones is a key decision support tool for IFS – it brings to light knowledge such as how more days above 35 degrees C (95 F) during the October ripening stage of rice in Cambodia will reduce grains per plant; and that litchi trees require at least 100 hours below 15°C in winter to flower and fruit¹¹. Crop suitability models should be consulted when identifying IFS crops, livestock, trees, and aquaculture systems.

2.1.2. Reducing Water Risk

Given climate change often manifests through shifts in the hydrological cycle, on farm risks of too much or too little water are increasingly common. Temporal changes – like increased rainfall intensity or prolonged gaps in days without rain – and shifts in spatial dispersion of rainfall make farm-level water management a challenge. Integrated farming employs strategies that hedge these water risks. For example, water infiltration ponds, planting trees by cropping plots, and maintaining adequate natural grassland zones all contribute to improving soil moisture and reducing irrigation needs. Similarly, when facing increased flooding events, IFS techniques such as leaving low-lying areas in a natural state or planting fruit trees can help prevent erosion and capture the benefits of floodwaters (nutrient transfer, groundwater recharge) on the land.

¹¹ Carew-Reid, J. et al. *USAID Mekong ARCC Climate Change Impact & Adaptation Study for the Lower Mekong Basin; Agriculture Report*. USAID, 2014

2.1.3. Real-time Pest Control

Farms with low agro-biological diversity face a much higher risk of crop loss due to destructive pests. Shifts in climate zones mean that, for example, a flood event and higher average temperatures at higher elevations during coffee plant fruiting can create conditions for a sudden growth in the population of a well-known pest called green scales (*Coccus celatus*). Once green scale infestation takes hold, farmers can act quickly to apply proper pesticides to control the population, however crop loss and pesticide costs eat into the farmer's profits. IFS practice defends against such green scale population outbursts by maintaining a diverse habitat that encourages natural pest control – ladybugs, wasps, and ladybird beetles all feed on the tiny insects, acting as an integrated real-time response system.

2.1.4. Production & Income Smoothing

Increased variability in weather means increased variability in farmer incomes/losses; diversifying income streams is a classic method of hedging against such risk. Widening the productivity threshold – discussed above – ensures that one crop system succeeds in a hotter drier year of weather even as another might struggle. Incorporating perennials like fruit trees, woodlots, hedgerows, and some grasses both increases agro-biodiversity and provides a lower-maintenance income source to complement annual crop systems. IFS also encourages seasonal income smoothing by moving away from single crop harvests. In the highlands of Thailand, for example, farmers have started adding Assam tea plants to forested zones of their land – the high value tea can be harvested for much of the year, is relatively low maintenance, and complements their traditional upland rice production systems. Resilience to climate variability ultimately builds economic resilience, a key objective of CSA.

2.2. Designing Effective Integrated Farming Systems

IFS – and its cohort of practices, integrated crop management (ICM), integrated landscape management (ILM), etc. – acknowledge that agriculture is a productive system that relies on the vibrancy of surrounding natural systems. IFS attempts to mimic ecological relationships by aligning interlinking production systems that include crops, livestock, horticulture, agroforestry, aquaculture, and flora and fauna in such a way that the waste of one is recycled and used as an input for another.

The difference between mixed farming and integrated farming is that IFS enterprises interact eco-biologically, in space and time, and are mutually supportive and depend on each other. The goal of this 'whole farm' systems approach is to provide a steady income through diverse land uses that achieve agro-ecological equilibrium¹². A resilience strategy practiced in various forms through history, integrated farming techniques are experiencing a renaissance as a sound CSA practice.

The most common **examples** of IFS involve mixed cropping and livestock systems,

¹² Caribbean Agricultural Research and Development Institute (CARDI). *A Manual on Integrated Farming Systems*. United Nations Development Program (UNDP). Agriculture Enterprise Development (AED) for Rural Belize project. 2010

while the more advanced systems include aquaculture and tree crops. Integrating canals in a rice paddy to raise fish and ducks is a well-known system in some parts of lowland Southeast Asia, while agroforestry systems like planting shade-grown tea under taller fruit trees (rambutan, plum cherry, etc.) are common in higher elevations of the region. A widely-practiced IFS system across China involves integrated livestock and fish systems. Pig feeding troughs with slatted floors are built above fish ponds allowing manure to fall into the water, where its organic nutrients feed the bacteria and phytoplankton that stimulate production at the base of the pond’s food web. The model reduces the need to dispose of pig waste while at the same time lowering the cost of inputs required to maintain a productive aquaculture pond.

2.2.1. Characteristics & Benefits

A principle characteristic of integrated farming is the **diversity in land use**. As opposed to monocultures, IFS derives its health and resilience from a variety of land uses within a given landscape. For example, fruit trees and bamboo planted on a hillside (providing erosion control and livelihood products) might transition into a horticulture plot of high value vegetables surrounded by nitrogen-fixing shrubs, which are separated from a nearby stream by a filter strip of natural grasses and shade trees. The same plot may include an aquaculture pond also used for pasturing waterfowl, whose droppings help maintain the health of the fish habitat below. Altogether, this diversity of land use helps to maintain a balanced eco-agricultural system that provides co-benefits to the local **ecology**, as well as the **economic** livelihoods and **health** of the farmers.

Table 3. IFS Benefits.

Benefits of Integrated Farming	
Ecology	Improves soil fertility, moisture, structure, and health
	Reduces weeds, insect pests and disease
	Improved habitat for pollinating insects
	Utilization of crop residues and livestock wastes
	Erosion control
	Groundwater recharge
Economics	Reduces costs of production – fertilizers, agrochemicals, feeds, energy, etc.
	Improves space utilization & increases productivity per unit area
	Provides diversification of income streams
	Develops seasonal income smoothing (perennials, annuals, livestock, etc.)
Health	Provides balanced nutritional foods from on-farm production
	Efficient use of family labor due to improved space utilization
	Improves water quality through reduce in fertilizer & livestock waste runoff

2.2.2. Basics of Integrated Farming

While each farm will have unique characteristics and requirements, the basics of integrated farming are relatively straightforward and approach planning in a systemic fashion. Extension agents, cooperatives, and farmers themselves should address the following **four elements** when transitioning to an integrated farming system.

2.2.2.1. Soil Management: This entails maintaining long-term soil fertility and minimizing erosion and soil compaction. Using a soil map can help plan crop suitability, rotation, and conservation measures. The use of cover crops and organic compost to build soil organic matter and help maintain proper soil moisture is

important. Soil nutrients can also be enhanced through planting nitrogen-fixing trees and shrubs – in Northwest Vietnam farmers use trees like acacia, teak, plum and mango to enhance the nitrogen content in upland rice and cassava field soils, while also serving to prevent hillside erosion of nutrient-rich topsoil.

2.2.2.2. Water Management, Use & Protection: On the *management* side, this means both maintenance of drainage systems and watercourses as well as rainwater harvesting and groundwater recharge. The root systems from fruit trees used as hedgerows can help improve water infiltration and enhance soil moisture for crops in adjacent plots. In terms of water *use*, efficient irrigation techniques are recommended as are small catchment systems for household aquaculture maintenance. Water *protection* focuses on reducing excess runoff from livestock manure and fertilizers that could impact water quality – using small water filtration ponds with reeds or maintaining grass covered buffer strips near streams are both common strategies.

2.2.2.3. Crop & Livestock System Selection: Selecting an IFS model requires some systemic planning and technical support from experts, such as agriculture extension officers, research scientists at universities, or similar. For each system – fruit trees, aquaculture, chickens, rice, etc. – farmers should map out the inputs required for each alongside the outputs/waste expected. The more ‘matches’ between system outputs and inputs (like rice hulls for chicken coups or cow methane for biogas digesters), the more robust the IFS model will be. Beyond the support from extension officers, farmers can identify the agro-ecological zones of specific crops (temperature and rainfall ranges) from the online FAO Ecocrop tool, and find common agroforestry systems for their region from reports by CIFOR and the World Agroforestry Center/ICRAF.

2.2.2.4. Crop Protection through Land Use Diversity: A key tenet of integrated farming, land use diversity requires leaving areas of the landscape – field margins, riparian buffers, hedges, etc. – in a natural state. Not only does this practice support sound soil and water management, but it also provides habitat that ensures diversity in wild plants, animals, and insects that are critical to a healthy farming system. While monoculture farms with low biodiversity are highly susceptible to pest infestations, integrated farms incorporate natural pest management through, for example, supporting a population of tree-dwelling birds that feed on the insects that pose a threat to various crops. Estimates suggest that as little as 20% of non-crop habitat can preserve effective on-farm pest suppression¹³. Combining land use diversity with best practices in integrated pest management (IPM), the IFS will require fewer pesticides and be more resilient when pest populations spike after prolonged rains and heat, for example.

2.2.3. Technical Challenges with IFS

In countries where smallholder farmers use traditional practices, the concepts of IFS are very likely being employed in some form or fashion to achieve income diversification. Applying a climate lens to these practices requires broader planning

¹³ Landis, D. (2016, July 20). Designing agricultural landscapes for biodiversity-based ecosystem services. *Basic and Applied Ecology*.

in terms of how to maximize the connectivity among the on-farm systems. A few overarching challenges to transitioning to IFS include:

No one-size-fits-all model – Each system is dependent upon the given landscape and micro-climate. Identifying ideal combinations of IFS for the area will require close coordination with agricultural/livestock/aquaculture extension officers and experts from local universities with a focus on agro-ecology.

Technical planning requirements – The technical calculations around systems integration requires input from experts of each production system. For example, identifying the ideal quantity of pig manure per gallon of water in a fish pond, and its suitability for specific fish species, can be a challenge without highly knowledgeable aquaculture and livestock experts.

Production Limitations – Achieving harmony among the various production systems may require limiting the quantity of a particular system. Asking a farmer to reduce his/her rice production or quantity of chickens to introduce a new system can be a risk that many farmers are reluctant to make.

Transition time/start-up costs – Adding in any production system with a longer return on investment time horizon – versus the current cropping regime – can be a barrier for a risk averse farmer. Incorporating grants, small loans, or co-investment from cooperatives are a few of the many strategies to help finance a transition to IFS.

Policy disincentives – A country's agricultural or land-use policy incentives can themselves be a barrier to IFS. Subsidized inputs for rice farming or credits for fertilizers and herbicides may encourage the expansion of a mono-cropping model and make an IFS transition appear like a costly investment.

Many of these technical challenges to establishing an IFS can be overcome, however, taking a full systems approach to farm planning will take a mix of capacity building at the community level, aligning policy incentives, and identifying financial risk reduction strategies.

