german cooperation
DEUTSCHE ZUSAMMENARBEIT

Published by
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

In cooperation with
NAFRI National Agriculture and Forestry Research Institute
SEAMEO SEARCA

Promotion of Climate Resilience in Rice and Maize

Lao PDR National Study

Imprint

This publication is a joint undertaking by the ASEAN Technical Working Group on Agricultural Research and Development (ATWGARD) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH through the ASEAN-German Programme on Response to Climate Change (GAP-CC).

In partnership with the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

Published by the
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

ASEAN-German Programme on Response to Climate Change (GAP-CC)
GIZ Office Jakarta
Menara BCA, 46th floor
Jl. MH. Thamrin No. 1
Jakarta 10310, Indonesia
Phone: +62-21-2358-7111
Fax: +62-21-2358-7110
Email: giz-indonesia@giz.de
www.giz.de
www.gapcc.org

As at
April 2015

Printed by/design and layout
SEARCA
College, Los Baños
Laguna - 4031

Photo Credits
Souphaphone Rattanarasy (SEARCA Photo Contest)

Authors
Dr. Outhai Soukkhy
Mr. Xayavong Chanthasone

On behalf of the
German Federal Ministry for Economic Cooperation and Development (BMZ)
Alternatively: German Federal Foreign Office

Promotion of Climate Resilience in Rice and Maize

Lao PDR National Study

ASSOCIATION OF SOUTHEAST ASIAN NATIONS (ASEAN) and the GERMAN-ASEAN PROGRAMME ON RESPONSE TO CLIMATE CHANGE (GAP-CC), DEUTSCHE GESELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT (GIZ) GMBH. IN PARTNERSHIP WITH THE SOUTHEAST ASIAN REGIONAL CENTER FOR GRADUATE STUDY AND RESEARCH IN AGRICULTURE (SEARCA)

List of Acronyms

ADS	Agriculture Development Strategy
AMP	Agricultural Master Plan
AMS	ASEAN Member States
ATWGARD	ASEAN Technical Working Group on Agricultural Research and Development
ASEAN	Association of Southeast Asian Nations
AWD	Alternate Wetting and Drying
CCA	Climate Change Adaptation
DAFO	Department of Agriculture and Forestry Office
DMC	Direct Seeding Mulch-based Cropping
DOA	Department of Agriculture
FGD	Focus Group Discussion
GAPCC	German-ASEAN Programme on Response to Climate Change: Agriculture, Forestry, and Related Sectors
GIZ	Gesellschaft für Internationale Zusammenarbeit
HRD	Human Resources Development
IRAS	Improving the Resilience of the Agriculture Sector to Climate Change Impacts
KII	Key Informant Interview
MAF	Ministry of Agriculture and Forestry
NAFRI	National Agriculture and Forestry Research Institute
PAFO	Provincial Agriculture and Forestry Office
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SRI	System of Rice Intensification

Table of Contents

Table of Contents

List of Tables

List of Figures

Foreword

The National Agriculture and Forestry Institute (NAFRI) under the Ministry of Agriculture and Forestry is very happy to endorse this national study on promoting resiliency of rice and other crops. We are grateful to be given the opportunity through the ASEAN Technical Working Group on Agriculture and Research Development (ATWGARD) with generous support of GIZ to be able to participate and review good practices within the agriculture value chains that are currently being implemented in Lao People's Democratic Republic (PDR) to deal with the risks posed by climate change.

Climate change is a major driver of the economy and livelihoods of the Lao people, especially the marginalized rural poor for whom agriculture is extremely critical. The potential for agricultural production is set by many biophysical factors that include climate. Lao PDR faces the following climate hazards: drought, flood, erratic and more intense rainfall. The good practices identified in Laos for rice are: Rice Biodiversity, System of Rice Intensification (SRI), and improved varieties resistant to drought and submergence. For maize, the good practices identified are: Direct Mulching Crop (DMC) and maize integrated with legumes.

We hope that this good practices will be scaled up and replicated in other areas in order to minimize the threats of a changing climate to food security. We are looking forward to sharing these with our ASEAN neighbors, as well as learning and implementing the knowledge gained on adaptive practices from each national studies through regional collaboration of joint measures such as research and information exchange for the benefit of the people of Lao PDR and the region.

Khamphone Mounlamai
Director
Planning and Cooperation Division
National Agriculture and Forestry Research Institute
Ministry of Agriculture and Forestry

Acknowledgement

This document is an output of the research project ASEAN Network on Promoting Climate Resilience of Rice and Others Crops. The project was financed by the Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH through the Association of Southeast Asian Nations (ASEAN) Technical Working Group on Agricultural Research and Development (ATWGARD); supported by the German-ASEAN Programme on Response to Climate Change: Agriculture, Forestry, and Related Sectors (GAPCC); and implemented by the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA). The views expressed herein are not necessarily those of GIZ, ATWGARD, GAPCC, and SEARCA. The accuracy of the content is the authors' sole responsibility.

Executive Summary

Farming is the backbone of the Lao people because agriculture is their main livelihood. Through daily agricultural practices, farmers observe changes in natural events, such as rainfall pattern, lightning, star clusters, and pest and disease outbreaks, which they strive to cope with to ensure food on the table for their family. Farmer communities in Lao PDR, mostly in the labor force, barter seeds and varieties among themselves. This is a good practice shared in their communities.

Seven ASEAN Member States (AMS) participated in the project ASEAN Network on Promoting Climate Resilience of Rice and Other Crops to determine good agricultural practices for rice, maize, and cassava. This report presents the results of the study conducted in Lao PDR. The following case studies on good practices in climate change adaptation (CCA) options for rice and maize were prioritized: for rice, (1) System of Rice Intensification (SRI), (2) rice biodiversity conservation, and (3) improving drought- and submergence-tolerant varieties in lowland areas; and for maize, (1) direct seeding mulch-based cropping (DMC) systems and (2) maize integrated with legumes.

Farmers' knowledge and skills in enhancing and creating diversity is important in local crop development. Farmers choose varieties (i.e., early, medium, and late varieties) based on different concerns (e.g., family labor distribution, climate risk, and traditional pest and disease management). They grow a number of rice varieties in the same field, but each variety is confined to a small plot. In general, three to five rice varieties of different maturities are grown. The rationale in growing several varieties is to reduce vulnerability to climate risks (e.g., erratic rainfall), meet religious requirements, match eating behavior, ensure the fair distribution of labor demand, and meet grain quality and specific consumption requirements for ethnic minorities (Appa Rao 2006).

The Lao PDR Agricultural Master Plan (AMP) 2011–2015 covers eight programs: (1) food production; (2) commodity production and farmer organizations; (3) sustainable production patterns, land allocation, and rural development; (4) forestry development; (5) irrigated agriculture; (6) other agriculture and forestry infrastructure; (7) agriculture and forestry research and extension; and (8) human resources development (HRD) (MAF 2010).

The government of Lao PDR prioritizes food production. As per the AMP 2011–2015, the smallholder farmers will have "food security based on increased productivity of rice and diversified farming systems that are resilient to climate change and related extreme weather events and induced disasters" (MAF 2010).

The Ministry of Agriculture and Forestry (MAF), Department of Agriculture (DOA), and National Agriculture and Forestry Research Institute (NAFRI) are mandated to implement and promote best agricultural practices. In the past, however, there were some limitations on best agricultural practices implemented by the government of Lao PDR and research institutions that focus more on research, where there is a need to translate research to action and implementation.

I. INTRODUCTION

Agriculture is the chief activity of most Lao people and the main driver of Lao PDR's economy. In the northern part of the mountainous country, slash-and-burn agriculture is a common practice (DOA 2012a). The potential for agricultural production is set by many biophysical factors such as climate, soil quality, topography, latitude, and altitude. Climate, particularly the amount and distribution of rainfall, largely influences the degree of potential production achieved each year (Lefroy 2010).

In 2012, Lao PDR had a total population of 6.5 million, of which 80 percent lived in rural areas and 81 percent depended on agriculture for livelihood. Rice, the staple food in the country, accounted for more than 80 percent of agricultural land and from 73 percent to 84 percent of the total agricultural output (DOA 2012a).

