Community preparedness for climate change and increased water use efficiency for rice cultivation using principles of System of Rice Intensification (SRI) in Central Thailand

Final Report

APFED Showcase, 2008

Submitted by

Agricultural Systems and Engineering Field of Study
School of Environment, Resources and Development
Asian Institute of Technology, Thailand

Community preparedness for climate change and increased water use efficiency for rice cultivation using principles of System of Rice Intensification (SRI) in Central Thailand

Final Report

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Prepared by

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Final Evaluation Report

Project #	*(Office use)*
Project title:	**Community preparedness for climate change and increased water use efficiency for rice cultivation using principles of System of Rice Intensification (SRI) in Central Thailand**
Country	Thailand/ Ratchaburi/ Ban Pong
Selected year	2009
Implementing organisation:	Asian Institute of Technology (AIT)
Partner organisations:	Department of Agriculture Extension, Thailand
NetRes	Thailand Environment Institute
Project duration:	12/2009 - 06 / 2011(18 months)

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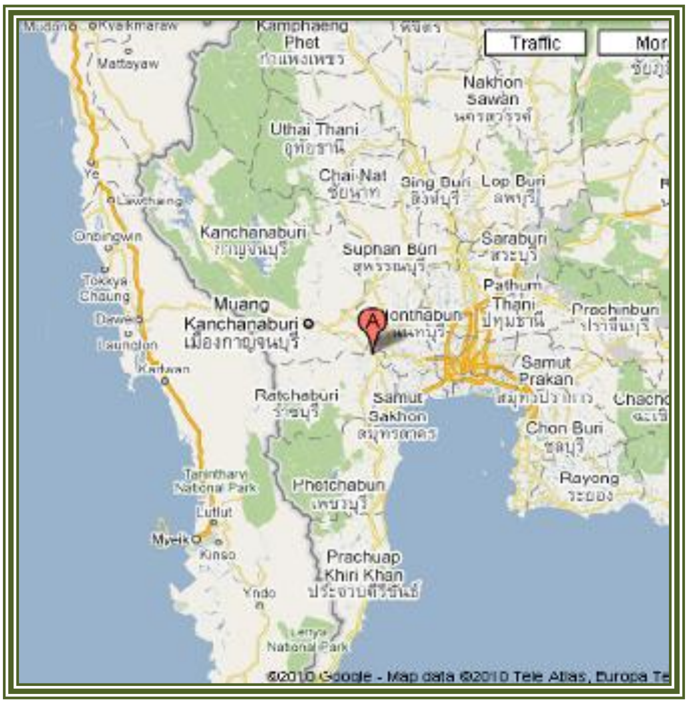
PREFACE

This APFED Showcase 2008 supported project '**Community preparedness for climate change and increased water use efficiency for rice cultivation using principles of System of Rice Intensification (SRI) in Central Thailand**' is among few projects in the region that attempted to bring the latest agricultural innovation to the rice farming communities of central Thailand with the aim to prepare them to cope with the negative externalities of the climate change.

This work has been made possible due to innovative scientific studies undertaken at AIT by lead Rice researchers utilizing the framework of SRI. This successful intervention in Central Thailand will help to sensitize the other farmers as well as donor communities in supporting science based adaption wok using Farmers' Field School (FFS) platforms in coming months and years.

Dr. Prabhat Kumar
AIT, Thailand
May 2011

LOCATION MAP



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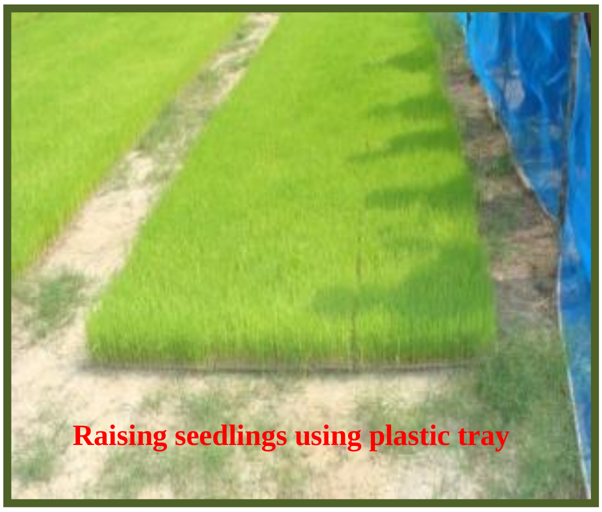

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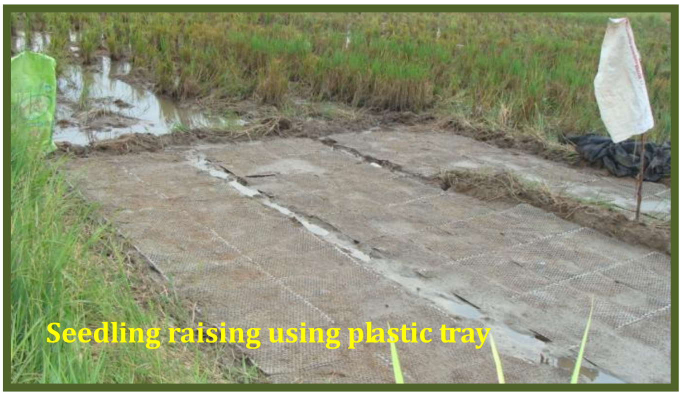
One of the women famers who has started seedling selling business after FFS activity



Seedling raising using plastic tray

SRI-P rice field

Field visit after FFS activity

ACRONYMS

AESA	*Agro-Ecosystem Analysis*
AIT	*Asian Institute of Technology*
CF	Chemical free
CPM	Center of Pest Management
DAS	*Days after seeding/ sowing*
DAT	*Days after transplanting*
DoAE	*Department of Agricultural Extension*
FFS	*Farmers' Field School*
FP	Farmers' practice
IPM	Integrated Pest Management
NPK	*Nitrogen, Phosphorus and Potassium*
OA-B	Office of Agriculture, Banpong Distrct
OAPQD	Office of Agriculture Product Quality Development
OA-R	Office of Agriculture, Ratchaburi province
SRI	*System of Rice Intensification*
SRI-P	*SRI-Parachute*

SUMMARY (Apdx. 4)

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Project title:	**Community preparedness for climate change and increased water use efficiency for rice cultivation using principles of System of Rice Intensification (SRI) in Central Thailand**
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I. OUTLINE OF THE PROJECT

Issue/Sector:	**Climate Change and Freshwater use for Rice Cultivation/Agriculture**
Total cost:	**US$ 53, 725** (30,000 US$ from APFED funds)

1. Background of the Project

In Thailand, rice is the most important crop grown (55 % of cropped area), consumed (42% of daily caloric intake) and exported (40% global share in 2008), but growing rice with conventional practice is no more sustainable in the context of increasing water scarcity and climate change variability since flooded rice contributes significant amount of amount of GHG, methane emission from flooded rice paddies, and has lower water use inefficiency. More sustainable/cleaner and eco-friendly production systems, like SRI* are necessity in agricultural field in the context of climate change.

2. Project Overview

The overall aim of the project was to strengthen farmers' capacity to deal with location-specific heterogeneity and develop area-specific *green* technologies on rice production systems focusing on sustainable water use to address the challenges of climate change and economic development.