2.3. Status of Integrated Farming Systems in ASEAN

IFS – and its cohort of practices, ICM, ILM, etc., have been promoted for decades in AMS and in the most basic interpretation, integrated or mixed farming systems have been used traditionally by rural communities. In order to collaborate amongst AMS on improving and promoting IFS approaches to increase the resilience and livelihoods of farming communities, a first step would be a thorough assessment of the existing knowledge, level of implementation and lessons learned on IFS in the different AMS. In the national reports within the regional study on Promotion of Climate Resilience for Food Security in ASEAN a number of AMS specific integrated farming or cropping systems that are promoted to increase climate resilience are mentioned.

Lao in particular highlights intercropping maize with legumes like red bean, mung

bean and soy bean, as a good practice promoted in the country to increase resilience. Intercropping with legumes is promoted during the same crop as well as in between different rice crops to control weeds as well as increase soil nutrient content. The research however was limited to only three provinces in Lao.

Philippines as well promoted IFS to deal with the impacts of climate change in maize and rice production as their selected priority crops for food security. With this in mind, ICM has been integrated into the “PalayCheck” and “Palayamanan Plus” approaches which are promoted for scaling-up to increase rice yields. Challenges in scaling-up IFS remain due to the popularity of mono-cropping and the limited knowledge of farmers on implementation.

Using the terminology “model farming”, Cambodia identified IFS as a priority practice to increase the resilience of rice and cassava cropping systems, which have highest relevance for food security in the country. Women are expected to especially benefit. Cambodia promotes a diverse system of crops, aquaculture and livestock in the model farming approach and also addresses local water sources for irrigation as well as nutrient recycling from livestock and aquaculture. IFS increase farmers’ income and through diversify incomes, their resilience to climate change. Barriers for implementation of the approach are seen in the extensive interaction with farmers necessary for its promotion as well as relatively high initial investment cost and limited access to finance.

During the First ASEAN-CRN Planning Meeting in Bali, Indonesia in December 2015, countries reported further progress on the promotion of CSA practices. IFS or its cohort practices was reported on by Cambodia, Indonesia, Laos, Philippines, Thailand and Vietnam who reported the respective level of priority and progress of IFS in their country as shown in Table 4 below.

Table 4. Reported IFS practices in ASEAN during the 1st ASEAN-CRN Planning Meeting.

AMS	Particular IFS approach	Priority Crops	National level progress in scaling-up of CSA practices					
			Level of country priority (1 lowest – 5 highest)	Field testing takes place	Evidence based assessed	Promoted in agricultural policies	Disseminated through agricultural extension services	Widely implemented by producers/farmers
CA	Model Farming	Rice- base	3	√	√	√	√	
ID	Integrated Crop Management	Rice	5	√	√	√	√	√
LA	Maize integrated with legumes	Maize	2	√	√	√	√	√
PH	Palayamanan Plus / Fish / Livestock	Rice	5	√	√	√	√	√
TH	Integrated Crop Management	Cassava	5	√	√	√	√	√
VN	Integrated Crop Management	Rice Maize	3	√	√	√	√	

Almost all participating AMS gave IFS some priority and significant progress has been made according to the assessment of the delegates to the meeting. Limited data exists still on the extent of uptake of the approach for example in hectare or percentage of farms and how this has been increasing the resilience of farmers.

2.4. Potential for Regional Collaboration on Integrated Farming Systems in ASEAN

IFS is one of the research programs suggested by Thailand under a proposed ASEAN Research Network Program as proposed in the Thai National Study. During the prioritization of good practices for climate resilience documented in the Regional Study on Promotion of Climate Resilience for Food Security in ASEAN, IFS has received particular interest for regional collaboration by Cambodia and Laos.

While no dedicated knowledge exchange activities were organized within the ASEAN-CRN process since the interest was raised, the ASEAN-CRN Bali Action Plan (2015) emphasizes the interest of AMS in regional collaboration on IFS. Particular interest on the topic was expressed by Cambodia, Laos and Vietnam and a work program was proposed. Further regional collaboration efforts would be necessary to follow up on the proposed work program and advance the state of regional collaboration on IFS in the ASEAN.

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3 CLIMATE SERVICES

3. Climate Services: Tools to Mitigate Climate Risk in Agriculture

Story from the Field: How climate information is helping farmers become smarter, productive and efficient

Gerona lies at the heart of the province of Tarlac—a province located in the central plains of Luzon—considered to be among the top rice growing regions in the country. The climate is generally extreme wet and dry and this weather pattern affects the people’s livelihoods particularly rice, corn and root crops production in Gerona. Farm flooding submerged standing crops under water, while extended dry spells and droughts usually result in little to no irrigation water. Most farmers are still dependent on rainfall and/or pumped ground water for irrigation since there is no national irrigations system. Unfortunately, both climatic events result in low production and impacts on farmers’ livelihoods and food security.

Climate information services is now becoming an indispensable public service for the farmers of Gerona, Tarlac. Farmers are routinely seeking weather forecast and advisories that they can use in their farm management. TV and radio are the usual sources of farmers in obtaining weather information. Despite having access to climate/weather forecast, Arnold Galapon, Danilo Galleon and Samson Velasco—all Gerona farmers in their 40’s and 50s, said that they hardly use them in their farming and commented further, that they had little confidence on weather forecast at all. This was several years ago.

Today, the story is a little different. The LGU of Gerona has been implementing the Climate Resiliency Field School (CrFS) and the localized climate information service (CIS)—a season-long learning program that discusses the different weather systems in the Philippines and the weather-related risks to the farmers’ livelihoods, among others. The LGU is now regularly advising farmers on how to manage the risks by providing ecological, mechanical and cultural management solutions that is disseminated through short messaging service, use of weather boards and the local climate forum.

Elohim Ancheta, Paulina Galapon and Homer Bucad, who are also graduates of the CrFS in Gerona, claimed they learned to value and integrate the use of seasonal forecast and 10-day forecast. They use the information to decide on the timing of activities they need to do in their farms. Aside from the usual source of weather/climate information, they now benefit from the information and advisories that come from Gerona Weather and Climate Information Center.

Farmer Ancheta said his farm actions and farm success are not just sheer luck but now forecast-based. “No other agency gives this kind of information that is more suited to farmers”, he said.



Gerona’s Municipal Weather and Climate Information Center

Paulina Galapon—who is a woman farmer—claimed her use of climate information and advisories helped reduce their production costs. Farmers said that that they were also able to reduce their chemical use, thus reducing costs while maintaining similar productivity level and are now slowly using organic fertilizers, that they themselves produced, in their own farm.

They have also learned that weather and crops have a relationship other than the very obvious impacts—such as flooding and drought. They also learned other weather parameters such as temperature, solar radiation and relationship to certain crop pests and plant diseases, etc.

All farmers attest to learning a lot in their CrFS experience. They became more nurturing and observant of their farms—so much so that they can now identify possible risks and do not immediately panic and resort to unnecessary actions that in the end will do more harm than good.

Their learning experience as well as the regular farm-weather advise of the LGU provide them with appropriate and timely management ideas to help avoid negative impacts of weather. Farmers particularly enjoyed doing their agro-ecosystem analysis (AESAs) in their CrFS sessions where they get to interact with fellow farmers on farm to collect and gather farm data. Together with the use of weather forecast, they use these to come up with their analysis and risk management plan for the week. The farmers not only gain additional learning but build close relations with other farmers during this period. Ancheta shared he even learned to improve his interaction skills thru this program.

In 2011, the LGU of Gerona adopted the CrFS and later, the localized CIS, in partnership with Rice Watch Action Network (an NGO) and PAGASA—the Philippines national meteorological agency. These include provision of early warning service for agriculture, training and assisting farmers on adaptation and resiliency mechanisms that will save their farms, crops and livelihood from extreme weather patterns.

Jan., 21 - 30, 2015	Farm-Weather conditions
General Weather Affecting Gerona	Fair weather with isolated, light rain condition at noon Moderate wind
Expected tropical depression within the period	
Forecast rainfall	0-10 mm
Ave. Rainy Days	Less chance
Soil Moisture Condition	Moist
Ave Range of relative humidity	50-70 %
Min-Max Temp.	20-33 degrees centigrade

FARM-WEATHER ADVISORY
Gerona Climate Information Center,
Jan., 21 - 30, 2015

Legend
Jan.,21 – fair & light clouds w/ rain, l.s.
Jan.,22 – fair with light clouds
Jan.,23 – mostly cloudy
Jan.,24 – fair with light clouds
Jan.,25 – fair with light clouds
Jan.,26 – fair with light clouds
Jan.,27 – fair with light clouds
Jan.,28 – fair with light clouds
Jan.,29 – mostly clear sky
Jan.,30 – fair with light clouds

FARM-WEATHER ADVISORY
Gerona Climate Information Center,
January 21 - 30, 2015

Crops	Stage	Possible impact of weather	Advisories
Rice	Dry season- 95% planted/ tillering, vegetative stage	Favorable to crops and reduces the fast drying of soil due to clouds and possible light rain	Huwag pabayaang matuyo ang lupa sa taniman para maiwasan ang pagdami ng damo sa palayan Obserbahan ang palayan para sa mga insektong mapanira sa tanim lala na ang RBB(Rice Black Bug)
Corn	vegetative		Observe soil moisture, irrigate if needed
Sugarcane	Maturing / Harvesting stage	favorable for sugarcane	Weeding and skinning off old leaves will induce maturing for early harvesting
vegetable	Production & harvesting	favorable to crops flowers and produce	Protect crops from excessive heat from sunlight use alternative mulching
Rootcrops (sweet potato)	vegetative	Fast drying of soil	Observe soil moisture irrigate if needed Weeding is advised on some areas

Inihanda ni Milagros Pacheco MAO- Gerona / Rodelio Taberna – Gerona Agromet Observer

3.1. Climate Services: Definitions and components

Climate services provide information to support decision-making by governments, organizations, and individuals to manage the risks and opportunities arising from climate variability and climate change.

The Global Framework for Climate Services (GFCS) is an UN-led initiative that guides the development and application of climate information and services in support of decision-making. GFCS was established as an outcome of the World Climate Conference-3 (WCC-3) organized by the World Meteorological Organization (WMO), in collaboration with FAO, UN Environment, UNESCO, and other intergovernmental and non-governmental partners. Establishment of GFCS was endorsed by 13 heads of government and 81 ministers, including delegates from ASEAN Member States.