The impacts of climate change on rainfed agriculture are a particular concern because farm livelihoods that are based on rainfed crop cultivation are highly vulnerable to climate stresses (Chinvanno et al. 2006). Rainfed agriculture is the dominant economic activity of the region, engaging a high proportion of the population, especially in the eight northern provinces of Lao PDR (DOA 2012a). The harsh effects of climate change can significantly affect the economy of the country and the livelihoods of its people, especially the marginalized rural poor for whom agriculture is extremely critical.

II. VALUE CHAIN MAPPING

2.1 Rice

Agricultural practices in Lao PDR are classified into three ecosystems: (1) irrigated lowland, with a total land area of 711,134 hectares (ha); (2) rainfed lowland, with a total land area of 108,037 ha; and (3) rainfed upland, with a total land area of 119,840 ha (DOA 2012b).

Rice, currently the most important crop in Lao PDR, accounts for more than 80 percent of the cropped land area in the country. In 2013, approximately 88 percent of the area planted to rice and 83 percent of rice production came from wet season cropping activities.

In 2012, wet season lowland rice cultivation accounted for 85 percent of the lowland rice cultivated area and 82 percent of rice production. The rainfed upland environment accounted for a further 21 percent of the area and 12 percent of production. Dry season irrigated rice was grown to about 108,037 ha from 2011 to 2012 (DOA 2012a). Lao PDR is the largest producer and consumer of glutinous rice in the region. In 2005, rice accounted for about 67 percent of the people's calorie intake in the country (Schiller 2004).

The country's total planted, damaged, and harvested area; production volume; and average yield for rice in the wet and dry seasons are presented in Table 1.

Table 1. Rice area, production, and yield per region, wet and dry seasons, 2012

Region	Planted area (ha)	Damaged area (ha)	Harvested area (ha)	Production (t)	Yield (t/ha)
North	202,351	207	202,144	659,744	3.26
Central	494,234	2,918	491,316	1,890,322	3.85
South	242,426	2,119	240,307	939,144	3.91
Total	**939,011**	**5,244**	**933,767**	**3,489,210**	**3.74**

Source: DOA (2012)

In the dry season of 2012, the total planted, damaged, and harvested area for irrigated lowland rice was 108,037 ha; about 70 ha; and 107,967 ha, respectively. The production volume was 509,920 tons (t) with an average yield of 4.72 t/ha (Table 2)..

Table 2. Irrigated rice area, production, and yield per region, dry season, 2012

Region	Planted area (ha)	Damaged area (ha)	Harvested area (ha)	Production (t)	Yield (t/ha)
North	9,933	1	9,932	41,460	4.17
Central	73,453	69	73,384	343,745	4.68
South	24,651	-	24,651	124,715	5.06
Total	**108,037**	**70**	**107,967**	**509,920**	**4.72**

Source: DOA (2012)

The total planted, damaged, and harvested area for rainfed lowland rice was 711,134 ha; 5,106 ha; and 706,028 ha, respectively. The production volume was 2,763,150 t with an average yield of 3.91 a/ha (Table 3).

Table 3. Rainfed lowland rice area, production, and yield per region, wet season, 2012

Region	Planted area (ha)	Damaged area (ha)	Harvested area (ha)	Production (t)	Yield (t/ha)
North	104,560	138	104,422	458,740	4.39
Central	399,720	2,849	396,871	1,508,375	3.80
South	206,854	2,119	204,735	796,035	3.89
Total	**711,134**	**5,106**	**706,028**	**2,763,150**	**3.91**

Source: DOA (2012)

Farmers in irrigated lowland rice areas mostly use improved and short varieties. The maturity age of these varieties ranges from 135 days to 140 days. On the other hand, farmers in rainfed lowland areas tend to use a mixture of traditional and improved varieties, including the drought-tolerant khao dor nam pa. khao phair, khao deang dou, and khao mak kheu, which are also drought-tolerant varieties, are used in rainfed upland areas.

Farmers in irrigated lowland rice areas mostly use improved and short varieties. The maturity age of these varieties ranges from 135 days to 140 days. On the other hand, farmers in rainfed lowland areas tend to use a mixture of traditional and improved varieties, including the drought-tolerant khao dor nam pa. khao phair, khao deang dou, and khao mak kheu, which are also drought-tolerant varieties, are used in rainfed upland areas.

In the wet season of 2012, the total planted, damaged, and harvested area for rainfed upland rice was 119,840 ha; 68 ha; and 119,772 ha, respectively. The production volume was 216,140 t with an average yield of 1.80 t/ha (DOA 2012a) (Table 4).

Table 4. Rainfed upland rice area, production, and yield per region, wet season, 2012

Region	Planted area (ha)	Damaged area (ha)	Harvested area (ha)	Production (t)	Yield (t/ha)
North	87,858	68	87,790	159,544	1.82
Central	21,061	-	21,061	38,202	1.81
South	10,921	-	10,921	18,394	1.68
Total	**119,840**	**68**	**119,772**	**216,140**	**1.80**

Source: DOA (2012)

The government of Lao PDR has a policy to increase forest cover from 53 percent in 2010 to 65 percent in 2015 and to 70 percent in 2020 (MAF 2010). This is expected to affect rice production.

Farmers in the northern part of Lao PDR engage in upland agriculture and largely depend on rainfall. They practice permanent upland rice-based cropping systems. Many farmers take the risk of low production by planting during long drought periods. The outbreak of grub-devastated upland rice after the long drought period increases rapidly

during the initial part of the wet season.
The planted, damaged, and harvested area for permanent upland rice is 62,422 ha; 68 ha; and 62,345 ha, respectively. The production volume was 103,565 t with an average yield of 1.66 t/ha (Table 5).

Table 5. Permanent upland rice area, production, and yield per region, 2012

Region	Planted area (ha)	Damaged area (ha)	Harvested area (ha)	Production (t)	Yield (t/ha)
North	38,641	68	38,573	61,540	1.60
Central	17,434	-	17,434	32,306	1.85
South	6,347	-	6,347	9,719	1.53
Total	**62,422**	**68**	**62,345**	**103,565**	**1.66**

Source: DOA (2012)

2.2 Maize

A large percentage of maize production in Lao PDR occurs in Xayaboury (29.2%), Oudomxay (18.8%), and Borkeo (10.2%) (MAF 2007). The harvested areas in these provinces account for 53.4 percent and 58.2 percent of the country's total maize harvest and yield production, respectively (DOA 2012a; MAF 2007). In the wet season of 2012, the total planted area for maize was 196,815 ha. The production volume of 1,125,485 t represented 85 percent of the total country production (Table 6). Farmers in the northern part of Lao PDR use hybrid maize varieties such as LVN10 from Vietnam, and CP 888 and CP 999 Pioneer from Thailand.

Table 6. Maize national area, production, and yield, wet season, 2012

Particulars	Year	Planted area (ha)	Harvested area (ha)	Production (t)	Yield (t/ha)
Whole country	2012	221,885	196,815	1,318,865	5,100
Maize	2012	176,940	176,940	926,830	5,240
Sweet Corn		19,875	19,875	198,655	10,00
Total	**2012**	**196,815**		**1,125,485**	

Source: DOA (2012)

In 2012, the International Development Research Centre studied maize production costs and seed rates in five northern provinces of Lao PDR. In these provinces, it was found that an average farmer used 17–20 kilograms (kg)/ha of maize plantation. The planting distance used (e.g., 35 x 70 cm, 50 x70 cm, and 50 x 80 cm) varied from province to province. Maize seeds cost an average of USD 64/ha (Peñalba and Dulce 2013).

According to farmer respondents in Oudomxay, Bokeo, and Luang Namtha, which are more than 1,000 meters above sea level (masl), they start planting maize during the last week of May before the rain starts. They believe that the first rainfall is valuable because they can plant on time. They can harvest four months after transplanting.