(1) Project Objective/Expected Outcome

To develop innovative location-specific crop and water management techniques with active involvement of farmers along with experts at selected farmers' field, and creation of knowledge base/understanding in order to raise awareness and disseminate information at wider scale and to share and disseminate project learning at farmers, provincial and regional level.

(2) Outputs

The project helped rice farmers to become partners for climate-change mitigation and adaptation, *preparing for and coping with*, strategies through adapting and adopting improved crop and water management practices. The resulting higher yields along with higher economic return was both incentive for the farmers, and reinforcement for their behavioural changes involved in changing crop, soil, water, and nutrient management practices.

(3) Inputs
NetRes Institute (Showcase Facility)

30,000 US$

Implementing Organisation

23,150 US$

Others

The partner Thai institutions time and in-kind support (4 trainers + 2 subject matter specialist for 8 months)

II. EVALUATION

Period of Evaluation	12/2009-05/2011

1. Summary of Evaluation Results
(1) Relevance

Growing competition for water and rising cost of cultivation due to increased fuel and fertilizers cost are the major concern now for most of the farmers. Therefore, project intervention was timely and was based on the need of the farmers and the target area. Similarly, the collaborative approach used to address the location-specific need was useful for brining-up the climate change adaptation as actual experientially learnt practice by the farmers.

(2) Effectiveness

Rising demand of rice to meet the demands of growing population must be accomplished with less land per capita, smaller and less reliable water supply, less degradation of the environment, and less drain on the resources of small farmers who constitute the majority of the rice farmers. This series of collaborative work undertaken with partnership of DoAE, Thailand demonstrated that amply.

(3) Self-reliance

Being an experiential learning process, it is expected that knowledge and experiences generated within the community will be available for further refinement and adaptation by its farmers. Also, as the local partners from DoAE has been trained in the process and also were part of the technology development, it is further expected that they would support more farmers group in raising their yield with climate change consensus and activities.

(4) Participation

The process of field experimentation and other related activities were appreciated by the farmers as evident through their presence and return to all successive session. Over 90% sessions and weekly meetings/other activities were attended by majority of the farmers clearly indicating their interest. The average attendance of the 23 attending farmers over 18 weekly sessions was 82.00±4.35 %, which clearly demonstrates the interest and excellent participation.

(5) Contributing Factors

The outstanding phenotype of rice plants in SRI plots compared to farmer's practice plots and plans of the sessions are important factors. Also, the increasing cost and irregular water supply through canal and through rain (as water is vital for rice), created lots of interest among farmers to learn alternative yet high yielding method. Further, the regular workshop, field-visits by the researchers, weekly meeting and discussion added very strongly towards successful contributing factor for the project.

(6) Conclusion

The project helped rice farmers to become partners for climate-change mitigation and adaptation, *preparing for and coping with*, strategies through adapting and adopting improved crop and water management practices towards such as intermittent irrigation, which is well- known and scientifically established way for reduction in CH_4 emission.

(7) Lessons Learned

The project successfully developed the locally suitable suit of technology that could not only enhance the yield level substantially but also in a manner that is climate-friendly. However successes at these plot level works require adequate government support and incentive to the farmers to move to the spatial level to reap the grater advantages for famers and as well for environment in years to come.

(8) Recommendations for the Project/IO (to be prepared by NetRes Institute)

OUTLINE OF THE EVALUATION STUDY

1.1 Project background

In Thailand, rice is the most important crop grown (55 % of cropped area), consumed (42% of daily caloric intake) and exported (40% global share in 2008). It occupies the core of agriculture and is grown in all four corners of the country in different rice-growing ecosystems, ranging from rainfed lowland production in NE Thailand to irrigated systems in the central part of the country. The central region accounts for about one-fifth of the total cultivated rice land of the country in the wet season. Almost 75% of the dry-season rice grown under irrigated conditions is located in this region. Water requirements for irrigated rice paddies are very high, and on an average, one kg of rice production needs 2,000-5,000 litres of water (Molden et al., 2007). At the same time, it is well established fact that flooded rice paddies are a significant source of the greenhouse gas, methane (Neue & Boonjawat, 1998; Denier Van Der Gon, 2000; Li et al., 2002), contributing over 10% of the total methane flux to the atmosphere (Prather & Ehhalt, 2001), which may have substantial impacts on atmospheric chemistry and climate. Thus, continuing impacts of increasing CO_2 and global warming on rice grain yield could have additional impacts on food supplies not only to people in Thailand but in many parts of world, where imported Thai rice is a food source.

While water shortage in rice cultivation is emerging challenge worldwide, water use efficiency of rice is very low and is further lowered at the farmers' field. It is greatly believed that better on-farm management could significantly improve water productivity, increase water use efficiency with better rice yield (Molden et al., 2007). Moreover, CH_4 emission rates could also be modified through better crop management techniques (Cole, 1996). The rate of CH_4 emissions from rice fields depends on growth of the plants and the subsequent availability of carbon substrates in the soil, as well as cultural conditions that affect the soil, such as irrigation regime, fertilizer amount and type, return of organic residues to the soils, and seasonal climate (Neue, 1993; Neue et al., 1996). Movement of CH_4 from the soil to air is largely rice plant mediated, as CH_4 diffuses from the rhizosphere through the stem, and out through micropores in the leaf sheaths (Nouchi et al., 1990).

In light of the above background and with increasing international demand; urgent need of a technological shift toward more sustainable and cleaner production system and economically rewarding production systems have compelled farmers and researchers alike in Thailand (Towprayoon et al. 2005) to explore alternative crop and water management options such as System of Rice Intensification (SRI). The agroecologically-based SRI principles are well established initiatives for innovation that offer synergy in their methodologies; environmentally-sound practices for conservation of natural resources such as soil and water. The benefits extend to affecting climate change, in that avoiding continuous soil saturation reduces methane emissions from rice fields without generating offsetting nitrous oxide emissions (Yan et al., 2009).

Several studies and farmers' field research in various countries and in NE Thailand have shown that SRI could provide better alternative to mitigate these challenges with improved rice production and economic return in a sustainable way (Mishra et al, 2006; Mishra and Salokhe, 2008; Uphoff and Mishra, 2009; Mishra and Salokhe, 2010, Mishra and Uphoff, 2011). Therefore, considering the varied socio-economic and bio-physical realities of farm and rice farmers, there is urgent need to adapt and adopt such farmers' friendly agronomic practices as a means to address both challenges facing the rice sector i.e. to deal with location-specific heterogeneity which is the main factor for yield gap experienced at farmers' field, and to reduce CH_4 emissions and increase water productivity, especially for irrigated rice paddies.

In the lights of these concern, AIT in association with Department of Agriculture Extension (DoAE), Royal Thai Government (RTG) (Initial project partner was Rice Department, RTG)--under a funding support from the United Nation Environment Programme's (UNEP's) Asia Pacific Forum for Environment and Development (APFED) Showcase Project 2008--investigated, documented and assessed the results of a collaborative action research and undertaken season-long learning and training to address the above-stated challenges.