The Global Framework for Climate Services provides the conceptual framework for the design and delivery of climate services. Some useful definitions are provided below:

- **Climate data:** Historical and real-time climate observations along with direct model outputs covering historical and future periods. Note: Metadata should accompany all climate data.
- **Climate product:** A combination of climate data with climate knowledge to add value.
- **Climate information:** Climate data, climate products and/or climate knowledge.
- **Climate service:** Climate information provided in a manner that assists decision making by individuals and organizations. A service responds to user needs and includes an effective mechanism for users to access climate information.

This chapter reviews the four (4) principal components of climate services, applied to the agriculture sector:

- **Production** and supply of climate information;
- **Translation** of climate data into climate products and services;
- **Communication** of climate information and services; and
- **Use** of climate information and services in climate-informed decision-making and climate-smart policy and planning

3.2. Designing Effective Climate Services for Agriculture: Practices, Challenges, and Lessons

Despite the importance of climate information and services to the agricultural sector, appropriate information is not always delivered to end-users in a timely and useful manner. In some cases, end-users are not aware that the information they need exists. In other cases, end users are aware that the data they need is available, but it has not yet been translated into products and services they can actually access

and use. Generation and dissemination of climate information and services useful for decision-making face a series of challenges regarding climate data (Bernardi, 2011):

- Insufficient data policies, which impedes free and open data dissemination: institutions face important financial difficulties (e.g. limited budgets, privatization, cost recovery) that lead them to impose restrictions on the distribution of data they generate;
- Worldwide, climate archives still need adequate processing (digitization, quality control, homogenization) in order to deliver comprehensive climate services. These archives need also to be expanded to cover not solely physical aspects (e.g. precipitation and temperature) of the climate system but also biological, socio-economic and environmental aspects;
- Gaps in the climate observation records in critical areas when meteorological weather stations have stopped functioning. This significantly affects the efforts to quantify climate change and variability, which are fundamental for operational management and early warning systems;
- Insufficient capacity to integrate using remote sensing (i.e. satellite) data with traditional climate datasets.

Farmers should be at the center of the analysis of impacts assessments and response strategies. However, addressing the challenges listed above will involve multiple actors, including: government agencies, research institutions; academia; extension workers; civil society; farmers; and the private sector. There are complicated interactions between all of these actors, each with different perspectives and objectives. Their individual actions and efforts should be integrated with the objective of delivering effective climate services to farmers and to the other actors, who also require climate information and services to guide their decisions (Bernardi, 2011).

Additional challenges have been identified across the ASEAN region (ASEAN-CRN, 2017), in particular:

- Improved data for developing information products that address specific decision-making needs, for example, developing crop-specific information products that address specific management practices. This challenge requires developing new capacities across national meteorological services;
- Developing and strengthening communication channels and formats, for example, using local terminologies and providing responses that can be applied by farmers as part of their usual activities;
- Developing scalable pilot efforts and balancing specific context needs with cost effectiveness at large scales;
- Improving institutional arrangements to enable a sustained provision of the services.

Potential opportunities to overcome some of these issues relate to the development capacities among farmers to act on information, information and communication technology (ICT) solutions, crowd-sourcing of information and private sector involvement (ASEAN-CRN, 2017).

Experiences from other regions (i.e. Caribbean countries) suggest that data

producers and users interactions can be enhanced through the development of collaborative group processes, embedded capacities, knowledge networks, and information brokers, whose interaction is supported by boundary organizations (Guido et al., 2016).

3.2.1. Production and Supply of Climate Data and Information

Climate information for agriculture should address different planning time-scales requiring climate information at intra-seasonal (e.g. daily forecasts), seasonal and long-term horizons. This information supports agriculture ministries, non-governmental organizations, private companies, farmers and their associations for policy and planning processes from national to farm levels. Data needs are varied and range from climate observations, forecasts and scenarios to soils, agronomic practices, crop phenology and yields, socio-economic factors, or market prices that are analyzed and integrated to produce information that supports decisions making for risk reduction. At the farm scale, for example, information can support decisions on crop planting dates, farm inputs needs, management practices or post-harvest processing needs.

3.2.1.1. Types of Climate Services useful for Agriculture

Climate information is a broad concept that encompasses climate data, climate knowledge, and climate products and can be classified in historical, observed and future climate information. Climate data refers to the historical and real-time records of observations, as well model simulations of past, present and future conditions. Observations usually refer to data obtained from field instruments (for example, weather stations or satellites); model simulations usually integrate these observations aiming at expanding the spatial and temporal coverage of the data. A climate product consists of a synthesis of climate data with added value as a result of its integration with knowledge related to decision making processes. A climate product, for example, could be based on interpreting a seasonal forecast under the scope of its impacts on crop productivity and potential management responses.

Historical climate information describes climate patterns (e.g. ENSO climate conditions), climate variability (e.g. frequency and magnitude of extreme precipitation events), anomalies (e.g. changes in precipitation for a specific date compared to historical mean values) and trends (e.g. rates of increased decadal mean temperature) derived from observation records and model simulations.

Observed climate information refers to physical quantities of the climate system collected with the current observation networks. The record of climate observations dates back to the 19th century, with the installation of surface weather observations. Radiosonde observations—balloon-based measures in the atmosphere up to several kilometers above the surface—were established in the 20th century. Satellite-based observations (e.g. temperature and humidity) began since the 1970s. All these data are the fundamental for validation of numerical models used for weather prediction (short-term predictions), and for long-term, scenario-based projections.

Future climate information consists of climate projections that span different time scales: short-term and seasonal forecasts, decadal predictions and long-term

scenarios.

Short-term predictions of climate predictions usually span less than two weeks, consisting in forecasts of the day-to-day evolution of the climate system (weather forecasts). Short-term predictions also include seasonal forecasts, which involve periods of about 2 weeks to around 1 year. Short-term and seasonal forecasts share a common dependence on the state of the climate system, i.e. the current weather conditions that define its short-term future evolution. This is why weather/seasonal forecast systems strongly rely on detailed information (i.e. observations) of the climate system—they continuously assimilate the observations to make an accurate forecast.

Seasonal Climate Forecasts are developed by Regional Climate Centers, each using a different model and/or an ensemble which combine multiple outputs from two or more regional or global climate models. Outputs from Regional Climate Centers are shared with National Meteorological and Hydrological Services (NMHS) at Regional Climate Outlook Forums, at which a consensus forecast for the region is developed and disseminated to the public. Many NMHS prepare their own seasonal forecast using outputs from one or several models that have the greatest skill at predicting the specific climate conditions in their country. Seasonal forecasts produced by NMHS are usually more elaborate than the consensus regional forecast products and may include additional climate parameters that are directly relevant to the agriculture sector, such as evapotranspiration, wind, humidity, solar radiation, and monsoon onset dates. Some NMHS prepare and distribute an assessment of the impacts that the forecast conditions could have on specific crops.

Decadal predictions, lie on a time-scale between seasonal forecasts and long-term climate projections, predicting conditions from several years to a decade into the future. Like short-term forecasts, decadal predictions depend upon the conditions of the climate at the beginning of forecast, but also upon one or more external forcing agents, which are outside the Earth's climate system, such as the concentration of long-lived greenhouse gases. Decadal predictions are still in a relatively early stage and are not commonly used for decision support in the agriculture sector. However, decadal prediction systems have shown a promising degree of skill in hindcasting, which is the prediction of a past event by assimilating observations prior to that event. Current research aims to improve decadal prediction systems and to better understand their apparent skill (Kirtman et al., 2013).

Climate change scenarios are based upon long-term projections of the climate, usually beyond the middle of this century, from 2050 to 2100. Climate projections, unlike short-term weather forecasts, do not make definitive deterministic predictions of the state of the climate system. While the goal of weather forecasting is to accurately predict the value of particular climatic variables, future climate projections are used to address questions such as the likelihood that the average temperature during a given season will be higher than the long-term average of past seasons.

Climate scenarios are based upon assumptions about both natural and external forcing agents, including the natural variability of the climate system and the potential trajectories of greenhouse gas emissions in the future. Climate change scenarios are the last element in a chain that starts with assumptions on the evolution of

anthropogenic forcing (mainly the increase in greenhouse gases in the atmosphere due to human activities), which are input to a global climate model to simulate the climate of the future. There is also uncertainty associated with climate projections because our understanding of the climate system is incomplete and there are limitations on our current capacity to simulate how it functions.

3.2.1.2. Data Challenges

The primary source of historical climate data is observation by ground-based weather stations, recorded and maintained by NMHS of each nation. The second source is satellite-derived observations, which provides comprehensive spatial coverage, but may require local station data for calibration. The main strength of ground station observations is that they give the accurate estimates (measurements) of the true state of climate variables of interest. However, in many parts of Asia, meteorological stations are sparse and/or unevenly distributed. Although the WMO recommends a minimum of one rainfall station for every 15 to 25 square kilometers, depending on geography, this level of coverage is not currently met in all parts of Southeast Asia. Compounding this problem, the distribution of existing stations is uneven, with many located in and around cities and towns or along major roads. As a result, coverage may be inadequate in rural areas, where livelihoods are most vulnerable to climate variability and extreme events. Where meteorological stations do exist, the observations may be of poor quality or have gaps in the record. As a result, national meteorological agencies face real challenges providing high-quality historical climate data that covers the entire country.

While many countries in Asia and the Pacific are investing in improvements to their observation networks, the agriculture sector has an urgent need for data and derived information products based upon the current infrastructure. The Enhancing National Climate Services (ENACTS) initiative offers a solution that is available through the International Research Institute for Climate and Society (IRI), a research partner of the CGIAR. ENACTS utilizes climate data currently available from NMHS and integrates it with global satellite-derived products to create higher-quality climate information in a format compatible with crop yield and hydrological models. ENACTS tools facilitate quality control checks and corrections to data from the national observation network and combines that quality-controlled data with satellite derived estimates for rainfall, elevation maps, and with reanalysis products for temperature. Users are able to access higher quality data and derived information products immediately, without waiting for the necessary improvements in observation networks. When observations from the new stations become available, they can be absorbed into the integrated data system.

In addition to the conventional observations made by the global observation network and space-borne instruments, other types of biophysical data are required:

- Observations of soil moisture and temperature;
- Observations that yield vegetation indices (e.g. photosynthetic activity), evapo-transpiration measurements, presence of aerosols and other pollutants (e.g. ozone);

- Phenological observations that keep track of important phases in plant (e.g. leafing, flowering, leaf-fall of trees) and animal life (e.g. migration, appearance of insects);

Socio-economic and agricultural production information are required if comprehensive climate services are to be delivered to the agriculture sector (WMO, 2014):

- Data on crop yields and production statistics; livestock production; biodiversity; vulnerability assessments relevant for identifying and keeping track of climate impacts on agriculture;
- Other measures of vulnerability: dependency on agriculture; level of human development and education; political and institutional environment; access to natural resources; access to infrastructure; access to markets; baseline health; historical exposure to natural hazards (e.g. droughts, floods).