During the focus group discussions (FGDs) and key informant interviews (KIIs), the farmer respondents said that if they plant from early May to June, they can harvest a higher yield than if they plant from July to August. However, farmers in Luang Prabang and Xayaboury, which are located less than 1,000 masl, plant maize in the middle of May before the rains start. In the dry season of 2012, the total planted area for maize was 25, 070 ha. The production volume of 193,380 t represented 15 percent of the total country production (Table 7).

Table 7. Maize national area, production, and yield, dry season, 2012

Particulars	Planted area (ha)	Harvested area (ha)	Production (t)	Yield (t/ha)
Whole country	25,070	25,070	193,380	6.59
Maize	16,955	16,955	111,675	6.59
Total			**111,675**	
Sweet Corn	8,115	8,115	81,705	10.07
Total			**81,705**	

Source: DOA (2012)

According to the farmers, maize planted from November to December produce higher yield than maize planted from January to February. Fog starts to decrease during the latter. In Luang Prabang and Xayaboury, farmers start planting maize during the dry season from the last week of December when fog falls during the night and early morning.

Next to rice, maize is considered a major agricultural commodity in Lao PDR. In 2012, the maize area increased to 188,690 ha.

According to the farmers, maize planted from November to December produce higher yield than maize planted from January to February. Fog starts to decrease during the latter. In Luang Prabang and Xayaboury, farmers start planting maize during the dry season from the last week of December when fog falls during the night and early morning.

Next to rice, maize is considered a major agricultural commodity in Lao PDR. In 2012, the maize area increased to 188,690 ha from 165,465 ha in 2009, and the production volume also increased to 1,043,740 t from 818,230 t in 2009 (DOA 2012b). In that same year, maize exports increased to 1,400,000 metric t from 124,000 metric t in 2002.

The total planted area for maize during the wet season was 159,975 ha. The production volume was 815,115 t with an average yield of 5.1 tons/ha (DOA 2012a). For sweet corn, the total planted area was 11,760 ha. The production volume was 116,950 tons with an average yield of 9.9 tons/ha. The total planted area for maize during the dry season was only 16,955 ha due to lack of water. The production volume was 111,675 t with an average yield of 6.5 tons /ha (DOA 2012b).

The government of Lao PDR aims to make the country self-sufficient in rice. It also aims to produce rice surplus for export to neighboring countries. Organic rice is preferred by the foreign clientele. In 2007, maize became a major agricultural export commodity that represented 19.8 percent of the total export of agricultural products. About 99 percent of maize products in Lao PDR were exported to neighboring countries (MAF 2010). In 2006–2007, maize exports to Thailand, China, and Vietnam comprised 83 percent, 11 percent, and 5 percent of total maize products from Lao PDR respectively (MAF 2010). However, the exportation of maize from Lao PDR is still vulnerable to bargaining power and market risks (Southavilay 2009).

As shown in the AMP 2011–2015, the government of Lao PDR also aims to expand rice production area and yield (Figure 1).

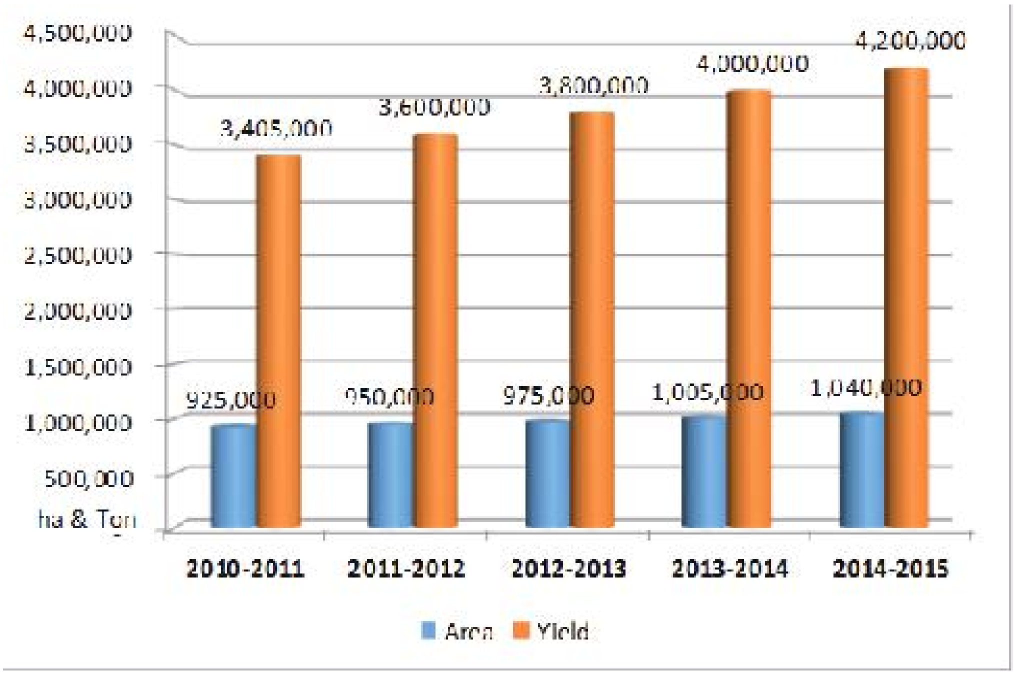

Figure 1. National rice production goals, 2011–2015
Source: MAF (2010)

However, upon comparing the current production system with the planned production system, it can be seen that the goals have not yet been achieved. This can be attributed to damages caused by floods and droughts throughout the country in 2011 (Figure 2).

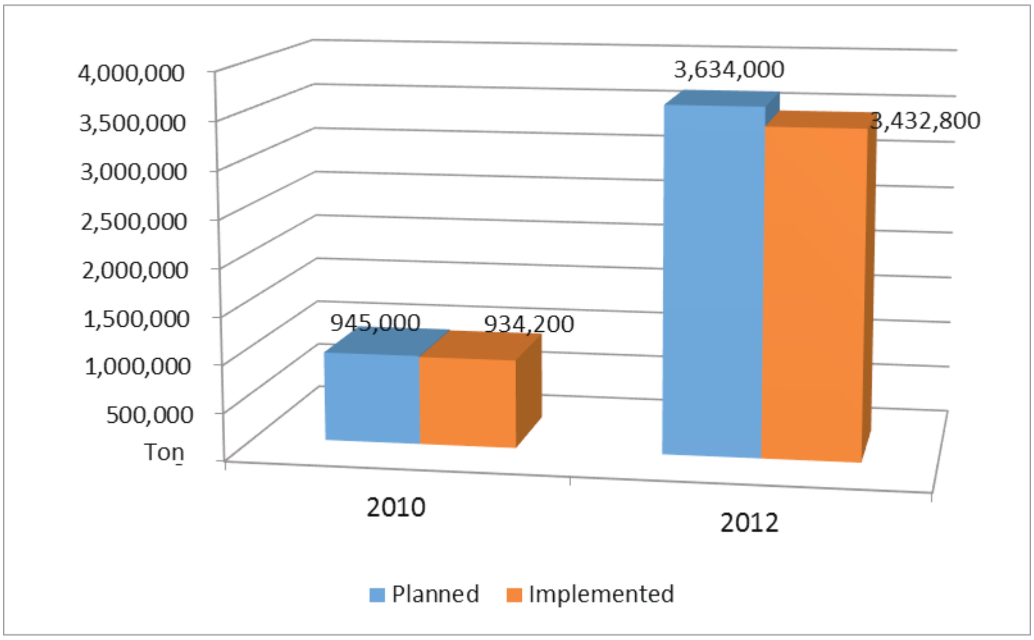

Figure 2. National rice production plans, 2010–2012
Source: MAF (2010)

III. REVIEW OF CLIMATE CHANGE IMPACTS AND VULNERABILITIES

Climate risks are not new to farmers in the lower Mekong region. These include mid-season dry spells that can damage young plants, and late-season floods just before harvest that can cause severe crop loss. Farmers have developed and used various measures to cope with such risks. Rice farmers' experiences in managing climate risks, and their perspectives on the potential for applying the same measures to adapt to climate change, were determined through interviews and FGDs conducted in selected farming villages in Lao PDR (Chinvanno et al. 2006). It was found that farmers use short, medium, and late varieties to cope with climate viability as well as with insects and pests' outbreak.