1.2 Project overview

The overall project aim was to strengthen farmers' capacity by encouraging innovation and experimentation to deal with location-specific heterogeneity and develop area-specific *green* and robust technologies on rice production. More specifically, project was focusing on optimal use of purchased input, and water in rice production in order to help them to prepare against the negative externalities of the climate change, and achieve higher net returns from rice farming. In order to achieve this ambitious goal, project focused on two main key activities:

1) **Collaborative action research set up:** A collaborative action research involving farmers, researchers, trainers and other resource persons had been set up using Farmers' Field School (FFS) platform. Department of Agricultural Extension (DOAE), which has been on the forefront of Farmers' Field School (FFS) implementation and which has required capacity in assisting farmers to undertake action research, partnered with AIT in this project implementation at Ban Nongri, Nongkob sub-district, Ban Pong district, Ratchaburi province of central Thailand. The field experiments--a part of action research--started since 25 November, 2009 and completed its final harvesting on 10 March, 2010.

   Knowledge sharing and dissemination: ***At farmers' level***: After completion of field experiments, the farmers and the cooperating organizations organized "Field Day" on 10 March 2010 to share and disseminate the learned knowledge to neighbouring farmers and other stakeholder engaged in healthy and profitable rice production systems. 30 man and women rice farmers along with 5 trainers from DoAE are directly participating in these action research and FFS. In addition, approximately 100 outside farmers were invited from time to time to participate and learn from the key activities. In addition to the DoAE, other local agriculture departments and officials regularly visited the project site and have been briefed by the AIT project team, which provides weekly backstopping to the project. Project overview could be further accessed at http://www.ait.ac.th/news-and-events/2010/news/climate-friendly-rice-production-demonstrated-in-central-thailand/view. ***At provincial level:*** Followed to that a final workshop was organized in Ratchaburi on 20 September 2010 involving Office of Agricultural Promotion; Office of Agricultural Product Quality Development; Center of Pest Management (Suphanburi Province); Office of Agriculture, Banpong District, Office of Agriculture, Ratchaburi Province; DoAE, AIT along with farmers (FFS and non-FFS) to share and exchange the learning and get feedback from various stakeholders. Prior to the workshop, a field visit was made in the project area to gather information from farmers' field on the adoption and adaptation of learned techniques. ***At regional and international level:*** various international workshops and meeting were used as platform to share and disseminate project learning to wider audience. (See at http://www.iges.or.jp/en/ad/pdf/activity20110131/proceeding.pdf;
   http://sri.ciifad.cornell.edu/countries/thailand/index.html
   http://ait.gmseenet.org/th/content/innovative-climate-friendly-rice-production-central-thailand...)

1.3 Study objectives

The overall objective of this study was to develop innovative location-specific crop and water management techniques in order to intensify sustainable rice production using less water and less physical inputs with involvement of rice farmers, extension personnel, rice scientists from AIT, and officials from DoAE RTG using Participatory Action Research (PAR) approach at selected farmers' field in Ratchaburi province, Central Thailand.

To cover the various areas related to the set project objective, following agronomic studies were designed:

a. To study some of the *System of Rice Intensification (SRI) principles for achieving higher yield with less seed and less water (SRI)*:

Some of the selected management practices of SRI were used to set up this trial. *Younger seedlings*, 12-day-old, were transplanted @ 1-2 seedlings/hill with 25 x 25 cm, and water management *alternate wet and dry* was followed at early growth stage. Other cultural operations such as weeding, fertilizer application (rate and methods) were same as farmers' practise (see below). Harmful chemicals such as pesticides and herbicides were not used in this treatment. Seedlings were prepared using seedling tray with 1-2 seeds/hole (See Picture 3) instead of using conventional wet seedbed.

b. *To integrate SRI principles with parachute method of transplanting for higher yield with less seed and water, and with less labour cost (SRI–Parachute (SRI-P)):*

Instead of conventional Parachute technique (see Box 1) in this case the seedlings were prepared by sowing *less seed*, 2-3 seeds/hole, in seedling tray (see Box 2) instead of 6-7 seeds/hole (conventionally practiced). Also, the age of seedlings at transplanting were kept *younger,* 12-day-old, instead of relatively older seedlings, 21-30 days, Transplanting was done using same method as conventional parachute i.e. by uprooting seedlings from the seedling tray and throwing uniformly in the puddled and levelled field. Fertilizers and other cultural operations were same as farmers' practice.

c. *To study and learn Integrated Pest Management (IPM) process for growing pesticide free crop and for making informed decision in crop field (IPM) :*

In this trial, planting was done by direct sowing with seed rate @ 15 kg/Rai (approx. 93.75 kg/ha). Fertilizers used are based on the recommendation by the government agencies, 16-20-0 (NPK) @ 25 kg/rai (156 kg/ha) as a basal dose and 25 kg/rai at 20 days after seeding/sowing (DAS). Urea (46-0-0) was applied @ 25 kg/rai at 55 days after sowing (DAS). Weekly field monitoring performed and decision on crop management was taken on the basis of crop's condition and agro-ecosystem analysis.

d. *To compare Organic rice cultivation using cow extract with farmers' practice (Organic)*:

In this trial, chemical fertilizers were not used except rock phosphate. Cow manure were used @ 500 kg/rai (3.15 t/ha) incorporated during final land preparation and rock phosphate @ 50 kg/rai (312 kg/ha) was applied at 20 DAS. Field monitoring were performed same as IPM plot.

e. *To compare yield potential and net return of chemical free rice with farmers' practice (Control-chemical free (CF)):*

This plot received no chemical fertilizer. Cow manure were used @ 500 kg/rai (3.15 t/ha). Weekly field monitoring carried out to observe and compare with other plants on crop morphology, ecosystem and yield comparison eventually. The broadcasting method was followed for planting with seed rate @ 25 kg/rai (156.25 kg/ha), same like the local farming practices.

f. Conventional rice growing practice (*Farmer's Practice (FP)):*

This plot followed all the field operation as commonly agreed by the local participating farmers in the area in relation to the seed, fertilizers, herbicides, insecticides, and fungicides uses. This plot used seed @ 25 kg/rai, pellet manure 10 kg +urea 25 kg at 20 DAS, and NPK (16-20-0) amount 25 kg/rai at 56 DAS. Weekly field monitoring is carried out to observe the crop condition and ecosystem. Decisions made by farmers were similar as they usually practice in their field.

In addition, for farmers, the objectives of conducting these trials was aiming to reduce the cost of rice production and increase the productivity of irrigation water and learn to grow rice without chemicals. It was expected that after action research and season-long training of farmers they will be able to manage their farm for following benefits:

- Would be able to make decision to optimize factor of production and gain new insight and knowledge to solve the farm problems with location-specific solutions.
- Would be able to grow good quality rice
- Would be able to get higher productivity
- Would be able to reduce cost of production and achieve higher net return
- Would be able to reduce the amount of irrigation water

- Would be able to share their knowledge with other farmers

And finally project was also aiming to learn, share and disseminate learned knowledge with wider audience.