3.2.1.3. Downscaling, formatting: from global to regional and local climate data

Climate forecasts are generally prepared, processed, analyzed, and disseminated as maps depicting values of one or more climate variables. Short-term weather forecasts using state-of-the-art prediction models can produce maps of relatively high resolutions, with grid cells measuring 5 to 15 kilometers on a side. Seasonal climate forecasts are output from global climate models at considerably lower spatial resolutions, with grid cells measuring hundreds of kilometers on a side. At such resolutions, seasonal forecasts do not provide enough spatial detail for agricultural applications at the local scale. However, methods exist to generate predictions at a scale relevant for agriculture, using global models as a starting point (Hansen et al., 2011).

Dynamic downscaling

Dynamic downscaling is computationally intensive and uses a Regional Climate Model (RCM), which is a climate circulation model applied over a limited-area or domain. RCMs require data about the initial conditions (climate conditions at the time the simulation commences) and the conditions at the borders of the simulation domain (RCMs need information about the fluxes of energy, mass and momentum that enter the domain). Initial and boundary conditions can be obtained from another global climate model, or from global reanalysis (historical reconstructions of the global weather using global circulation models and observed data). The Regional Integrated Multi-Hazard Early Warning System (RIMES) uses a RCM to provide dynamically downscaled seasonal forecasts and future climate projections to NMHS in Southeast Asia.

Statistical downscaling

Statistical downscaling is less computationally intensive and does not require use of an RCM. Statistical downscaling is accomplished by establishing empirical relationships between large-scale atmospheric variables (predictors) from global or regional climate models and local/regional climate variables (predictants) observed at specific sites over time (e.g. meteorological station observations). Local/regional future projections may then be obtained by applying those relationships to predictors

from future simulations generated by global climate models. Statistical downscaling is applied to predictors from regional climate models to obtain a seasonal climate forecast with higher spatial resolutions, suitable for use at local scales by the agricultural sector.

Variable-resolution global climate models

These global models make use of variable horizontal resolutions (e.g. pixel size), and offer higher resolution over an area of interest. Previous research with these category of models has shown improvements in representing, for example, monsoon systems in Africa (Abiodun et al., 2011), and in temperature- and precipitation-related extreme indices (White et al., 2013), relative to conventional global models.

Atmospheric general circulation models

Global atmospheric models (AGCMSs) that run at higher resolutions than the atmosphere–ocean general circulation models (AOGCMs) are also referred to as global downscaling models. AOGCMs, called coupled models, are computationally demanding because they represent both atmospheric and ocean circulation and the interactions between them. AGCMs are simpler and represent only the atmospheric circulation, which allows them to gain in resolution at a given computational cost relative to a coupled-model. Like the RCMs, AGCMs are forced with a coupled, lower resolution model. Important applications of higher resolution AGCMs include the simulation of tropical cyclones (Murakami et al., 2012; Zhao et al., 2009).

Climate Surfaces

Climate surfaces are climate data derived from observation stations that have been interpolated on two-dimensional grids. Climate surfaces are used to fill information gaps in areas where the observation network is sparse. They are particularly useful for agricultural modeling applications, such as simulation of crop yield (Hijmans et al., 2003), or the distribution of organisms (Jones et al., 2003). Examples of such climate surfaces include the WorldClim database, which provides climatological (long-term average) surfaces of physical and bioclimatic variables based on surface weather stations and the Climate Hazards group Infrared Precipitation with Stations (CHIRPS) dataset (Funk et al., 2015), which provides an uninterrupted, spatially consistent, 30-year record of precipitation data by blending satellite observations with precipitation data from meteorological stations. At national scale, for example, a recent gridded rainfall dataset has been developed for Vietnam (Nguyen-Xuan et al., 2016), by interpolating data from rain gauges from all over the country for the period 1980 – 2010.

3.2.1.4. Presenting and distributing climate information to users

The agriculture sector needs access to long-term (30 year), historical and near real-time climate data to support a wide range of operational activities, including: early warning; monitoring of soil moisture conditions and crop production; crop suitability analysis; assessing vulnerability to climate variability and extreme weather events; and providing site-specific nutrient management and other agro-advisory services to farmers.

To meet this challenge, NMHS of Indonesia, Lao PDR, and the Philippines have each established a Data Library and a Map Room to present and distribute their

climate data and maps to users, with support from IRI. A Data Library is designed to make climate and other data products accessible to a wide range of users. It provides tools to store, organize, and transform national climate data. It simplifies access to and transformation of global datasets that are stored and shared as collections of files at multiple service points. Users access their Data Library via a Map Room, which is a tool designed specifically to disseminate climate data, information, and maps to users. The Map Room includes tools to merge standard climate products with other GIS data (administrative boundaries) (Blumenthal et al., 2011).

3.2.2. Translation of Data into Climate Information and Services

3.2.2.1. Agro-Advisories

A key challenge of translating data into climate services is that these services reach the hands of farmers, because information is too complex or inadequate, or because inadequate means of disseminating the information. Agro-advisories should address the gap between farmers and experts in agricultural sciences and exploit the power of climate-informed ICT. Examples of these agro-advisories are: crop calendars, impacts assessments and site-specific nutrient management (SSNM) guides.

A cropping calendar is a tool that provides information on planting, sowing and harvesting periods for selected products, aimed at promoting local crop production. Integrated Cropping Calendars have been developed in Indonesia and Laos, by IRI with financial support from the International Fund for Agricultural Development (IFAD). Integrated Cropping Calendar tools are used to generate information about optimal planting dates, which is communicated to farmers accompanied by recommendations on which crop varieties are best suited to the current planting season, potential impacts of plant diseases or pests, and information about climate uncertainties during the cropping cycle.

Crop management practices have not yet made full use of recent technical advances in forecasting of seasonal rainfall characteristics. While onset, strength and duration of the wet season are strongly linked to climate patterns such as the El Niño Southern Oscillation (ENSO), the traditional crop calendar used by farmers is not sufficiently flexible to account for such variability. Enhancing the responsiveness of crop management systems to seasonal variations in precipitation helps farmers reduce risk.

A Dynamic Cropping Calendar is used to forecast precipitation patterns with sufficient lead time for farmers to adjust their planting dates, choice of varieties, and crop management strategies. Tools generate information about optimal planting dates, which are communicated to farmers accompanied by recommendations on which crop varieties are best suited to the current planting season. Forecasts generated throughout the growing season, provide information about climate uncertainties during the cropping cycle and early warning of climate conditions that could result in outbreaks of plant diseases or pests. A Dynamic Cropping Calendar was developed in Indonesia, by IRI and Institut Pertanian Bogor (IPB) with financial support from USAID. IRI was able to continue development of the tool and extended it to other districts with financial support from an IFAD grant (IRI, 2015).

NMHS in AMS produce a variety of climate information products and services at different temporal and geospatial scales. In the Philippines, a Climate Impact Assessment for Philippines Agriculture (Rice and Corn) is produced monthly by PAGASA's Climatology and Agro-meteorology Division (CAD), Impact Assessment Applications Section (IAAS). This climate service provides an example of good practice translating data into a usable climate service. The bulletin is prepared monthly and posted to the PAGASA website for distribution to the public as well as government agencies concerned with food security and economic planning. PAGASA produces other climate information products specifically for agriculture including: a 10-day (decadal) Regional Agri-weather Information and a daily Farm Weather Forecast and Advisory.

SSNM guides are recommendations to optimize the supply of nutrients to the crops over time and space, according to crops requirements. Although mainly oriented to increase crops yield and incomes, SSNM guides can enhance the overall resilience of crop and livestock productions systems to climate change (Thornton and Herrero, 2014).

3.2.2.2. Agricultural Forecasting: Connecting Climate Data to Crop Models

Governments and their development partners need reliable intra-season estimates of crop production, in order to plan and implement policies and programs relating to commodity pricing, marketing, export/import, distribution, and overall food security management. However, estimating crop production by traditional crop cutting methods is time consuming and costly. Results often become available only after the crops have been harvested and production tallied. By integrating crop growth models with Geographic Information Systems (GIS) software, tools have been developed that are capable of simulating agricultural production. Chiangmai University developed the CropDSS (GIS) shell and has been employing it to simulate crop production in Thailand, starting with sugar cane. Applying this tool to forecasting rice production in Thailand is the subject of an ongoing collaboration between Chiangmai University and the Rice Department of Thailand. The tool has also been used to simulate the impacts of climate change on rice, cassava, sugarcane and maize in a collaboration between Chiangmai University, Khon Kaen University, Rice Department, Department of Agriculture, Land Development Department, and the Thailand Meteorological Department.

The CCAFS Regional Agricultural Forecasting Toolbox (CRAFT) further advances these technologies, by integrating seasonal climate forecasts to produce probabilistic forecasts of crop yields and area-aggregated production. CRAFT incorporates multivariate statistical forecast and downscaling models (IRI's Climate Predictability Tool, CPT), running in the background, to connect the predictable components of seasonal climate with the crop simulation. Instead of developing the downscaled seasonal forecast model on historic weather data, it is developed from crop yields simulated with historic weather data. Where seasonal rainfall forecasts are skillful, this can substantially reduce the uncertainty of production forecasts made early in the growing season.

CRAFT has designed a tool for within-season forecasting of crop production and

allows for user-defined risk analysis and climate impact study scenarios. The Decision Support System for Agrotechnology Transfer (DSSAT) and the Agricultural Production Systems sIMulator (APSIM) are embedded in CRAFT as external engines, providing forecasting capability for more than 40 different crops. The CRAFT application is based upon a grid model which divides the project area into equal grid cells of 5 arc minute or 30 arc minute resolution. CRAFT processes each cell one by one and passes data to the external crop simulation engine as objects, which uses these objects to execute the model. The results are then returned to CRAFT where a user interface supports visualization of simulation results as tables, summary statistics and maps. The Climate Predictability Tool (CPT) is embedded in CRAFT as an external engine to produce seasonal climate forecasts by downscaling outputs from a general circulation model or by relating seasonal climate to changes in sea-surface temperatures using a statistical approach. CPT provides support for probabilistic analysis of forecast uncertainty and includes diagnostics to select appropriate predictors and their associated spatial domains.