The inevitability of climate change is a major policy concern due to its expected impacts on food security and the livelihoods of small-scale farmers who largely depend on agriculture. It threatens the production systems, availability, and accessibility of food. The impacts of climate change on agriculture are expected to be multifaceted because farming systems across countries and agro-ecological zones are heterogeneous. Lao PDR and other AMS are among the countries whose exposure to climate risks seriously threatens food security and livelihood, particularly of small-scale farmers, due to the interaction of social, economic, environmental, and political factors that could affect food supply and demand (Soukkhy, et al. 2012).

Typhoon Haima (Nok Ten) in 2011 greatly affected 14 districts; 360 villages; 18,142 families; and 108,856 people, of which 32,000 were female. The most affected districts were Champhone, Xayaboury, Song Khone, and Art Saphangthong, where a total of 38,967 ha of paddy fields were destroyed.

3.1 History of Climate Change in Lao PDR

The National Strategy on Integrated Flood Management of the Department of Meteorology and Hydrology (2012) classified Vientiane, Bolikhamxay, Khammuane, Savannakhet, Saravane, Sekong, Attpeu, and Champasack as flood-prone provinces because they experience periodic flooding (Figure 3). It classified the northern provinces of Xayaboury, Xiengkhuang, Luang Prabang, Oudomxay, Luangnamtha, and Bokeo as flash flood-prone areas (Figure 4).

Figure 3. Flood-prone areas in Lao PDR
Source: MoNRE (2010)

Figure 4. Flash flood-prone areas in Lao PDR
Source: MoNRE (2010)

Based on record data of the Mekong River water level at the Vientiane gauging station from 1895 to 2011, the highest water levels were observed during the following years (MoNRE 2010):

- 1924 – Flooding caused the water level to rise to 12.6 m.

- 1966 – Flooding caused the water level to rise to 12.71 m. (dikes were constructed along the Mekong riverbanks in case of an emergency)

- 1971 – Flooding caused the water level to rise to 12.6 m and the dykes to collapse.

- 1978 – Agricultural production and public properties in Champasack were damaged by flooding. The maximum water level of the Mekong River at Pakse was 14.7 m on 17 August 1978 with a corresponding maximum peak flood discharge of 58,000 cubic meters per second.

- 2008 – Flooding caused the water level to rise to 13.67 m, which is the maximum. It was considered the most extreme rise in water level and the highest observed in 112 years.

- 2009 – In September 2009, the southern provinces of Saravane, Sekong, and Attapeu were inundated by the Sedone and Sekong rivers because of Typhoon Ketsana.

- 2011 – Eleven provinces were affected by Typhoons Haima and Nockten.

In 2011, insect pests destroyed a paddy field area of more than 32,608 ha, inflicting a yield loss of 100,000 t. The long mid-season drought spell made it conducive for grubs to destroy the root system of upland rice, a common scenario during such period (PAFO 2012).

Indications of climate change include increasing temperature; changes in precipitation; increase in the frequency, duration, and intensity of dry spells and droughts; changes in the timing, duration, intensity, and geographic location of rain; increase in the frequency and intensity of storms and floods; and greater seasonal weather variability and changes in the start and end of wet seasons.

In the summer monsoon season of 2013, a series of five major storms caused flooding in 12 of 17 provinces (52 of 145 districts) across Lao PDR. The natural disaster affected 395,000 people. Flooding is not unusual at this time of the year, but the individual floods were caused by different weather systems, which occurred in different locations at different points in time (i.e., starting in July and ending in October), and hit the affected areas with varying levels of severity. In the southern region of the country, the flood water levels were high for up to six days, inundating the rice crops that were almost ready to be harvested. Many fields in the country appeared lush green, but the rice crops were completely damaged because of prolonged submergence in water. Severe damage was mainly observed in agricultural land with rice, the Lao staple food and the single most affected crop (WFP 2013).

A total of 221 villages reported that their agricultural land was affected to some extent, while a countrywide a total of 50,247 ha of agricultural land for rice cultivation was lost during the 2013 harvest. The national production shortfall caused by flooding was assessed to be approximately 6.9 percent of the total area under production in the affected districts. The risk to national food security is rather low, but poor farming households who lost all of their crop and livestock are at risk of becoming food insecure in due course (WFP 2013).

3.2 Socio-economic Profile (Paddy Area and Production)

Between 2010 and 2012, the area harvested with paddy increased by an annual average rate of 6.4 percent in Savannakhet (162,767 ha in 2010 and 173,200 ha in 2012) and 10.6 percent in Luang Prabang (33,030 ha in 2010 and 36,532 ha in 2012) (Figures 5 and 6).

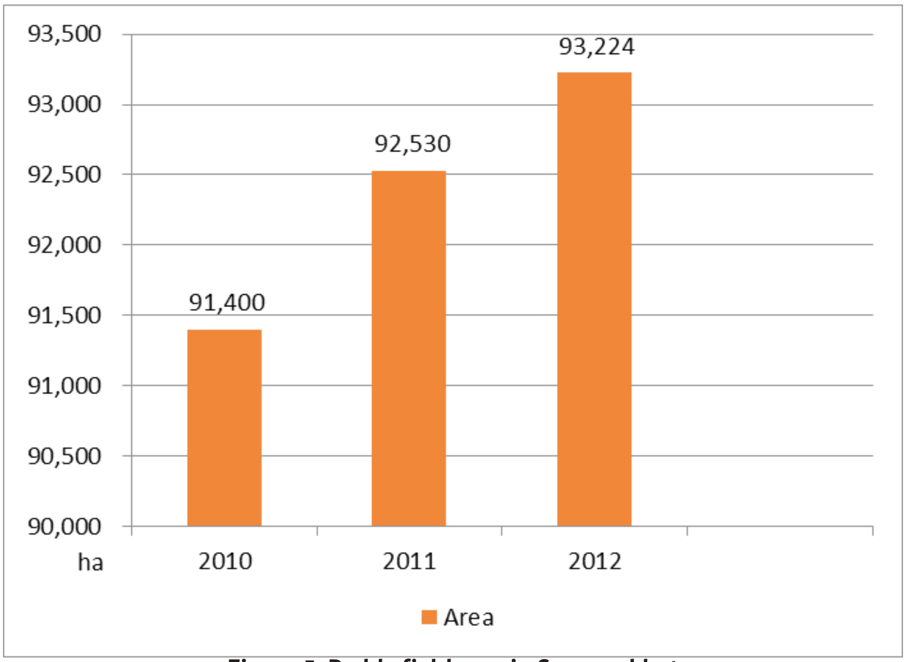

Figure 5. Paddy field area in Savannakhet
Source: Keo Oudone (2011)

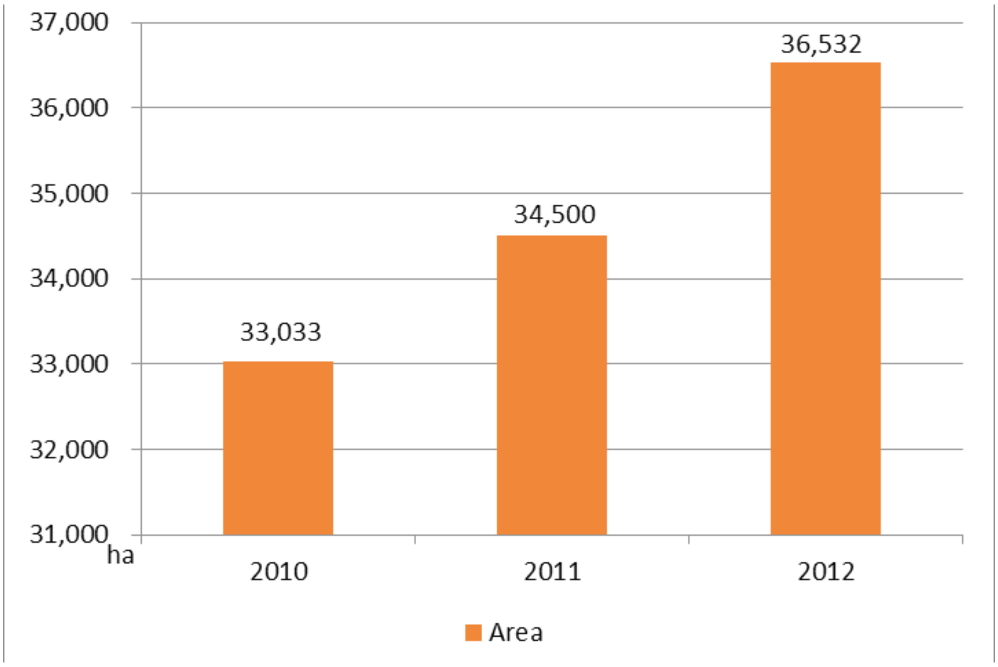

Figure 6. Paddy field area in Luang Prabang
Source: Sivilaysack (2012)