1.4 Scope of work

The project aimed to create a knowledge base/understanding on the climate change and relevance of green and robust technology for the rice farmers in general, also for the government organizations (GOs) working in the project area keeping in my mind the emerging needs of the farmers and environment which is not yet well perceived by the rice farming community. It was expected that project exercise will create awareness and disseminate information further that may be later taken up through various other extension means by the larger cross-sections of the farming community in the country and beyond. More specifically, the scope of the work has been summarized as follows:

- There are limited action research activities addressing the concern of rice farmers and the environment for managing higher yield with less water and less chemicals for safer and sustainable environment. It was expected that the participatory action research conducted on sustainable rice intensification will create awareness among all stakeholders engaged in this trial and address the local as well as global concern for developing sustainable solution for growing rice with 'green' technology.
- Since participatory action research was carried out with the involvement of farmers, researchers, extension personnel and government departments; therefore, it was expected that the research processes and outcomes will directly benefit the participants to understand the rice production system of a given location and how the location-specific technologies can be useful for combating global problems such as reducing the methane emission from rice field.
- Though the action research was conducted for a season only and it was location-specific, even it was assumed that the research outcome will have considerable replicability.

1.5 Study period

Project period: December 2009 – June 2011; Field study/crop period: November 2010 – March 2010; Data analysis, workshop, knowledge sharing, evaluation and documentation: April 2010-March 2011

Box 1

Parachute Transplanting: In this method, seedlings are grown in seedling tray (see Box 2). Each tray contains approximately 435-450 holes. Holes are filled with light soils and 8-10 seeds are sown in each hole. Normally seedlings are grown for 20-25 days and then transplanted in the puddled and levelled field by throwing which is called as Parachute transplanting. During transplanting seedlings clumps are uprooted from the hole and thrown in the wet field. Usually 75-80 trays are required to transplant 1 rai (0.62 hectare) in conventional parachute transplanting. For SRI and SRI-Parachute practices seedling tray were prepared by sowing 1-2 seedlings/hole.

Box 2

Seeding raising using plastic tray: Firstly, digest the dry soil at 0.5 cm (soil should not mix with the rice weed). After that, bring the plastic tray to prepared area (the area should be smooth equally) in roll (2-4 plastic trays per one roll according to needed). Then, scatter the soil 50-70% and follow by the pure seed (soak 1 night and cover one night or dry seed) at 3-4 kilograms (50-60 trays per rai). Finally, scatter the soil properly and equally. Soil should not be over the hole because the root will be engaged its self when it is parachuting.

People to be used in digest the soil should be 1 person per 150-200 trays per day (it can be used for 2-3 rais). First of watering the seed should be dropped with tiny water (water should be as smaller as it can). Be careful of seed, it will throw off. Moreover, seed should be not be flooded by the water. However, if there is much rain, the old sack should be taken to cover the seed until the rice root germinate. This method can be used as in door and out door. After it roots around 12-16 days with roots long around 3-5 inches (according to the quality of the material), it can be parachuted immediately. Area for cultivating seed is around 12-15 square meters per 50-60 tray which can be scattered for 1 rai.

This method can create the accurate method to put the seed. It can control the soil and number of seeding as wanted. Moreover, this method can be further refined in the future.

1. METHODOLOGY

Field experimentation: to evaluate the selected crop management practices, randomized block design was used with three replications. Agronomic parameters (plant height, no of productive tillers per square meter, spikelet per panicle, filled grain per panicle, yield per square meter, etc. were recorded to compare the differences among tested management practices.

Pre-and-post ballot box test: To measure the knowledge, attitude and ultimately the desired behavioural changes of the participating farmers. Questioner method with 31 questions related to following aspects was used:

- Rice morphology
- Water use
- Crop Management (biotic and abiotic stresses)
- Agro-ecosystem
- General aspects

2.1 Evaluation Questions

(Attached in Annex 2, 2.2)

2.2 Methodology

Using a post-then-pre design to identify self-reported behavioural changes can provide substantial evidence for project impact. In this kind of test, extension specialists and agents develop programs from a set of behavioural change objectives (the objectives of the project). Once these objectives are identified, it leads to formulations of the core session design (like in this case the various aspects of climate resilient production methodologies using SRI principles for rice crop) and later through a post-test measures the changes using questionnaire techniques with multiple choices and live specimens (to the extent possible).

2.3 Schedule of the Study

Kindly refer to "Start completed month" column of the Table "Plan and Actual Activities" of Project Implementation component, 3.1, of the Result section, 3.

2. RESULTS

2.1. Project Implementation

Planned and Actual Input

Activities	$ Total APFED fund	Expenditure	Remarks
Activity 1: Inception Workshop	***2275***.00	***1200.00***	
Activity 2: Baseline Survey	***3900***.00	***3900.00***	
Activity 3: Participatory Problem sensing and analysis using crop calendar	***3550***.00	***3550.00***	
Activity 4: Participatory Trial Development workshop	***3750***.00	***3750.00***	
Activity 5: Participatory Action Research and learning	***10250***.00	***10250.00***	
Activity 6: Weekly farmer's meeting	***8500***.00	***8500.00***	

Activity 7: Mid-season and end-of-season evaluations of farmers. Monitoring and evaluation of project activities	***1800***.00	***1800.00***	
Activity: 8 Data analysis and result preparation	***1500***.00	***1500.00***	
Activity 9: Result-sharing workshop	***3200***.00	***3200.00***	
Activity 10: Farmer meeting (post project implementation)		***500.00***	Additional activity
Total	***38725 (agreement for 30,00.00 US$ only from APFED)***	***38150.00***	

Planned and Actual Activities:

Activities	Status	Start –Completed month	Remarks
Activity 1: Inception Workshop	Several discussions meetings held		The project was introduced to the Rice Department in May 2009. Later again with change of partner, a similar meeting was held with DoAE to introduce project at IPM Centre Suphanburi. A detail end-of-meeting workshop was organized to inform other stakeholders about the project
Activity 2: Baseline Survey	Completed	Dec. 2009	Crop Calendar developed to help to build trials. Detail analysis was taken before setting up field study
Activity 3: Participatory Problem sensing and analysis using crop calendar	Completed	Dec. 2009	
Activity 4 Participatory Trial Development workshop	Completed	Dec. 2009	
Activity 5: Participatory Action Research and learning	Completed	Dec. 09 – March 2010	
Activity 6: Weekly farmer's meeting	Completed	Dec. 09 – March 2010	
Activity 7: Mid-season and end-of-season evaluations of farmers. Monitoring and evaluation of project activities	Completed	January 2010 and March 2010 respectively	
Activity: 8 Data translation (from Thai to English), analysis and result preparation	Completed	April 2010-February 2011	
Activity 9:	Completed	September 2010	

Result-sharing workshop and post- survey of action research			
Activity 10: Report writing in consultation with different stakeholders	Complete	Sept 2010-May 2011	

2.2. Relevance

Rising demand of rice to meet the demands of growing population must be accomplished with less land per capita, smaller and less reliable water supply, less degradation of the environment, and less drain on the resources of farmers. Additionally, rising cost of cultivation due to increased fuel and fertilizers cost is putting additional pressure on farmers. Therefore, there is a need to develop alternative technologies for addressing these multiple issues in a more holistic way. And this project tried to initiate this process through collaborative research at farmers' field.

Needs of Target Group / Target Area

Last year 14,000 villages in 36 provinces were hit by big drought in Thailand (**Bangkok Post, March 17, 2010**). It is also important to note that the government is worried about the growing problem of water shortages that is affecting people in several parts of the country. There is also a concerned about the likelihood of food shortages, particularly of rice.