CRAFT has been developed by CCAFS in collaboration with the International Research Institute for Climate and Society (IRI), the Asia Risk Centre (ARC), University of Florida (UF) and Washington State University (WSU). Software, tutorials, and sample data for use with CRAFT are available through CCAFS, the CGIAR centers or the IRI. Shelia et al., (2015) provides a technical description of CRAFT, accompanied by descriptions of case studies simulating rice production in Bangladesh and wheat production in India. CRAFT is providing operational forecasts for rice and wheat production in Nepal, as part of the national food security monitoring system.

3.2.3. Communication of Climate Services

Climate services are most useful when built upon the interaction of the actors both on the provider and user sides—scientists, forecasters, intermediaries, farmers, extension workers, institution, businesses. Experiences across Southeast Asia illustrate successful examples of dissemination of climate services through participatory processes and communication methods, which have also addressed issues of inequitable access to climate information.

3.2.3.1. Participatory communication processes

The Farmer Field School (FFS) is a participatory, non-formal extension approach that provides farmers with a low-risk setting to experiment with new agricultural technologies and management practices. The approach was originally developed in response to unsustainable pesticide use promoted in many South-East Asian countries in the context of the Green Revolution. It was first applied in Indonesia in 1989 to introduce the concept of IPM to farmers. The approach has expanded throughout South-East Asia and later to other areas of the world. It has been adapted to different crops, production systems and topics. In recent years, the curriculum has been expanded to include information about climate smart agricultural practices and climate services. The approach may be named Climate Field Schools (CFS), FFS, or a locally relevant name, but the programs all involve common elements such as educating farmers on how to use climate services that are available to them, including short-term weather forecasts and seasonal climate

forecasts.

The first Climate Field School in Southeast Asia was established in Indonesia by the Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) to improve the capacity of extension workers and farmers to apply climate forecasts and other agro-meteorological information to improve farm production and mitigate the impacts of extreme weather events, particularly drought. An ASEAN Climate Field School was organized in Indramayu, West Java by BMKG, the Directorate General of Food Crops of the Ministry of Agriculture (Jakarta), the University of Agriculture (Bogor), and the Asian Disaster Preparedness Centre (ADPC). The number of Climate Field Schools rapidly expanded following this high-profile pilot project, building upon Indonesia's successful experience with FFS. By 2014, Climate Field Schools were operating in 25 provinces. In support of this BMKG provides observed and forecast meteorological data and information needed for farming activities, such as rainfall, humidity, temperature, evapotranspiration, and seasonal outlook.

The Philippines established its first CFS in 2007 with technical and financial support from the ADPC. The school is managed by the Agro-Met station in Dumangas Municipality, Iloilo province, with training on climate-smart agricultural technologies and practices provided by agricultural extension workers. More than 700 farmers have graduated from this CFS, completing a 16-week curriculum. Building upon this successful pilot, PAGASA has established CFS in municipalities throughout The Philippines. The schools serve as test sites for new climate services, decision-support tools, and climate-smart sustainable agricultural practices. In 2014, the Agro-Met station in Dumangas organized its first CFS for Fisheries focused on climate risk management for aquaculture. The Philippines also operates Climate-smart Farmer Business Schools, which utilize climate services to support decision about agriculture trading and marketing. Lao PDR is organizing Climate Farmer Field schools, applying an approach similar to that of Indonesia, as reported by the National Agriculture and Forestry Research Institute (NAFRI) (ASEAN-CRN, 2017).

Myanmar operates Forecast Application for Risk Management in Agriculture (FARM) schools, with technical support from RIMES. The objective of the FARM schools is to enhance farmers' capacity to manage risk by understanding and using climate information and forecast products of different timescales, and the curriculum is similar to that of the Climate Field Schools in Indonesia and the Philippines (Policarpio and Sheinkman, 2015).

The CCAFS research program of the CGIAR introduced Climate-Smart Villages (CSV) to Southeast Asia in 2014. Six villages were selected, representing different climatically-exposed agroecosystems: three in Vietnam; two in Lao; one in Cambodia. The villages are test sites for Climate Smart Agriculture technologies and build on partnerships between CGIAR and local agencies. After sites were selected, a steering group of community representatives and researchers identify appropriate climate-smart options for that village. These include climate-smart technologies, climate information services, local development and adaptation plans and supportive institutions and policies, all tailored to that community's needs. The community chooses its preferred options in a process that aims to be as participatory and inclusive as possible, encouraging women and more vulnerable groups to

participate.

Documentation and other resources are available to support establishing and expanding these community based approaches. Guidance on climate information requirements for community-level risk management and adaptation has been published by RIMES (Srinivasan et al., 2011) and FAO has recently published a Farmer Field School Guidance Document (FAO, 2016).

CCAFS developed the Participatory Integrated Climate Services for Agriculture (PICSA) approach. This participatory learning approach aims at spreading climate information and help farmers apply it in their particular situations. Through this approach farmers are presented with historical records of temperature and precipitation, along with seasonal cycles of crops, and have the opportunity to confront that information with their experience. Then farmers are given crop, livestock and livelihood management options. They compare them in terms of water requirements and season lengths that match the recent climate trends, and learn to calculate the probability of suitable conditions. Trainers present the farmers with options of suitable crops, but the farmers make the final assessment. By using locally-specific climate information, the tools provide support on complex and context-specific decisions regarding labor and resource allocation. The tool has been disseminated—through training workshops for extension workers and intermediaries—particularly in Africa (Tanzania, Malawi, Zimbabwe, Kenya, Ghana), although examples also exist in Central America (Honduras).

3.2.3.2. Combining communication channels

Sometimes, the extend of face-to-face dialogue between the actors is limited and costly, and constrains the scaling-up of climate services for farmers. In contrast, radio broadcasts are very efficient, and have enormous reach and coverage.

In the Philippines, information on climate services and smart agriculture is disseminated to rural communities by radio broadcasts. Experts from the Department of Agriculture discuss developments in agricultural technologies and management practices with listeners who are mostly farmers. Listeners provide feedback in real time, including questions, which are addressed by the experts on-air (ASEAN-CRN, 2017).

Myanmar Radio and Television (MRTV) collaborates with the Department of Meteorology and Hydrology of Myanmar (DMH) to disseminate climate information to the public, including weather forecasts and warnings. MRTV broadcasts the Farmers Channel, a dedicated TV channel, on which agricultural topics are discussed (Policarpio and Sheinkman, 2015).

Vietnam has developed a climate-informed agro-advisory service for major food crops which allows farmers and extension workers to access field-specific information on recommended farming practices as well as on nutrient management to increase farm yields (Policarpio and Sheinkman, 2015).

3.2.3.3. Climate Risk Management and Gender Inclusion

There is a need to ensure that women have equal access to climate information and services. The “Agro-climate Information Services (ACIS) for Women and Ethnic Minority farmers in South-East Asia” provides an example of how gender issues related to climate risk management can be addressed. ACIS assists local communities in Vietnam, Cambodia, and Laos to generate actionable agro-climate information and reduce weather-related crop failures. Both men and women are consulted in the development of advisories to ensure that these will be understood by all community members. This is complemented by trainings and other activities on gender awareness. Some interesting findings from the project show that developing the advisories in women-only-groups made women more confident in going out and sharing the information afterwards, both to women and men.

3.2.4. Monitoring and Evaluation, including User Feedback

Conceiving a framework for monitoring and evaluation (M&E) of climate services is challenging. Multiple aspects are involved and different sectors—agricultural, political, scientific, private business—have different perspectives regarding the quality of climate services. Conceptually, according to the GFCS, the user – provider interface (UIP) should provide the mechanisms for the interaction between actors, in both the provider and user ends, and this dialog should help the parts define the criteria to assess the quality of climate services. The UIP, though, is not well developed (Hewitt et al., 2012) and the GFCS does not provide details on which aspects of the services should be evaluated. Yet some criteria may be outlined around the characteristics of historical and forecast data and products:

Historical data / products

- Verifying that the reference climate data that serves as input to impact studies uses are representative of current climate conditions (i.e. impact studies during 2010s may indicate more/less serious climate effects when comparing with conditions during 1981 – 2010 than during 1951 – 1980);
- Assessing the skill of forecast methods by performing regional and national hindcasts and verifying whether these reproduce the historical records;
- Ensuring that products designed for assessment of agricultural potential and natural resources (e.g. Global Agro-Ecological Zones from FAO) are based on a reference climate representative of current climate conditions

Forecast data / products

- Assessing the level of participation of the countries in the Regional Climate Outlook / Monsoon Forum meetings, and the level of dissemination of the results of the discussions during the meetings;
- Do the forecasts produced in these regular meetings include the monsoon onset and recession (dates are very important to define planting and cropping periods)? Do the forecasts include variables that are relevant for agriculture other than classical precipitation forecast (e.g. temperature, humidity, evapotranspiration);
- What kind of crops are included the forecasts?

The previous ideas only illustrate the kind of measures that could be formulated to assess the climate information delivered to the users. Information from the field—

derived from the farmers' experience—will certainly bring more light on specific metrics to evaluate climate products. Climate forums, where service providers and end-users gather, are an instance for discussions on how to promote and improve the provision and delivery of climate-relevant products. This is discussed in Section 3.3.2. This dialog is essential to evolve from utility of the information to usability (Lemos et al., 2012) and ICT could potentially provide means for upscaling two-way feedback mechanisms between service providers and end-users.

Finally, Hewitt et al. (2012) pointed out that evaluating the success of climate services is essential to convince the different sectors of their importance. Therefore, indicators of the costs-damages-benefits are needed in order to develop baselines, monitoring and impact assessments to persuade the actors—including the private sector—of the social and economic impact of climate services.

3.2.5. Governance and Institutional Arrangements

Climate Services needs to be mainstreamed in the institutional and political frameworks of AMS, to ensure good practices can be scaled-up and applied to all stages of agricultural value chains. The process used to develop a National Adaptation Plan (NAP) provides a useful framework for planning and implementing the provision of climate services to the agriculture sector. Extending that same adaptation planning process to local levels is one potential mechanism for scaling out climate services and agro-advisories. Issues and challenges that will need to be addressed include: data sharing and interagency coordination at national level; mechanisms to engage local governments in the climate change adaptation planning process; mechanisms for integrating the private sector and ICT; and identification of effective mechanisms and arrangements to deliver climate services and agro-advisories to farmers, extension workers, and local governments.

In many countries, climate information is scattered across different institutions, each with different policies and procedures for access and use. To address data sharing and interagency coordination issues, Thailand has established a Database Center for the agriculture sector and a Technical Working Group to support preparation and monitoring of the Climate Change Strategic Plan for the Agriculture Sector.