Typhoon Helen damaged 32.12 ha of paddy fields and 43.66 ha of upland rice in the districts of Phone Xay, Nam-bak, and Xieng-nueung in Luang Prabang (PAFO 2012). The total damage cost was about LAK 6,929,359,000 (USD 866,000) (PAFO 2012).

Farmers in Luang Prabang engage in upland agriculture and largely depend on rainfall. They practice permanent upland rice-based cropping systems. Many farmers take the risk of low production by planting during long drought periods. The outbreak of grub devastated upland rice after the long drought period increases rapidly during the initial part of the wet season. Upland yield is very low, ranging from 900 kg/ha to 1,200 kg/ha. Farmers tend to increase the plantation areas to also increase yield. This forces farmers to resort to slash-and-burn agriculture, which destroys the forest.

In the northern provinces of Lao PDR, Xayaboury ranks first in maize production. The area planted to maize was 60,690 ha and production was 319,695 t in 2013 (Table 8).

Table 8. Maize area, production, and yield in the northern provinces, 2013

Province	Crop	Planted area (ha)	Damaged area (ha)	Harvested area (ha)	Production (t)	Yield (t/ha)
Phongsali	Yellow corn	3,735	-	3,735	17,655	4.73
	Sweet corn	680	-	680	6,890	10.13
	Total				**24,545**	
Luangnamtha	Yellow corn	3,450	-	3,450	12,110	3.51
	Sweet corn	810	-	810	7,840	9.68
	Total				**19,950**	
Bokeo	Yellow corn	13,555	-	13,555	91,710	6.77
	Sweet corn	-	-	-	-	-
	Total				**91,710**	
Luang Prabang	Yellow corn	7,360	-	7,360	34,960	4.75
	Sweet corn	1,490	-	1,490	16,005	10.74
	Total				**50,965**	
Huaphan	Yellow corn	18,565	-	18,565	103,060	5.55
	Sweet corn	75	-	75	745	9.93
	Total				**103,805**	
Xaiyaboury	Yellow corn	60,690	-	60,690	319,695	5.27
	Sweet corn	350	-	350	3,630	10.37
	Total				**323,325**	
Xiangkhoang	Yellow corn	25,535	-	25,535	134,455	5.27
	Sweet corn	510	-	510	4,545	8.91
	Total				**139,000**	
Total	**Yellow corn**				**852,645**	
	Sweet corn				**39,655**	

Maize cultivation is booming in the northern provinces of Lao PDR. The export of maize increased rapidly from 1996 to 2012. From 78,000 t in 1996 to 1,108,000 t in 2008, maize production increased to 14,000,000 t in 2012 (FAOSTAT 2012; MAF 2007) (Table 9).

Table 9. Maize production, 1995–2012

Market year	Production (t)	Growth Rate (%)
1995	50,000	NA
1996	78,000	56.00
1997	78,000	0.00
1998	110,000	41.03
1999	96,000	-12.73
2000	117,000	21.88
2001	112,000	-4.27
2002	124,000	10.71
2003	143,000	15.32
2004	204,000	42.66
2005	373,000	82.84
2006	450,000	20.64
2007	688,000	52.89
2008	1,108,000	61.05
2009	1,134,000	2.35
2010	1,080,000	-4.76
2011	1,250,000	15.74
2012	1,400,000	12.00

Source: FAOSTAT (2012)

The price of maize increased from only LAK 400–500/kg in 2000 to LAK 1,500–2,000/kg (Peñalba and Dulce 2013).

Big maize production areas are located in the following northern provinces, where the environment is favorable for maize production in both seasons: Xayaboury (yellow corn – 60,690 ha; sweet corn – 350 ha), Oudomxay (yellow corn – 32,975 ha; sweet corn – 1,295 ha), Luangnamtha (yellow corn – 3,450 ha; sweet corn – 810 ha), Luang Prabang (yellow corn – 7,360 ha; sweet corn – 1,490 ha), and Bokeo (yellow corn and sweet corn – 13,555 ha).

The average yield per hectare varies per province: 4.970 kg/ha in Oudomxay; 3.770 kg/ha in Luang Prabang; 5.050 kg/ha in Xayaboury; 5.370 kg/ha in Bokeo; and 3.690 kg/ha Luangnamtha.

A large percentage of maize production in Lao PDR occurs in Xayaboury (29.2%), Oudomxay (18.8%), and Borkeo (10.2%) (MAF 2007). The harvested areas in these provinces account for 53.4 percent and 58.2 percent of the country's total maize harvest and yield production, respectively (MAF 2010) (Table 10).

Table 10. Maize area, production, and yield per province, 2010

Province	Planted area (ha)	Harvested area (ha)	Production (t)	Yield (t/ha)
Xayaboury	63,025	63,025	317,650	5.05
Oudomxay	27,755	27,755	137,945	4.97
Luangnamtha	5,995	5,995	21,605	3.69
LuangPrabang	9,800	9,800	33,300	3.77
Bokeo	20,065	20,065	107,820	5.37
Vientiane	16,780	16,780	90,470	5.84
Savannakhet	4,025	4,025	9,250	3.49
Phongsaly	4,415	4,415	19,765	5.02
Huaphan	20,410	20,410	105,570	5.17
Xiangkhoang	20,400	20,400	81,675	4.00
Borikhamxai	3,300	3,300	16,385	5.72
Khammouan	1,245	1,245	6,090	3.97
Saravan	5,005	5,005	21,280	5.28
Sekong	905	905	3,470	5.36
Champasack	7,200	7,200	37,050	5.65
Attapu	170	170	680	4.67
Vientiane	1,810	1,810	9,235	5.01
Whole Country	**212,305**	**212,305**	**1,019,240**	**4.801**

Source: DOA (2012)

For the cropping calendar, farmers grow rice in the wet season from May to October and in the dry season from December to April. Other crops (e.g., vegetables) are grown from November to March (Table 11).

Table 11. Cropping calendar and months when water and food supply is critical

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cropping calendar												
Wet season rice					x	x	x	x	x	x		
Dry season rice	x	x	x	x								x
Vegetables	x	x	x								x	x
Other crops												
Scarce water supply	x	x	x	x								
Excess water supply								x	x			
Food supply critical								x	x	x		

Source: Soukkhy et al. (2012)

Scarce water supply occurs from January to April, excess water supply occurs from August to September, and critical food supply occurs from August to October. After harvesting rice, farmers grow vegetables, such as yam, long bean, peanut, lettuce, cabbages, chili, eggplant, cucumber, and cow pea, during the dry season when they use less water.

IV. AREAS FOR REGIONAL COLLABORATION

4.1 Good Practices and Regional Collaboration

4.1.1 Regional Networking and Collaboration for Action Research and Development

There are many opportunities for regional networking and collaboration for action research and development (R&D) through the following channels: Asia Pacific Adaptation Network on climate change; CGIAR Research Program on Climate Change, Agriculture, and Food Security; SEARCA networks; International Rice Research Institute Rainfed Lowland Rice Consortium; and Lao Agriculture Development Strategy (ADS) 2011–2020. The ADS provides the framework, vision, and long-term development goals of the government of Lao PDR. The first priority is to improve livelihoods through agriculture and livestock activities, as well as food security (MAF 2010). Lao PDR will have more opportunities for regional cooperation with and among AMS.