This threat is already hitting Thailand's economy, with farmers being urged not to plant a second rice crop in order to reduce stress on water supplies. Left unsolved, this would mean a water crisis of unprecedented proportion, especially in rice which is extremely water dependent crop. Additionally, rising cost of cultivation due to increased fuel and fertilizers cost is putting additional pressure on farmers. Therefore, the concern that project tried to address is the priority for the rice farmers as well as for the nation.

Relevance of Project Scope, Expected Outcome and Approach

SRI is perhaps the best current example of options available to promote community-led agricultural growth while managing soil and water resources more sustainably and even enhancing their future productivity. Keeping this view, the project aim was to strengthen farmers' capacity to deal with location-specific heterogeneity and develop area-specific technologies on rice production systems using SRI that focuses on 'growing healthy root systems for healthy crop and uses minimal water and chemicals.

Such knowledge intensive practice using FFS processes not only helps farming community to prepare against the negative externalities of the climate change, such as water scarcity and rising fuel cost, but also helps to achieve higher net returns from rice farming. Therefore, the project work was relevant to the local as well as global needs.

Similarly, participatory action research provided opportunity to develop location-specific rice management practices. Such farmers-centred strategies not only allowed to carry out research with farmers and other stakeholders to develop technologies that were based on sound science but also worked on farmers' condition and were acceptable to farmers. This was clear indicator for the need of such approaches towards technology generation and adoption

2.3. Effectiveness

Achievement of the Project Objective

1. **Higher productivity with less water and less chemicals**: Rice productivity and water productivity were increased under SRI practice compared to the farmers' and other evaluated practices (*See* Figure 2a & 2b). SRI practice used
    a. younger seedling (12-day-old);
    b. single seedling transplanting with 30 x 30 cm;
    c. alternate wetting and drying of field at vegetative stage

d. No pesticide use

2. **Higher economic return:** With SRI, cost of cultivation reduced and net profit increased (Figure 2a & 2b)

3. **Innovation for location-specific adaptation:** To address the increasing labour constraint in rice farming and to facilitate adaptation of SRI principle to local condition, farmers were stimulated to integrate Parachute transplanting method with SRI principle to reduce labour, transplanting time, and cost associated with transplanting. This innovation was named as SRI-parachute (SRI-P). The result showed that SRI-P significantly increased the yield, the water productivity and net return compared to the farmers' practice (*See* Figure 2 &3).

4. **Changes in knowledge and attitude of the participating farmers:** The average score obtained by majority of the participants at Pre Test was around 30%, which rose to the level of about 60% in post-test, indicating a positive impact on change in farmer's knowledge (*see* Figure.3). The lowest individual score obtained was 40% whereas highest was 70% in post tests (*see* Table 1, Annex 2).

5. **Sharing and dissemination of learned knowledge:** The project experience was shared with like-minded organizations, networks, and policy makers through workshops, seminars, etc., to provide stakeholders with qualitative and some quantitative evidence that such activities can create a more favourable environment for low-input intensification in agriculture and will encourage the recognition of such collaborative work in changing agricultural production systems that reduce climate forcing. Some of the websites are listed below for further information:

http://www.iges.or.jp/en/ad/pdf/activity20110131/proceeding.pdf;
http://sri.ciifad.cornell.edu/countries/thailand/index.html
http://ait.gmseenet.org/th/content/innovative-climate-friendly-rice-production-central-thailand

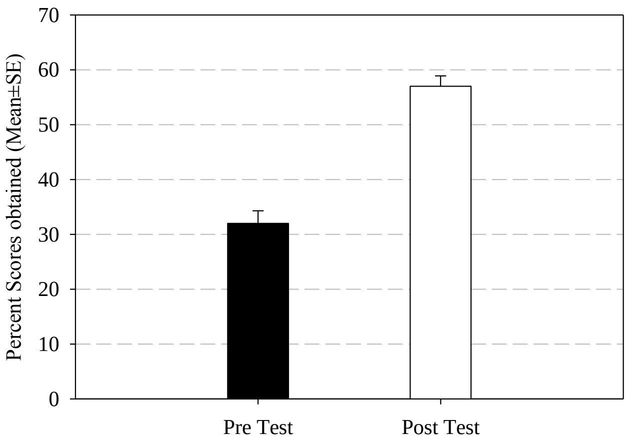
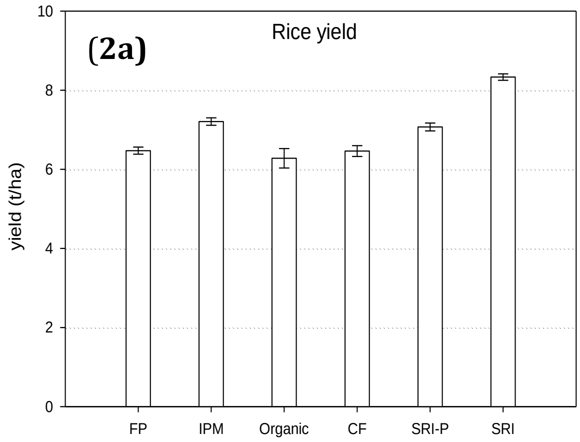


Figure 1: The average percent (SE) scores obtained by the participating farmers in pre and post ballot box test. The ballot box tests was designed to learn the changes in knowledge-attitude-behaviour of the farmers those who took part in the FFS-PAR cycles and in follow-up meetings of the project at Ratchaburi, Thailand (n = 22).

Yield and water productivity



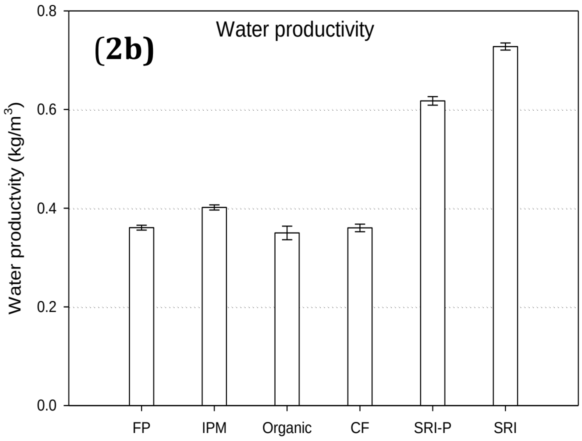
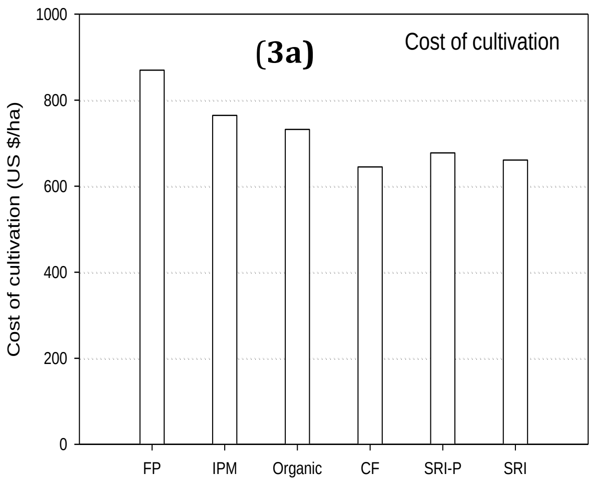


Figure 2a & 2b: Rice yield (2a) and water productivity (2b) under various crop management practices in participatory action research trial conducted using FFS at Ban Nongree village, Tambol Nongkob, Banpong district, Ratchburi province Thailand, 2009-2010. FP = farmers' practice; IMP = integrated pest management; Organic = organic rice cultivation using cow urine extract; SRI-P = SRI principles with parachute transplanting method; and SRI = System of rice intensification practice. (For further detail, see page 18-19).