In the Philippines, few local government units have their own localized climate change action plans. Where local plans exist, the local process is not integrated with the national adaptation planning process. A mechanism is needed to integrate local planning processes with the preparation of the National Adaptation Plan or community based disaster risk management.

In Vietnam, local governments prepare their own climate change adaptation plans, which are submitted to the national government as inputs to the National Adaptation Plan. The challenge is how to transform and deliver climate information and agro-climate information from national to local levels to support this planning process. Both Myanmar and Vietnam have held meetings at sub-national levels to disseminate the seasonal climate forecast, with support from RIMES. However, replicating these national meetings in each region or province is a logistical and financial challenge. Integrating seasonal climate forum events into the local planning process is a more sustainable approach, but capacity building of local government

officials will be needed to maintain common standards for preparation and implementation of the plans.

3.3. Status of Climate Services for the agricultural sector in ASEAN

3.3.1. Assessments of NMHS capacity

The status of climate information and services in Vietnam, Cambodia, Lao PDR, Indonesia, and the Philippines, as of 2013, has been documented in a series of Country Assessment Reports published by the United Nations Office for Disaster Risk Reduction (UNISDR). These Country Assessment Reports were part of a study that aimed to strengthen the hydro-meteorological services in South East Asia. It was a collaborative effort of the World Bank, the UNISDR, the WMO and the NHMS, with financial support from the Global Facility for Disaster Reduction and Recovery (GFDRR). Each report contains an assessment of the capacity of the NHMS to respond to the increasing demands for improved meteorological and hydrological information by various socio-economic sectors. The reports include recommendations and investment plans to improve the NHMS with the goal of reducing losses due to natural hazard-induced disasters, supporting sustainable economic growth and enhancing the capability to respond to climate change. These assessments and recommendations have informed multilateral loan projects in the region, including the Hydro-meteorological component of the Managing Natural Hazards Project (\$30 million) in Vietnam.

In Myanmar, the Department of Meteorology and Hydrology conducted capacity assessments for meteorology and agro-meteorology in 2013, with technical assistance from RIMES. The state of climate information products and services for agriculture and food security was documented by RIMES in a CCAFS working paper (No. 140). The assessments and the working paper were provided to GFDRR to support design of the Hydro-meteorological Service Delivery Systems sub-component of the Ayerawaddy River Basin Management project.

At the 2017 ASEAN-CRN knowledge sharing event on the topic of Climate Services, delegates from each AMS drafted a national action plan to improve Climate Services for agriculture. Each of these national action plans was unique, reflecting differing capacities, resources, and circumstances. Common needs among the AMS were identified, including: Expanding the network of meteorological ground stations to support generation of forecasts tailored to local areas; Capacity building of NMHS staff in the use of advanced modeling techniques to support forecasting and climate analyses; Incorporating climate services into government and private sector communications channels, including radio, television, and other media formats; and creating an enabling environment for collaboration between different ministries and institutions involved in producing, translating, and distributing climate information and services to users. A table summarizing the draft national action plans has been included in the ASEAN-CRN meeting report, available from www.asean-crn.org.

3.3.2. Climate Outlook Forum events

Regional - ASEAN Climate Outlook Forum (ASEANCOF)

ASEANCOF, the regional climate outlook forum for Southeast Asia, is organized twice per year by the ASEAN Meteorological Center (ASMC), as part of the Global Framework for Climate Services. Representatives of national meteorological and hydrological services analyze and compare outputs from different seasonal forecasting models and a consensus forecast for Southeast Asia is produced. The observed climate for the previous season is reviewed and a description is prepared to accompany the consensus seasonal forecast (<http://asmc.asean.org/asmc-seasonal-outlook>).

National - Seasonal Climate Outlook Forum / Monsoon Forum events

Climate Outlook Forum (COF) events at national level are organized by NMHS with the objective of communicating the seasonal climate forecast to users of climate information and services from multiple sectors, including agriculture, water resources management, public health, and disaster management. From 2009 to 2010, NMHS in the Philippines, Vietnam, and Indonesia received support to organize Climate Outlook Forum events under a project to enhance the capacities of national Red Cross and Red Crescent Societies to utilize early warning information, including seasonal climate forecasts. NMHS continue to hold national COF in the Philippines and Vietnam. There is no record of Indonesia organizing a national COF event after the project concluded. National COF were organized by NMHS in Myanmar, Lao PDR, and Cambodia from 2010 to 2012 with technical support from RIMES and financed by a FAO-European Commission food security project. NMHS continue to hold national COF in all three countries with technical support from RIMES and financial support from UN ESCAP.

In the Philippines, more than 90 national Climate Outlook Forum events have been organized by PAGASA, Climatology and Agro-meteorology Division (CAD), Climate Monitoring and Prediction Section (CLIMPS). The national Climate Outlook Forum is held every three to six months during ENSO-neutral years. It is held more frequently during El Niño years, due to the significant impact that ENSO has on the climate of the Philippines. The agenda of a typical Climate Forum includes presentations on: a “Climate Outlook” for the next 3 to 6 months; a “Review of Climate Conditions” for past months, a “Weather Update” on extreme events, and a report on the “Status of Dams” (<http://www1.pagasa.dost.gov.ph/index.php/climate/climate-outlook-forum>).

PAGASA posts the presentation files delivered at the Climate Outlook Forum directly to their website, which include contact details for the presenter, instead of preparing a written report of the meeting. PAGASA digitally records the presentations and posts these videos to the PAGASA YouTube Channel and to PAGASA’s FaceBook page. Publication of presentation files directly to their website and posting video recordings of the presentations to YouTube and social media, should be recognized as a best practice, which could be adopted by NMHS who are not comfortable preparing a report after the event (<http://www1.pagasa.dost.gov.ph/index.php/climate/climate-outlook-forum>).

Twice per year, national Monsoon Forum events are organized in Myanmar

(www.dmh.gov.mm), Cambodia (<http://www.cambodiameteo.com>, www.mowram.gov.kh), and Lao PDR (www.dhmlao.etlao.com). At the events the seasonal climate forecast is communicated to users from multiple sectors, including agriculture, water resources management, health, and disaster management. Presentation files are distributed to those attending forum events, but are not posted to the NMHS website. The agenda of a national Monsoon Forum includes the following components:

- Communicate the season climate outlook
- Review the past season, including patterns and anomalies
- Obtain feedback from user institutions on the relevance/usability of the past seasonal forecast
- Obtain recommendations for enhancement of forecast products
- Discussion on potential impacts of climate outlook for each sector, including response options

In Vietnam, the National Hydro-Meteorological Services (www.nhms.gov.vn) of the Ministry of Natural Resources and the Environment (MONRE) is responsible for organizing national COF events. Four national COF were held in Vietnam from 2009 to 2010 with support from the Red Cross. A regional COF and a provincial COF were organized to assess the feasibility of organizing COF at sub-national levels. Seasonal Forecasts are produced by the National Hydro-Meteorological Forecasting Centre (NHMFC; www.nchmf.gov.vn) and communicated to Ministry representatives at national COF. Reports and presentations from national COF events were not available for download, as both the NHMS and the NHMCF websites are undergoing renovation.

In Indonesia, BKMKG produces a seasonal climate forecast (Prakiraan Musim) twice per year, with the dry season forecast released in early March and the wet season forecast released in early September. This forecast provides information on the general potential rainfall condition in various areas in the country, during the wet and dry seasons. A comprehensive document is prepared which provides the seasonal forecast for each province, as well as at national level. Bahasa language text is accompanied by summary tables and maps of each province. The document is available to the public on the BKMKG website.

The Thailand Meteorological Department (TMD) (www.tmd.go.th/en/seasonal_forecast.php, www.tmd.go.th/en/3month_forecast.php) produces a “Seasonal Forecast of Thailand” twice per year, with reports available online in both Thai and English languages. The “Season Forecast of Thailand” document includes the precipitation forecast in both table and text format. The content and style of the text is informative and concise, offering an example for NMHS in the region, although not yet publishing their Seasonal Forecast on the web. TMD maintains a separate webpage for the 3 Month Weather Forecast which describes the climate characteristics expected for the next 3 months by region and provides tables of expected rainfall (mm) and number of rainy days. The 3-month Forecast is updated every month.

3.4. Regional Cooperation on Climate Services for the Agricultural Sector

ASEAN Technical Working Groups provide platforms for knowledge exchange and regional cooperation on a wide range of topics, including climate services for the agriculture sector. Delegates from AMS participating in ASEAN-CRN have identified opportunities for collaboration at regional level.

Information on the status of climate services for agriculture in each AMS

Maintaining comprehensive and current information on the capacity of the NHMS to provide climate services to the agriculture sector is a regional collaboration activity that is high-value and low-cost. Baseline information on the status of climate services in each AMS has been collected and published in UNISDR Country Assessment reports for Vietnam, Cambodia, Lao PDR, Philippines, and Indonesia. RIMES prepared a report for Myanmar based upon self-assessments undertaken by DMH. Updates can be obtained from each NMHS at the ASEANCOF or from the national Climate Outlook / Monsoon Forum events. The investment plans included in the UNISDR Country Assessment reports provides a useful template to further develop the national action plans that were drafted during the ASEAN-CRN meeting. These plans support the efforts of NMHS and other climate services providers to obtain financial resources and external technical support necessary for them to deliver requested climate services.

Regional sharing of knowledge will be more effective if information is structured and available online as a database or document library that can be sorted by either country or topic, and can be searched by keyword or other identifier. To achieve this end, AMS can encourage and support national agricultural research institutions to document and publish their experiences with CFS, FARM schools, and Climate Smart Villages.

Publication types which support regional collaboration, include: practice briefs (technical descriptions), case studies (examples), reference manuals, training curricula and teaching materials. To ensure wide distribution, publications should be posted to the ASEAN-CRN regional website and/or the CCAFS website, as well as the website of the national research institution. Sharing of curriculum and course materials, exchange visits, and training workshops are all regional collaboration activities that are high-impact, but relatively low-cost. These activities strengthen existing extension activities while stimulating interest in the expansion of successful programs to new communities of farmers.

Other topics where documentation of past and ongoing activities would be beneficial include:

- Assessing impacts of seasonal variability on agricultural production
- Forecasting impacts of extreme weather events on the agricultural sector
- Institutional frameworks for climate services for the agriculture sector
- PPPs to develop and implement Agro-Advisories
- Strategies for financing development of Climate Services for Agriculture

AMS need to encourage and support national agricultural research institutions to document and publish their knowledge and experiences on these key topics. As a first step, governments can request their national research institutions to prepare an annotated bibliography or a literature review of existing documents and associated data on these topics. Whenever possible, relevant documents should be posted to the website of the national agricultural research institutions. Links to published documents can be replicated on the ASEAN-CRN regional website. National agricultural research institutions can obtain guidance and assistance from their development partners, including the CGIAR centers.