4.1.2 Institutional Collaboration for Community-based Conservation of Rice and Maize Biodiversity

Institutional collaboration for community-based rice and maize biodiversity conservation will further strengthen cooperation among AMS. The government of Lao PDR will support the promotion of indigenous varieties of glutinous rice (e.g., khao kai noy) for climate change resilience, increase in productivity, and diversification of farming practices (mixed farming and agroforestry) to increase access to food for improved nutrition and greater food security (MAF 2010).

4.1.3 Lao PDR Climate Change Adaptation Research Center for Human Resources Development

The Lao PDR Climate Change Adaptation Research Center for HRD should be supported. As shown in the AMP 2011–2015, the government of Lao PDR prioritizes HRD activities under Program 8 (MAF 2010).

4.1.4 Capacity-building Activities on Climate Change Adaptation, Mitigation, and Resilience

The government of Lao PDR wants to learn how its neighboring countries adapt to and mitigate the effects of climate change, especially in similar scenarios.

4.2 Institutional Challenges

4.2.1 Human Resources Development for Climate Change

HRD on climate change in Lao PDR is inadequate. Most of the research and activities conducted through foreign aid focus on crop modeling. There is a need to strengthen HRD in climate projection and climate scenarios.

4.2.2 Climate Change Prevention

Preventive methods for climate change are not in place. Lao people, particularly farmers, are not equipped with early warning systems and devices. This is very critical since the country is frequently affected by typhoons and flash floods.

4.2.3 Unpredictable Weather Events

Unpredictable weather events make adaptation difficult. As such, the government of Lao PDR, through NAFRI, will establish a CCA Center in Vientiane, and recruit and assign knowledgeable technical staff on CCA who can work more actively. However, this will be a lengthy process because the working system in Lao PDR focuses more on administrative work than technical tasks.

4.2.4 Human Resources Development for National Disaster Management

Natural disaster management in Lao PDR is weak due to lack of human resources. There are no buildings or evacuation camps during disaster periods. Farmers' houses are located near the river bank so that it will be easier for them to plant and harvest, fetch water, bathe, fish, and garden. However, their proximity to water bodies makes them highly prone to flash floods. A flash flood that devastated the Nai Hua Phia Village in Houn, Oudomxay in 2013 left 13 people dead, and the farmers had to travel 7–30 km just to reach the nearest hospital (Sivilaysack 2012).

4.2.5 Climate-proofing Irrigation Systems

Climate change has made operating irrigation systems more uncertain. Therefore, climate-proofing irrigation systems through proper assessment is extremely important. The first step is to develop a guideline and framework for climate-proofing, followed by pilot implementation activities with AMS, especially the Philippines and Vietnam because they have experience in climate-proofing irrigation systems.

4.2.6 Focal Point Person for Lao PDR

There should be one designated focal point person for Lao PDR who understands and can relate to the objectives of the project. The focal point person should be capable in mediating with the government of Lao PDR on matters related to the project.

4.3 Good Practices for Replication

The following good practices from other AMS can be replicated in Lao PDR:

(1) NAFRI has the mandate to establish the Climate Change Agricultural Adaptation (CCAA) Center for Lao PDR. As such, it will provide all information on climate prediction to the farmers. NAFRI may want to learn and replicate this practice from Indonesia.

(2) Lao PDR should promote the sharing and transfer of CCAA information and technology nationally and among AMS.

(3) CCAA R&D collaboration and partnership with scientists from the Philippines who have experience in climate scenarios and Site-specific Nutrient Management for maize. Lao PDR needs to develop HRD in these fields.

V. CASE STUDIES ON GOOD PRACTICES

5.1 Rice

5.1.1 System of Rice Intensification

According to its production guidelines, one of the main potential benefits of SRI is the reported impact of wetting and drying cycles on root development during the first 50 days after transplanting. Improved root development allows the rice plant to exploit (to a greater degree relative to conventional production practices) the soil environment in which it is growing (Schiller 2004).

Uniform water application in the early stages of crop growth can only be achieved with even paddy fields. Many paddy fields in both the rainfed and irrigated lowland rice environments in Lao PDR do not have the required uniformity to provide the required level of water control.

In both on-farm and on-station conditions where high yields were achieved from SRI, the inputs of organic fertilizer, particularly farm yard manure, were high. Such levels would be difficult, if not impossible, to achieve with wider adoption of the production practices being followed in the country.

SRI production practices adopted in the irrigated environment under Lao conditions will only be appropriate for small areas of production per household. It is suggested that an average family could only manage an area of about 1 rai (<0.2 ha) (Schiller 2004).

The institutional challenges of SRI are listed in Table 12.

Table 12. Institutional challenges of SRI as a good practice

Factor	Challenge
Water control (wetseason)	Water control with alternate wetting and drying (AWD) cycles to promote root development was very difficult to achieve under wet-season conditions. Furthermore, many paddy fields were not leveled enough to allow appropriate water management, particularly in the early growth period when seedlings were still very short.
Water control (dry season)	Although not faced with the problem of flooding associated with wet-season rains, dry-season water management (i.e., irrigation and drainage) was very difficult to achieve under irrigated conditions. Furthermore, even with improved reticulation and drainage systems, on a "scheme" basis it would be very difficult to synchronize the plantings of all farmers within an area (to use SRI) and thereby try to synchronize water delivery and drainage, according the desired wetting and drying cycles recommended for SRI.
Use of young seedlings (15 days old)	Wet-season rains that occur immediately after planting sometimes result in the submersion and death of young seedlings.
Weed management	AWD cycles resulted in significantly greater weed problems associated with conventional planting and watering systems. Weed problems were further aggravated when side spacing was used. With closer spacing, the rice canopy quickly provided the ground coverage required to suppress weed ingress. With wider spacing combined with AWD in the first 50 days after transplanting, the weed ingress was significantly greater. Furthermore, weed problems with high levels of organic fertilizer input under SRI was significantly greater than with inorganic fertilizer inputs. However, it is also acknowledged that nutrient inputs from any source increase the problems associated with weed ingress, relative to the unfertilized situation.
Land preparation	The magnitude of weed control required over soil moisture in the early stages of crop growth makes SRI impractical for wet-season cropping under Lao PDR conditions. Early wet-season rains can result in the submergence and death of seedlings transplanted at a young age, while drainage (drying) of lowland rice areas is generally impractical in most lowland areas. In an environment where periodic drought can be a regular occurrence in the rainfed lowland environment, release of water from rice fields in the early stages of crop growth (as prescribed in SRI) can potentially make the crop more prone to drought.

Table 12. cont...

Factor	Challenge
Water management	In the dry-season irrigated environment, SRI is restricted by poor water management (both delivery and drainage). Uniform water application in the early stages of crop growth can only be achieved with even paddy fields.
Pest management	In the dry-season irrigated environment, young seedlings are susceptible to the golden apple snail, grasshopper, and other pests.
Drainage system	Drainage during the young seedling stage causes weeding problems.

Source: Schiller (2004)

5.1.2 Rice Biodiversity Conservation

In the traditional system, farmers grow a number of rice varieties in the same field, but each variety is confined to a small plot. On the average, three to five rice varieties of different maturities are grown. In 1995, up to seven and as many as 18 varieties were recorded in a single village in the southern and northern regions of Lao PDR, respectively (Appa Rao 2006). The rationale in growing several varieties is to reduce vulnerability to climate risks (e.g., erratic rainfall), meet religious requirements, match eating behavior, ensure the fair distribution of labor demand, and meet grain quality and specific consumption requirements for ethnic minorities (Appa Rao 2006).