Cost of cultivation and net return



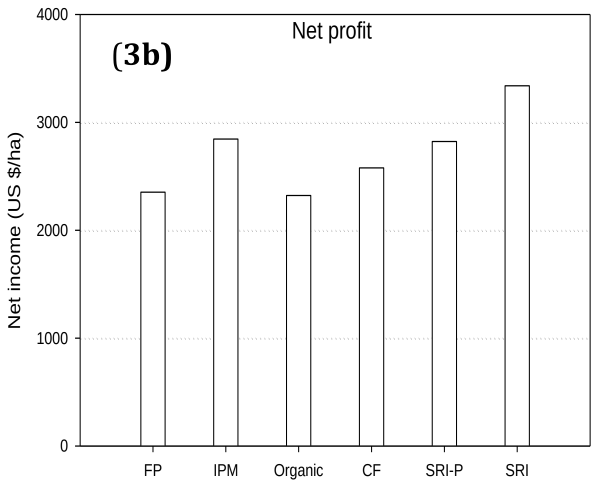


Figure 3a & 3b: Cost of cultivation (3a) and net profit (3b) under various crop management practices in participatory action research trial conducted using FFS at Ban Nongree village, Tambol Nongkob, Banpong district, Ratchburi province Thailand, 2009-2010. FP = farmers' practice; IMP = integrated pest management; Organic = organic rice cultivation using cow urine extract; SRI-P = SRI principles with parachute transplanting method; and SRI = System of rice intensification practice. (For further details, see page 18-19).

Attribution of Outputs on the Project Objective

- The project successfully developed ideas and technologies for increasing water productivity and reduce climate forcing for rice farming using collaborative action research approach. Since the technology was evaluated by farmers and SRI proved itself more efficient than existing farmers' practices, thus built a consciousness among farming community for the generation and adoption of such climate friendly technology with reduced input-use.

- The use of parachute transplanting successfully integrated with SRI elements to address the labour constraints which was one of the innovative elements of this project.

- Clearly the higher net return from the innovative technologies developed by project directly contributed to the enhanced livelihoods of the farmers. Cost and benefit graphs are attached which quantify these aspects (see page no 24).

- Since the intervention plan developed enhanced the productivity of inputs, and in many cases completely free from any form of chemicals that is detrimental to the local environment; without any doubt, the project added to the conservation and maintenance of the local environment. Apart from that, the various sessions conducted during FFS and training resulted into better understanding and appreciation of conservation of environment by the man and women rice farmers.

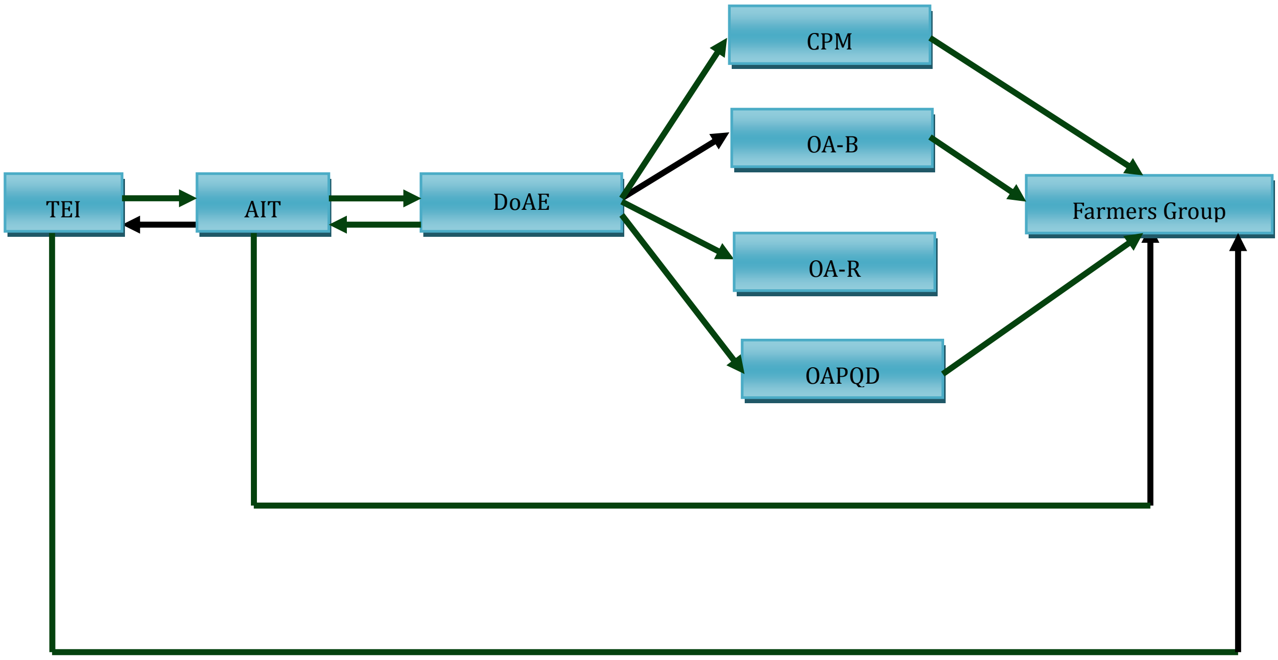
- Since participation and collaboration is the key to innovate, generate and develop location-specific technologies for climate friendly technologies, there cannot, and will not be one way to manage the crops and farms. Farmers will have to play a central role and their knowledge and skills are of paramount importance for any present or future work on this aspect in Asia or elsewhere. Scientists will have to work with farmers to help them to develop ideas on these aspects. This project's collaborative exercise demonstrated the usefulness of such engagement to address the concern related to climate change.

2.4. Self-reliance of the Project

As the project demonstrated benefits from innovation and collaborative exercise with government department and links to rice farming system improvements for coping with climate change in ways that reduce poverty and enhance food security, therefore, the commitments of governments can be expected to make this initiative more sustainable. More specifically, at community level, seedling raising method using plastic tray, and parachute transplanting have already been taken up by the farmers. Many project farmers are now actively involved in seedling raising business using plastic tray method making additional profit, quicker and assured.

2.5. Participation

Below diagram shows the partnership between all the institutions involved in the project.



(TEI = Thailand Environment Institute; AIT = Asian Institute of Technology; DoAE = Department of Agriculture Extension; CPM = Center of Pest Management, Suphanburi province; OA-B = Office of Agriculture, Banpong district; OA-R = Office of Agriculture, Ratchaburi province; OAPQD = Office of Agriculture Product Quality Development).

The process of field experimentation and other related activities were appreciated by the farmers as evident through their presence and return to all successive session. Over 90% sessions and weekly meetings/other activities were attended by majority of the farmers clearly indicating their interest. The average attendance of the 23 attending farmers over 18 weekly sessions was 82.00±4.35 %, which clearly demonstrates the interest and excellent participation.

Analysis of Factors Attributable to Project Results

There were the three actions that supported the collaborative work and active participation of all partners: (1) Workshops (2) Regular information exchange and discussion through field visits and e-mail exchanges and (3) technical backstopping by researcher/scientist.