Establish an ASEAN Climate Services User Forum for the Agricultural sector

A Climate Services User Forum for Agriculture (CSUF-Ag) will benefit AMS by establishing a mechanism for dialogue between consumers and producers of climate information and services, at regional level. It will complement and reinforce the national-level dialogue that takes place during the national Climate Outlook and Monsoon Forum events held in each country. Priority issues, needs, and challenges that have been identified at national-level can be shared with AMS colleagues during the regional dialogue. If solutions exist and AMS have pilot tested and/or implemented them, those experiences can be shared. Potential sources of external technical assistance, training, or financial support can be identified and contacts shared. The regional Knowledge Exchange Event organized by ASEAN-CRN in 2017 demonstrated the benefits of a regional-level dialogue on Climate Services. Institutionalizing regional-level dialogue at regular intervals through the CSUF-Ag is the next step.

In September 2016, Myanmar hosted the 2nd Climate Services User Forum for Agriculture for South Asia immediately after the 9th South Asia Seasonal Climate Outlook Forum (SASCOF). RIMES provided technical support for both Forum events, which were organized under the Global Framework for Climate Services of WMO. Representatives from the agriculture sector in South Asia were briefed on the consensus regional forecast as well as their own national forecast. Delegates shared their national priorities for climate services, common issues, challenges, potential solutions, and experiences implementing them.

Capacity building in use of crop simulation models for agricultural production forecasting

Regional collaboration is needed to enhance national capacity to utilize crop yield models to forecast agricultural production to provide decision makers with early warning of the potential impacts of seasonal variation in climate. Exchange of knowledge and data can accelerate preparation of model inputs in GIS compatible format, such as agricultural land use, soil characteristics, cultivars planted, irrigated areas, and crop management practices. Data from a new generation of high-resolution satellite sensors are available at no cost, which facilitates sharing of data and maps between AMS. Model calibration is another area where regional collaboration will be needed for effective solutions.

National 30-year historical climate data in grid format needed as input for models

Regional cooperation is needed to support NMHS to develop historical climate datasets which blend quality controlled meteorological station data with global satellite derived measurements. Forecasting the impacts of climate variability on agricultural production using the latest generation of modeling tools requires long-term historical climate data in grid format. Users of agricultural models are currently forced to choose between national data derived from meteorological stations or global data derived from satellite sensors. Through ASEAN-CRN, the agriculture sector is aware of the ENACTS initiative, which has developed tools capable of blending the two types of data. NMHS can consult RIMES about obtaining support for implementing ENACTS. AMS with one or more land borders will benefit most from regional collaboration, including: Thailand, Myanmar, Vietnam, Lao PDR, and Cambodia.

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4 RICE-SHRIMP FARMING

4. Rice Shrimp Farming

Story from the Field: Rice Shrimp Farming in the Mekong Delta

Mr. Ton Van Bac is a rice-shrimp farmer in the Vietnam Mekong Delta. For Thuan Hoa, a commune of 16,000, rice shrimp rotational farming is the largest source of income. In the dual rice shrimp system, land is used to grow rice for half the year and cultivate shrimp during the other half. While the system allows farmers to maximize their land to generate income year-round, it relies on heavy rainfall to flush residual salt from the shrimp cultivation period to prepare the soil for rice growing. According to Mr. Bac, the sustainability of this system is increasingly threatened, saying “we don’t get enough rain to wash the salt from the roots and the rice crop dies when the roots hit the salty soil”. Rainfall in these areas is already becoming more irregular and climate science projects it will worsen in the decades ahead, making it more challenging for these farmers to carry out their dual cultivation system. When the rains come late, or not at all, the residual salt from shrimp farming severely damages rice yields. After identifying both man-made and climate change points of impact on the community rice-shrimp production, Mr. Bac and the commune worked with aquaculture extension workers and technical experts to develop a low-cost adaptation solution that adjusts the current system to improve resilience. It does not require any land conversion or high-tech training but rather, simple solutions that farmers can easily adapt into their current practice.

By establishing a ‘nursery’ for post larvae (baby shrimp), Mr. Bac now gives the shrimp a ‘head start’ on surviving—harvesting them earlier which allows for more time for rains to flush the salt for rice growing. Whereas previously, Mr. Bac purchased post larvae through a middleman with a motorbike and cooler, now, through farmer cooperatives, he and his fellow farmers acquire disease-checked post larvae of higher quality at a reduced price. In a pilot activity in Thuan Hoa, these small changes meant a 74% increase in post larvae survival. As part of the identified adaptation solutions, Mr. Bac also learned about salt tolerant rice varieties which can be integrated into the system to increase resilience in the coming planting season.

4.1. Rice Shrimp Farming to Promote Climate Resilience in Agriculture

Farming systems in coastal zones throughout Asia face similar climate threats, including rising sea levels, saline intrusion, and increasing average temperatures that, taken together, can undermine traditional agricultural systems. A dual system like the rice-shrimp rotational model are more robust than traditional monocrop regimes, offering improved production and economic resiliency to farmers facing variable weather and more frequent extreme weather events. Incorporating climate resilient dual system farming techniques as outlined in section three can further buffer farmers from the negative climate impacts of variable rainfall and heat stress. The rice-shrimp system is classified as a climate smart agricultural technique based on the **production resilience** and **economic resilience** it provides farmers.

4.1.1. Production Resiliency

Improving land use sustainability. Farmers who traditionally harvest 2-3 rice crops per a year will no longer be able to do so with increasingly variable rainfall and higher temperatures. Mono-cropping exhausts soil, leaving it depleted of nutrients and requires fallow periods of unproductivity. Mono-cropping also requires inputs such as chemical fertilizers. In the rice-shrimp system the land is utilized year-round for both a staple of Asian diets (rice) and a high-value marketable crop (shrimp). The waste produced by shrimp and the residue of the rice crop are mutually beneficial to the alternate production system, providing nutrients to the soil and fodder for the post larvae respectively. Using the guidance in section two, farmers already employing the rice-shrimp system simply need to ‘tweak’ it to increase resiliency and efficiency. For example, providing a nursery gives post larvae a more stable environment in which to grow, increasing their chance of survival and reducing harvesting delays – this in turn allows a larger window for rain to flush salt from the pond before rice growing season. The rice-shrimp system also reduces land degradation by protecting the upper layer of soil from erosion caused by natural elements (wind, rain).

Working with nature, not against it. Given increasingly variable rainfall, compounded by financial pressures to grow larger shrimp, farmers are shortening the window for rain to flush salt in preparation for rice crops—a household staple. The rice shrimp with nursery adjustment, increases the survival rate of shrimp so that farmers do not need to delay harvest. The shrimp, ideally, are stronger before being released into the pond and subsequently grow at a healthy rate—matching the cropping calendar and giving farmers a broader window to allow for variable or delayed rainfall. The introduction of salt-tolerant rice addresses a number of climate change hazards currently threatening the Mekong Delta. Traditional rice breeds suffer from significant yield reductions due to increasing salinity in the soil and water. Salt-tolerant rice production is more resilient to salt residue in the soil caused by the combined effects of inadequate and/or variable rainfall, rising sea levels, and the increased occurrence of storms and flash floods that cause saline water from canals to flood into rice fields more extensively.

4.1.2. Economic Resiliency

Reducing household exposure to climate extremes. Incorporating aquaculture into traditional rice systems has been shown to raise incomes at the household level. According to the Directorate of Fisheries in Vietnam, rice-shrimp producing households earn 15-30% higher income than households whose income relies solely on rice. Production diversification also provides a buffer for particularly harsh years (drought, flood or variable rain) by ensuring that income from the aquaculture system, for example, offsets any losses in rice productivity.

The below table illustrates how the elements of the rice-shrimp system are resilient in the face of a shifting climate.

Table 5. Rice shrimp system elements

Climate Threat	Key System Elements	How the System Shows Resilience
Increased temperature	Shrimp Nursery Sedge planting	Provides a protected space to give shrimp a 'head start' by decreasing vulnerability to rising temperatures. Shrimp develop to a marketable size faster.
Variable rainfall / delayed rainfall	Shrimp Nursery Salt tolerant rice	Allows farmers to harvest shrimp in an adequate time frame, giving more time for rains to flush salt residue. Salt tolerant rice reduces risk of crop loss.

4.2. Designing Effective Rice Shrimp Farming Systems

4.2.1. Characteristics & Benefits

For Vietnam, the rice-shrimp semi-intensive model is now one of the most robust income producing systems, particularly for small scale farmers. In the rice shrimp dual system, shrimp are raised during the dry season (February to June) and rice is grown in the rainy season (August to December). By the end of the shrimp crop, the saline water that accumulates during the dry season must be flushed out of the shallow ponds to prepare them for growing rice. Since most machine-aided solutions to remove saline from the soil prior to growing rice are too expensive for the average farmer, they depend instead on wet season rainfall (traditionally June-August) to flush salt out of the ground and successfully transition from shrimp to rice.



Typical rice-shrimp system in Kien Giang, Vietnam
/Photo by Shannon Dugan (DAI)

Overall, rice shrimp rotational farming is seen as an efficient system and sustainably sound.

Key benefits include:

- Uses low cost natural inputs
- Contained systems lower risk of disease
- Shrimp fetches high market prices
- Reduced use of antibiotics/chemicals
- Improved nutrient cycling and soil quality from shrimp waste
- Viable in coastal zones accustomed to brackish water farming systems.

4.2.1.1. Observed Threats to the Rice-Shrimp Dual System

The main climate impacts rice-shrimp farmers face are less reliable rainfall patterns and higher temperatures in the dry season. Due to these changing conditions, delta farmers are finding it increasingly difficult to sufficiently flush their ponds of saline water prior to planting rice. It was widely reported during the 2014-15 and 2015-16 rice growing seasons that many farmers in Vietnam faced total crop failure due to severe drought conditions.¹⁴ Reduced yields and crop failure can result when extreme temperatures surpass 35 degrees Celsius during the pre-flowering and ripening stages. The functioning of the rice-shrimp system can also be impacted by socio-economic factors that amplify climate-driven problems. For example, because the incomes generated from shrimp are much higher than those produced through rice growing, farmers face financial pressure to delay the shrimp harvest as long as possible so that they can grow larger and more valuable shrimp. This limits the transition period normally needed to prepare for the rice crop. The late shrimp harvest exacerbates salinization issues associated with sea level rise and shifting rainfall patterns, and prohibits or delays establishment of the subsequent rice crop that is key to maintaining balance in the overall system. Furthermore, quality of post larvae shrimp used to stock the ponds can vary widely.