Farmers in the northern part of the country are not new to climate risks. These include mid-season dry spells that can damage young plants, and late-season floods just before harvest that can cause severe crop loss. They plant drought-tolerant varities such as khao dor nam pa, khao nok kok peuk, khao phair, khao khao, and khao chao dor. They also plant early-maturing varieties that can solve the food shortage during September–October.

Table 13. Recommendations for rice and maize biodiversity conservation

Recommendations	Remarks
Build awareness on rice and maize biodiversity conservation	The decrease in the number of rice and maize cultivars as well as traditional varieties indicates the farmers' and other concerned organizations' low awareness on rice biodiversity value and conservation. Therefore, building the farmers' and other stakeholders' awareness on rice and maize biodiversity conservation is vital in addressing the loss of biodiversity in these crops. The first step could be information exchange between and among local agricultural officers and representatives from local agro-support and service providers. A review of the farmers' strategies in selecting varieties, taking into consideration long adaptation cultivars, can also be conducted.
Improve seed systems and policy	Seeds sourced from farmers had the greatest contribution to variety richness and area abundance of rice and maize varieties, especially the traditional ones. Strengthening seed systems includes improving farmers' seed infrastructure (e.g., seed stores or banks, seed and variety selection practices, and activities to promote seed exchanges). This can be done by training farmers and organizing farmer-based activities for participatory seed and variety selection. The results of research on improved seed systems indicated that there were a number of farmers who wanted to reuse some of the lost varieties, but there were no more seeds available from the seed system. To increase the farmers' seed access and variety choices for this use, seeds of traditional varieties should be included in the formal seed system. This can be carried out at policy level through analyzing seed policy and its implication at the local level. Re-distribution of traditional or good adapted varieties could be done to meet the farmers' rice variety preferences.
Establish community initiatives on rice and maize biodiversity conservation	It is the farmers' choice to undertake on-farm rice and maize biodiversity conservation. However, the provision of agro-support services and the relations within farmer networks influence their decision. Therefore, participatory activities are necessary to provide farmers with more opportunities and empower them to integrate conservation objectives into their livelihood activities. Effective participatory activities include participatory evaluation of rice cultivars, seed and variety selections, information and seed exchanges among farmers and communities, and decision-making on land use.
Strengthen institutional collaboration towards community-based rice and maize biodiversity conservation	To attain farmer-based rice and maize biodiversity conservation, complementary inter- and intra-level institutional collaboration should be undertaken.

The institutional challenges of rice biodiversity conservation are listed in Table 14.

Table 14. Institutional challenges of rice and maize biodiversity conservation as a good practice

Factor	Challenge
New Economic Mechanism (NEM)	In 1986, the government of Lao PDR applied NEM, which was implemented to boost the economy through wide-ranging reforms in the economic environment (Siene 2000). New cash crops and high-yielding rice and maize varieties were introduced. This process effected changes in the socio-economic conditions of farmers and farming communities. As a result, these changes affected the resource base (e.g., crop diversity in general, and rice and maize diversity in particular).
Depletion of traditional rice and maize varieties	In recent years, the extinction or depletion of traditional rice and maize varieties and their distinct species population have accelerated at an alarming rate. The principal cause of genetic erosion has been the widespread adoption of high-yielding varieties (Borromeo 2002).
Maize hybrids	Farmers use hybrid maize varieties such as LVN10 from Vietnam, and CP 888 and Pacific 999S, Pioneer from Thailand. Market-oriented farmers have to buy hybrid maize seeds every year and discard traditional varieties that are dependent on exotic seeds.

5.1.3 Improving Drought- and Submergence-tolerant Varieties in Lowland Areas

With policy support from the government of Lao PDR, MAF and DOA have been working closely with NAFRI in the project Improving the Resilience of the Agriculture Sector to Climate Change Impacts (IRAS) to address farmers' problems with climate change, especially with floods and droughts. The IRAS project also involves the Provincial Agriculture and Forestry Offices (PAFOs) and District Agriculture and Forestry Offices (DAFOs).

In the wet season of 2009, five submergence-tolerant rice varieties (i.e., Swarna-Sub1, SambaMahsuri-Sub1, BR11-Sub1, TDK1-Sub1, and IR64-Sub1) were tested and demonstrated in nine target villages of the Nam Theun-Hinboon Hydropower Company 2. Based on the participatory varietal selection conducted during the maturity stage, majority of the farmers preferred TDK1-Sub1 (glutinous) and IR64-Sub1 (non-glutinous, early maturity). In the dry season of 2010, the farmers chose these two varieties and distributed them to five districts in Savannakhet (Phetmanyseng 2014).

Twenty farmers were given TDK1-Sub1 (138 kg) and IR64-Sub1 (285 kg) seeds for distribution to 11 villages. Farmers who were involved in the activity were trained in participatory approaches and management techniques. The plot size for planting submergence-tolerant varieties varied and depended on the farmers' capacity in each site. The total area for growing submergence-tolerant varieties in the 11 villages was about 2.6 ha. Seeds were sown from 27 November to 16 December 2009, while transplanting was done from 18 December 2009 to 1 January 2010.

The submergence-tolerant varieties TDK 1-1 and IR 64-1 were planted in Xayaboury, Khammoun, and Savannakhet, where the Xebang Fai River causes unpredictable natural flooding annually. Flood duration, which varies from year to year, can range from three days to one month (Keo Oudone 2011). A total of 6,805 kg of submergence-tolerant rice variety seeds was achieved, of which 2,078 kg were TDK1-Sub1 seeds and 4,727 kg were IR64-Sub1 seeds. The largest production of TDK1-

Sub1 was in Nongbok (750 kg), Xebangfai (550 kg), Xaybોury (432 kg), and Mahaxai (346 kg). The largest production of IR 64-Sub1 seeds was in Mahaxai (2,131 kg), Xayaboury (2,196 kg), Xebangfai (200 kg), Nongbok (200 kg). Training on rice seed production techniques was conducted in four sites in four districts. Thirty-seven trainees from 11 villages in four districts participated.

In the wet season of 2010, 3,445 kg of seeds were disseminated to 171 households in 42 villages in five districts. Of this amount, 1,680 kg (49%) were TDK1-Sub1 seeds and 1,765 kg (51%) were IR 64-sub 1 seeds.

Flood- and drought-resistant varieties should be distributed to farmers at a price that they can afford.

5.2 Maize

5.2.1 Direct Seeding Mulch-based Cropping (DMC) Systems

DMC systems were introduced to farmer organizations in the four southern districts of Xayaboury. This supports DAFO in improving food security and livelihoods of rural communities, where the capacity of local agriculture trader associations is also being strengthened (Chanthasone 2013).

To promote the adoption and dissemination of DMC systems, various rural development actors in all stages of the process (e.g., input providers, farmers, extension workers, researchers, decision-makers like PAFO and DAFO, and the private sector) should be integrated because they play important roles in DMC activities. In addition, their awareness on decreasing soil fertility and related socio-economic issues should be heightened.

In DMC systems, DAFO technician-staff are responsible for one geographic area with 2–3 farmer groups composed of 50–120 households. During the first two years, the use of new technology (e.g., drum seeder, dry direct seeding, and direct seeding techniques) requires strong support and assistance from extension workers who are responsible for planning, coordinating, and training. Training for extension agents from DAFO agronomy and livestock departments focus on agro-ecology concepts and techniques (PASS-PRONAE). It is also important to raise the awareness of farmer groups and organizations. In the past, before farmer groups were established, farmers had no marketing power to negotiate with traders since they have varying price and quality of seeds. After farmer groups were created, input providers such as credit systems began setting up with traders. To ensure the proper application of DMC systems, extension activities and demonstrations (e.g., training sessions on direct seeding techniques, recourse to inputs, and on-farm demonstrations with farmer groups) should be conducted.

Table 15. Institutional challenges of DMC as a good practice

Factor	Challenge
Steep slope	DMC systems are not appropriate for steep slopes, where the decomposing biomass can easily run off. “There was a gradual increase in DMC yields from the first to fourth years due to slow biomass decomposition. In the fifth year, the benefits of DMC as a good practice were evident in the soil.”
Ease of use	DMC systems are difficult to practice because farmers burn the biomass for easy management, and cattle can enter the field after harvesting to eat plant residues.
Pest management	Plant residues are favorable to pests and insects, especially rodents, termites, and ants.
Overgrazing	The farmers cannot allow cattle to enter the field after harvesting the crop because of overgrazing.