Further, the outstanding phenotype of rice plants in SRI plots compared to farmer's practice captured farmers' imagination and stimulated active participation of project farmers and their neighbours at all growth stages, and in all workshops organized at field level. Also, the increasing cost and irregular water supply through canal and through rain (as water is vital for rice), created lots of interest among farmers to learn alternative yet high yielding method.

2.6. Conclusions

The project helped rice farmers to become partners for climate-change mitigation and adaptation, *preparing for and coping with*, strategies through adapting and adopting improved crop and water management practices towards such as intermittent irrigation, which is well- known and scientifically established way for reduction in CH_4 emission. A proven concept like SRI, on other hand, increased crop and water productivity, and crop health to prepare farmers to intensify sustainable production with less water and less chemicals. The resulting higher yields were both incentive, and reinforcement for the behavioural changes involved in changing crop, soil, water, and nutrient management practices.

The positive impact of this plot-scale effort and emerging scenario of climate change and of food security issues need similar broader and collaborative efforts at national and regional level.

3. LESSONS LEARNED

- The research process helped establish new and sustainable partnership between all stakeholders. It raised farmers' awareness of optimizing the input use, encouraging them to adapt new methods for addressing their site-specific problem, such as water productivity, soil fertility and labour availability. Farmers' appreciation and willingness to adapt new practices revealed a flexibility and ability to tailor management strategies to changing circumstances and experience.

- Although, the project was successful at plot level in achieving higher yield and economic return and generating broader consensus among stakeholders engaged in rice production systems in Ratchaburi province of Thailand, it was felt that the positive results of these plot-scale efforts need to be scaled-up at spatial scale to realize the larger benefit of such efforts and galvanize supports from the policy makers.

- It was also felt that for sustainability of such approach a value added alternative production system that appreciates saving of water, chemicals and other inputs is required to sustain climate friendly crop management practices such as SRI. Existing agricultural policy needs to be revisited in the context of climate change to benefit farmers, consumers, and environment.

4. RECOMMENDATIONS TO THE IMPLEMENTING ORGANISATION (by NetRes)

5. ANNEX

Annex 1: Implementation Plan

Activities	Time frame				
	2009 Quarter 4	2010 Quarter 1	2010 Quarter 2	2010 Quarter 3-4	2011 Quarter 1
Activity 1: Inception Workshop	X				
Activity 2: Baseline Survey	X				
Activity 3: Participatory Problem sensing and analysis using crop calendar	X				
Activity 4 Participatory Trial Development workshop	X				
Activity 5: Participatory Action Research and learning		X	X		
Activity 6: Weekly farmer's meeting	X	X	X		
Activity 7: Mid-season and end-of-season evaluations of farmers. Monitoring and evaluation of project activities		X	X		
Activity: 8 Data analysis and result preparation				X	
Activity 9: Result-sharing workshop					X

Annex 2: Records of Surveys (interviews and questionnaires)

2.1. Questionnaire for Rice Farmer's survey

Name: ……………………………………Status in family………………………......

Household No……………………Village…………………Province…………………

Date of Interview………………………………………………………………………..

Name of Interviewee…………………………………………………………………………

Remarks:…………………………………………………………………………………
……………………………………………………………………………………………..
……………………………………………………………………………………………..

1. General Information

1.1 Household Member Information

No.	Gender	Relation (HH)	Age	Marital status	Educt	Occupt	Farm experience

Instructions;
Gender: F- Female. M- Male.
Relation with household: H- Head. W- wife/Husband. S- Son. D- Daughter. Others
Marital status: S- Single. M- Married. W- Widowed. SP- separated.

Education: I- Illiterate. P- Primary school. S- Secondary school. A- Above S.
Cultivation Practice: R- Rice crops only, RL/ O- Rice followed by legumes/ other crops, AO- Agricultural off-farm. S-Salary, NW- not working

1.2 Land holding or farm size

Land type	Area (m^2)	Suitability for	Yield (kg/h)	Levelled (Y/ N)	Cropping pattern
Home garden					
Agricultural land					
Area under rice crop					

1.3 Rice cultivation

1.3.1 Basic information

1. How long have you been growing rice in this area (Year) …………………..
2. What is the total land of rice growing area in this village (h)………………………
3. How many hectare each family grows rice for one season (h)………………………
4. How many growing season for rice …………………………………………………..
5. How many farmers is growing rice in this village? …………………………………
6. What is the main crop of this village? ……………………………………………………………
7. What is the main growing season? …………………………………………………………………
8. What is the seed rate/m^2 for planting? (g)……………………………………………………
9. Do you know SRI management practice? (Yes/ No)………………………………

1.3.2 Land preparation

1. What are the land preparation activities before planting? …… …… ……
2. No. of ploughing and harrowing……………………………………………..
3. When do you do puddling (on the day of transplanting or before?)…………………..
4. Do you level your land (Yes/ No)…………………………………………………..
5. Do you mix organic matter or any basal dose of fertilizer? If yes then what and how much……… ……………………………………….
6. Do you do deep ploughing?..

1.4 Cost and Return of rice crop/h…………**Variety**:………………………..				
Item	**Unit**	**Quantity**	**Unit Price Thai Bhat**	**Total Value Thai Baht**
Return				
Product	Kg			
By-Product	Kg			
Variable cost none cash				
Manure	Kg			
Seed	Kg			
Irrigation fee	Thai Baht			
Land tax	Thai Baht			
Others				
Variable cost in cash				
Fertilizer (NPK)	Kg			
Herbicide Costs	Thai Baht			
Insecticide Costs	Thai Baht			
Molluscicide cost				
Other agro-chemicals cost	Thai Baht			
Compost	Kg			
Hired labor (planting, harvesting, weeding)	Man-day			
Land preparation	Thai Baht			
Others				
Family labour	Man-day			
1.5 Total Cost and Net Return from rice cultivation with conventional rice management practices				

1.6 What input do you purchase from market for your rice production?

Inputs	**Unit (Kg)**	**Unit Price(Thai Baht)**	**Quantity (Kg)**	**Value (Thai Bhat)**
Seeds				
NPK				
Herbicides				
Compost				
Insecticides				
Molluscicide				
Others				

2. Specific information on management component of rice management practices

2.1 Pre-planting

1. Do you do seed treatment? (Yes/No)...................
2. Do you do seed soaking in water before planting? (Yes/ No)
3. Do you do seed germination test? (Yes/ No)

2.2 Seedling Raising

1. How do you prepare seed bed? ……….. ....

2. Do you use fertilize seed bed? (Yes/ No)…………………………………………………..
3. If yes then how, when, what type and how much (quantity).. ……………………………………………………………………………………………… ………………………………………………………………………………………………..
4. Do you irrigate the seed bed; if yes then how?... ………………………………………………………………………………………………...
5. How do you uproot the seedlings?.. ……………………………………………………………………………………………… ………………………………………………………………………………………………

2.3 Transplanting

1. What is the age of seedlings for transplanting (Days) ....
2. What is the usual time gap between seedlings uprooting and transplanting? (Hours)………………………………………………...
3. How many seedlings per hill?..
4. What is the spacing between hills and row ? …………………………..
5. Any problem encountered in the transplanting?...
6. Do you use any parameter for selecting healthy seedlings…………………………….
7. In case of mortality do you replace with fresh seedlings?...................................