4.2.2. Basics of Climate Resilient Rice-Shrimp Rotational Farming

4.2.2.1. Shrimp Nursery. The typical shrimp pond configuration has a deep channel (approximately 1 m) with open water around the circumference just inside the bank, and a shallow area (approximately 20 cm) in the center where vegetation grows. The shrimp nursery is constructed on one edge of the channel using netting and stakes, or mounded soil. Shrimp post larvae are released into the nursery area at a density of 20-50 PL/m². Artemia cysts, the preferred feed for post larvae (in Kien Giang, Vietnam), are expensive for low income farmers at 75-100 USD/kg, so “shrimp starter” feed that costs about 3-5 USD/kg can be used instead. Once released into the greater pond, stocking density of the shrimp at harvest should be 3-5 kg/m².¹⁵ Maintaining integrity of the shrimp pond, such as reinforcing banks, using proper netting and stakes, ensuring the pond is clear of potential predators to the PL, is critical to effective implementation of the system.

¹⁴ <https://www.nytimes.com/2016/05/29/world/asia/drought-and-rice-first-policy-imperil-vietnamese-farmers.html>

¹⁵ Thuan Hoa Adaptation Plan, An Minh District, Kien Gian Province, Mekong Adaptation and Resilience to Climate Change, p.7.

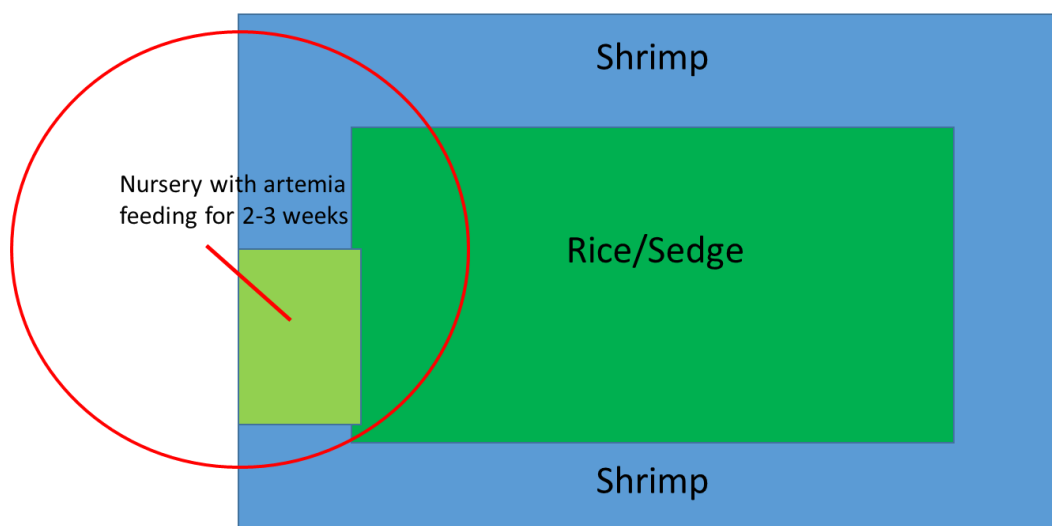


Figure 1: Schematic of shrimp nursery in rice shrimp farming system (Source: Dr. Jesper Claussen, 2014)

4.2.2.2. Shrimp-sedge for feedstock. *Scirpus littoralis* is a salt tolerant sedge variety that belongs to the Cyperaceae family. It provides an important feed source and also provides shade for the shrimp, which reduces heat stress when planted in the shallow center of the pond during the dry season. The sedge can be planted from seed or propagated, and the primary cost involved is labor for collecting the seed.¹⁶ Locally promoted sedge species can be implemented in other dual systems, such as with fish or duck raising.

4.2.2.3. Salt tolerant rice. Salt tolerant rice varieties are introduced as a resilience measure to the system. After the 2007-2009 food price crisis, ASEAN leaders worked to address future food security through the Integrated Food Security Framework and Strategic Plan of Action on ASEAN Food Security. The International Rice Research Institute (IRRI) was tasked by ASEAN to develop a Rice Action Plan. Building on this Action Plan, many ASEAN Member States have selected and introduced appropriate salt tolerant varieties. New rice varieties are being identified and introduced by the National Agricultural Research and Extension Systems (NARES) in the region, such as the Cuu Long Rice Research Institute in Can Tho, Vietnam, and the Cambodian Agricultural Research and Development Institute. These institutes provide the necessary, tested varieties that low income farmers can usually access at an affordable price.

Table 6. Rice Shrimp Farming Benefits

Benefits of Climate Resilient Rice Shrimp Farming	
Ecology	Improves soil fertility, moisture, structure, and health
	Reduces salinization of rice crop
	Improves shrimp pond environment
	Utilization of crop residue to improve shrimp health
	Reduces use of chemical fertilizer, improving ecology of land
Economics	Reduces costs of production – fertilizers, agrochemicals, feeds, energy, etc.

¹⁶ Thuan Hoa Adaptation Plan, An Minh District, Kien Gian Province, Mekong Adaptation and Resilience to Climate Change, p.8.

Benefits of Climate Resilient Rice Shrimp Farming	
	Optimizes land use and efficiency
	Provides diversification and increase in income streams
	Through cooperatives, access to better prices for higher quality inputs
	Reduces exposure to 'shocks' (i.e. extreme drought) that revert families back into poverty
Health	Higher chance of disease-free post larvae
	Increased food security; dual system provides food and nutrition for farmers
	Improves health of pond water when combined with sedge

4.2.3. Technical Challenges with Rice-Shrimp Farming

External Factors – For some areas, such as the Mekong Delta, production can be limited due to upstream activities, particularly around hydro-power development. Changes to the Mekong river system have dire effects – particularly in the Delta itself, which relies on nutritious sedimentation from upstream. Financial pressures on farmers to delay harvesting higher value shrimp continue to challenge the system. While the technical guidance outlined above intends to grow shrimp to a larger, harvestable size earlier, farmers may still wait, decreasing the window of time for rains to flush the saline.

Proper training – While improvements to the rice shrimp system are low cost and low tech, they do require proper training for farmers to fully adopt and see resiliency results. Inadequate pond construction, lack of proper infrastructure and ineffective guidelines must be addressed. Extension workers and farmers often lack comprehensive information on selecting good quality post-larvae, a process that can significantly impact the quality of farmers' shrimp harvest¹⁷. Training should be organized for and through agricultural extension officers in respective countries, where possible, and incorporate standard operating procedures with graphics for local farmers.

Rice varieties—While much research has been done on flood/heat tolerant rice varieties, these seeds can still be out of reach for the average farmer, either due to cost or lack of knowledge. It will be up to research institutes, donors and country governments to succinctly expand knowledge of and access to climate resilient rice varieties. The *ASEAN Regional Guidelines for Promoting Climate Smart Agricultural Practices* (vol.1) is a resource for country specific rice varieties.

Limited input production—The key input for more resilient rice-shrimp systems is giving post larvae a 'head start' in survival. The availability of high quality, disease-tested shrimp may be limited in some areas of ASEAN countries. For example, in Bangladesh, there are only nine hatcheries with a limited quantity of post larvae.

¹⁷ Development of Rice-Shrimp Farming in Mekong River Delta, Vietnam, Mekong Adaptation and Resilience to Climate Change, p.4.

4.3. Status of Rice Shrimp Farming in ASEAN

Dual systems, combining rice, shrimp or other crops by small landholders vary throughout Asia. In Malaysia, a traditional rice-fish farming system is practiced in which wild fish enter rice fields through irrigation canals where they are trapped early in the rice season, then raised and harvested with the rice crop.¹⁸ In Indonesia, fish are often grown with rice paddies or other cash crops such as pumpkin, spinach or cassava.¹⁹

Combining shrimp culture in saline water during the dry season and rotating to rice culture in the wet, fresh water season was first introduced to the Mekong Delta in Vietnam in the 1970s but has expanded rapidly since the early 2000s. Brackish water shrimp farming is one of the mainstays of Vietnam's aquaculture –particularly prevalent in the Mekong Delta region. In 2014, the total brackish water shrimp farming area was about 658,000 ha nationwide, shrimp production reached 560,000 tons, and shrimp export value reached nearly US\$4 billion. Of this, 83 percent (546,735 ha) of Vietnam's shrimp are farmed in the Delta, producing 420,000 tons, or 75 percent brackish water shrimp production nationwide.²⁰

In the national reports within the regional study on Promotion of Climate Resilience for Food Security in ASEAN, only Viet Nam mentioned rice-shrimp farming as a priority practices promoted to increase climate resilience. During the First ASEAN Climate Resilience Network (ASEAN-CRN) Planning Meeting in Bali, Indonesia in December 2015, countries reported further progress on the promotion of CSA practices. Vietnam reported on rice-shrimp farming regarding the level of priority and progress made as shown in Table 7 below.

Table 7. Rice Shrimp farming as a priority CSA practice of Vietnam

CSA Practices	Priority Crops	National level progress in scaling-up of CSA practices					
		Level of country priority (1 lowest – 5 highest)	Field testing takes place	Evidence based assessed	Promoted in agricultural policies	Disseminated through agricultural extension services	Widely implemented by producers/ farmers
Rice shrimp farming	Rice	3	√	√		√	√

4.4. Potential for Regional Collaboration on Rice Shrimp Farming in ASEAN

During the prioritization of good practices for climate resilience documented in the Regional Study on Promotion of Climate Resilience for Food Security in ASEAN, rice-shrimp farming has received particular interest for regional collaboration by the Philippines and Viet Nam. During the First ASEAN-CRN Planning Meeting in Bali, rice-shrimp farming was discussed as one element of the broader topic of model farming or IFS.

¹⁸ Integrated Agriculture-Aquaculture, FAO Fisheries Technical Paper 407.

¹⁹ Brackishwater Integrated Farming Systems in Southeast Asia, Catalino R. de la Cruz

²⁰ Ministry of Agriculture and Rural Development, 2014

A dedicated Chapter for IFS is contained in Section 2 of these guidelines and elaborates on the potential for regional collaboration on IFS.

In its National Study, Viet Nam mentions the following areas for regional collaboration:

- Develop rice varieties of better quality for this farming system
- Research on measures and technical options to ensure the sustainable development of this system such as specific types of fertilizers/chemicals for rice and safe medicines/chemicals for shrimp

To do so, technical and financial assistance would be needed.