Source: Chanthasone (2013)

5.2.2 Maize Integrated with Legumes

Farmers in Xayaboury, Oudomxay, and Luang Prabang practice integrating maize with legumes such as red bean, mungbean, and soybean.

The Napok Agriculture Research Center develops the following high-yielding legumes for distribution to the farmers: (1) Napok Agriculture Research 1 (100 days), (2) Napok Agriculture Research 2 (110 days), (3) Chiang Mai 60 (90 days), (4) DM12 (Vietnam) (90 days), and (5) KKU 35 (110 days). Most farmers plant soybean after harvesting.

Farmers plant legumes between rows of maize. Most farmers in Xayaboury integrate maize with legumes in two productions per year to control the weeds. The canopy of maize and legumes provide shade that can inhibit weed growth. Increased soil fertility reduces risks linked to variations in climate and maize price. The benefits from maize integrated with legumes are higher than mono maize planting by about 23 percent (MAF 2010).

VI. CONCLUSION

Lao PDR is classified into three zones: the northern region, which has many hills and steep slopes; the central region, which has many flatlands and is the rice basket of the country; and the southern region, which has many flatlands and sloping areas.

NAFRI served as the key implementing agency of this national study, which prioritized the following case studies on good practices in CCA options for rice and maize: for rice, (1) SRI, (2) rice biodiversity conservation, and (3) improving drought- and submergence-tolerant varieties in lowland areas; and for maize, (1) DMC and (2) maize integrated with legumes. These good practices in Lao PDR seem to be very location- and site-specific. The national study was conducted only in Xayaboury, Oudomxay, and Luang Prabang because of budget limitations and time constraints.

With policy support from the government of Lao PDR in conducting and strengthening good practices in the country, especially through DOA, NAFRI, MAF, PAFO, DAFO, and farmer organizations, the procedures and outcomes of the national case study were satisfactory. Two national consultative meetings were held at NAFRI to discuss the identified good practices in Lao PDR, where several scientists and researchers participated and contributed ideas to further the country's resilience to climate change.

Rice biodiversity conservation is commonly practiced in the eight northern provinces, where the topography is hilly and sloping. The northern region suits the country's three agricultural production systems: irrigated lowland, rainfed lowland, and rainfed upland. It also features more rice varieties because it is also home to diverse ethnic minorities, where poor farmers are found (Appa Rao 2006).

The rationale in growing several varieties is to reduce vulnerability to climate risks (e.g., erratic rainfall), meet religious requirements, match eating behavior, ensure the fair distribution of labor demand, and meet grain quality and specific consumption requirements for ethnic minorities (Appa Rao 2006). Among ethnic minority groups, the Hmong prefers non-sticky rice, the Lao Theung prefers sticky rice, and the Lao Loum prefers both. As reflected in the AMP, government policy also supports farmers in growing diversified crops and varieties to ensure food security and cope with unpredictable climate variability (MAF 2010).

Farmers in Xayaboury, the basket of maize production in the country, practice DMC. The number of farmers adopting DMC and direct seeding on plant cover quadrupled in the southern districts of Xayaboury. DMC and direct seeding on plant cover have been replicated in Luang Prabang and Oudomxay.

References

Appa Rao, S., 2006. **Collection of Rice Germplasm in Lao PDR between 1995 and 2000.** Ministry of Agriculture and Forestry/Laos-IRRI Project. Vientiane: Lao PDR.

Chinvanno, S., S. Souvannalath, B. Lersupavithnapa, V. Kerdsuk, and N.T.H. Thuan. 2006. “Climate Risks and Rice Farming in the Lower Mekong River Countries.” **Assessments of Impacts and Adaptations to Climate Change (AIACC) Working Paper No.40**

DOA (Department of Agriculture). 2012a. **Crop Statistics in Rainy Season Year 2012.** p. 126 Vientiane: Lao PDR.

DOA. 2012b. **Crop Statistics Year Book 2012.** pp. 87, 205. Vientiane: Lao PDR.

DOMH (Department of Meteorology and Hydrology). 2012. **National Strategy on Integrated Flood Management.** Vientiane: Lao PDR.

FAOSTAT (Food and Agriculture Organization Statistics). 2012. **Production Data: Lao People’s Democratic Republic.** Retrieved May 2014. http://faostat3.fao.org/browse/area/120/E

Lefroy, R. 2010. **Study on Potential Impacts of Climate Change on Land Use in Lao PDR.** Vientiane: NAFRI

MAF (Ministry of Agriculture and Forestry). 2007. **Annual Report.** Vientiane: Lao PDR.

——. 2010. **Agricultural Master Plan 2011 to 2015.** Vientiane: Lao PDR.

MoNRE (Ministry of Narural and Environmental Resource). 2010. **National Strategy on Integrated Flood Management.** Vientiane: Lao PDR.

PAFO (Provincial Agriculture and Forestry Office). 2012. **Annual Report.**

Peñalba, L., and D. Elazegui. 2013. “Improving Adaptive Capacity of Small-scale Rice Farmers: Comparative Analysis of Lao PDR and the Philippines.” **World Applied Sciences Journal** 24 (9): 1211-1220, 2013

Phetmanyseng, X. 2014. “Strategy of rice improvement for Climate change in Laos.” Presentation at the Laos 2nd National Consultative Meeting under the project, ASEAN Network on Promoting Climate Resilience of Rice and Other Crops, June 13, 2014, Vientiane, Laos.

Schiller, J.M. 2004. **System of rice intensification (SRI) Sustainability for lowland rice production in the Lao PDR.** IRRI: Lao PDR

Soukkhy, O., P. Bounmee, S. Keo Oudone, H. Sivilaysack, S. Chanhthyh, Houmpheang, Simone, Sinthalay. 2012. “Climate Change Implication to Food Security and Livelihood of Small-scale Farmers.” Presentation at the International Conference on Climate Change Impacts and Adaptation for Food and Environmental Security 2012, November 21-22, 2012, Los Baños, Laguna, Philippines.

Southavilay, S. 2009. “Agriculture Production in Xayaboury District, Savannakhet Province”. **Annual Report.** Xayaboury: Lao PDR.

WFP (World Food Program). 2013. **Mapping of Villages Affected by Floods.** Vientiane: Lao PDR.

Xayavong, C. 2013. **Conservation Development Agriculture Fund of Xayaboury.** Xayaboury: Lao PDR.

ANNEX 1: LAOS NATIONAL TASK FORCE

No.	Name/Surname	Organization	Contact Number	Email Address
1	Mr. Viengsavanh Phimmachanhvongsod	Lao ATWAGARD Focal Point	22005885	
2	Dr. Outhai Soukkhy	NAFC	55571828	outhainafc@yahoo.com
3	Dr. Vanhthong Phaengvichit	NAFRI	22107855	vanthongp@gmail.com
4	Dr. Palikone	CCA Research Center	22224147	palikone@gmail.com
5	Khamsai Inthavong	GIZ-LM- RED	22326902	Khamsai-_inthavong@giz.de
6	Pasalath Khounsy	NAFRI	22412049	pasalathikh@gmail.com
7	Khamphone Singngam	Xayaboury Research Station	55979677	khamphone@yahoo.com
8	Bouthan Souliyakham	Research & Extension	22355638	b.sulaiyakham@yahoo.com
9	Houmphengsivilaysack	Luang Prabang PAFO	55770951	houmphengsvs@hotmail.com
10	Saiphet Chanhthalangsy	PAFO Xayaboury	23758899	sayphetch@gmail.com
11	Chanthasone xayavong	Keanthao	55514023	xayavongchanhthasone@yahoo.com
12	Dr. Phet Phengxay	NAFREC	55212445	
13	Dr. Khamdok	NAFREC		