2.4 Irrigation Schedule

1. What is the common practice for irrigation in rice in wet season/ dry season ……………………………………………………………………………………………… ……………………………………………………………………………………………….. …………………………………………………………………………………………………..

2. What is the common/ available resource for irrigating rice in this area?...............................
…………………………………………………………………………………………..
…………………………………………………………………………………………..
3. Do you follow any water harvesting method? (Yes/No)……………………………………
If yes then which method (detail)………………………………………………………………
…………………………………………………………………………………………
…………………………………………………………………………………………..
……………………………………………………………………………………………..
4. How do you irrigate rice in wet season?...
5. What is the frequency of irrigation?...
6. What is the common water depth do you follow in rice field……………………………
7. Is this same for vegetative stage and reproductive stage (Yes/ No)…………………
if no then how do you proceed in different growth stage (detail)……………………..
……………………………………………………………………………………..
………………………………………………………………………………………..
………………………………………………………………………………………

2.5 Irrigation Schedule (specific)

Determinants	Rank	
Crop Growth stage	**Shallow irrigation (2-3 cm depth)**	**Completely flooded (> 5cm depth)**
Seedling establishment stage (at transplanting)		
Tillering stage		
Booting stage		
Flowering stage		
Grain filling stage		
Ripening stage		

2.6 Weed Control

1. Are any pre-planting activities part of weed management?..
…………………………………………………………………………………………
2. How do you do it? (Method)...
…………………………………………………………………………………………..
3. Why only this method; any advantage?..
4. Different type of weed management (alternative option)…………………………………..
…………………………………………………………………………………………..
5. When do you start to weed?..
6. Frequency of weeding………………………………………………………………………
7. Do you use Herbicides (Yes/ No)………………………………………………
8. If yes then when (crop growth stage)………………………………………………
9. In SRI method do you have more weed problem……………………………..
10. If yes then how do you manage? (herbicides/ manual)……………………..

2.7 Insect Pest and Disease occurrences and their management

2.7.1 Insect Pests (From the beginning of the season till harvesting)

Insect Pest	Crop Stage	Season	Control Methods

- แมลงศัตรูพืชที่เป็นปัญหาสำคัญที่สุดคือ…………………………………………………………………………………………
- What are major insect pest problems?……………………………………………………………………………………..

2.7.2 **โรคพืชที่ทำลายกระเจี๊ยบเขียวของท่านในฤดูที่ผ่านมา (เรียงจากต้นฤดูจนถึงเก็บเกี่ยว)**
Disease (From the beginning of the season till harvesting)

Disease	Crop St ge	Season	Control Methods

- โรคพืชที่เป็นปัญหาสำคัญที่สุดคือ What is the major disease?………………………………………………………

2.7.3. **ชื่อสารเคมีและสารสกัดจากธรรมชาติที่ท่านใช้ในการป้องกันกำจัดศัตรูพืช** Chemical and Bio pesticide uses

ชื่อสารเคมีและสารสกัดจากธรรมชาติ Name	แหล่งที่มา Source	ราคา Price	ปริมาณที่ใช้ต่อครั้งต่อไร่ Quantity/time/rai	ความถี่ในการฉีดพ่น Fr quency of spra ing	จำนวนครั้งที่ฉีดพ่น No. of application	ฉีดเอง/จ้าง Family/Hired	ฉีดเพื่อป้องกันอะไร Purpose

2.8 Fertilizer

1. When do you start to apply fertilizer? ………………………………………………….
2. Amount and type of fertilizer………………………………………………………………..
3. How much in basal dose and how much in split dose?..
………………………………………………………………………………………………
4. How do you do it (placement, spraying, broadcasting) ……………………………………
………………………………………………………………………………………………
5. Recommended dose of fertilizer?..
6. Do you apply compost (Yes/ No)…………………………………………………………..
7. Amount of compost…………………………………………………………………………..
8. Do you purchase …………………………….
9. If yes then from where and how much do you spend………………………………………..
10. When do you apply compost (during land preparation, during transplanting, after transplanting………………………………………………………………………………..
11. Type of compost………………………………………..
12. Do you apply manure……………………Amount……………………Type…………….
13. How do you prepare manure……………………………………………………………
14. When do you apply manure…………………………………………………………..

15. Tell us the average dose of inorganic and organic fertilizer…………………………..

2.2. Questions pool used for Pre and Post Ballot Box Test

1. For each soil types that you see in bags, match with their correct identification.
   Bag 1 (Sand)
   Bag 2 (Clay)
   Bag 3 (Sandy loam)
   Bag 4 (Compost)

2. For each fertilizer you see, what formula of it.
   Bag 1 (Urea)
   Bag 2 (NPK)
   Bag 3 (sand)
   Bag 4 (organic matter)

3. Please encircle the correct statements
   a. Rice can only be grown in ponded water situation
   b. Rice can grow under intermittent water ponding situation
   c. Throughout the cropping period ponded water is must
   d. Water can be judiciously used to increase water productivity

4. In SRI method, how old seedling is transplanted?
   a. 5-days old
   b. 15-days old
   c. at two leaves stage irrespective of age
   d. None of the above

5. In SRI method, how water should be managed (encircle the correct answers)?
   a. Continuously flooded
   b. Intermittent irrigation
   c. Shallow water depth
   d. Irrigate upon development of cracks in sodil
   e. None
   f. All

6. How best you could describe the changes in weather pattern in your area in last 10 years?
   a. Less rain
   b. More rain
   c. Pattern of rainfall changed
   d. None
   e. All

7. Younger seedlings of rice ?
   a. Establishes faster
   b. Produce more tiller
   c. Cope better with transplanting shock
   d. All
   e. None

8. Which one is usefulness of puddling?
   a. weed control
   b. leveling and ease of drainage
   c. rapid root anchorage into soil
   d. all correct

9. Which one is a difference between rice and weed?
   a. rice has auricles for insect protection but not in weed
   b. rice has auricles for precipitation protection but not in weed

c. a. and b. correct
d. all incorrect

10. What is the main role of rice leaves?
a. photosynthesis
b. respiration
c. nutrient absorption
d. a. and b. correct

11. What is the role of primary and secondary roots?
a. primary - for anchorage and secondary roots for nutrient absorption
b. secondary roots for anchorage and nutrient absorption
c. Both for anchorage and nutrient absorption
d. all correct

12. What is the function of a green part of rice?
a. photosynthesis
b. food storage
c. respiration
d. water absorption from air

13. What is the benefit if we can maintain lower leaves of rice?
a. good for more photosynthesis, more production
b. good for more tillering
c. not good for plant food competition
d. all incorrect

14. When does rice start the tillering stage?
a. 5 - 10 days of age
b. 10 - 20 days of age
c. 20 – 30 days of age
d. 30 days or more

15. What soil component that helps to improve water holding capacity?
a. minerals
b. Stone and sand
c. organic matters
d. all correct

16. What materials do you have in your village can improve water holding capacity?
a. rice husk b. rice straw c. manure d. all correct

17. What happens if there is no mulching within rice inter-spaces?
a. Weed problem
b. Good growth of rice
c. Increase of tillering
d. Weed problem and less moisture

18. How aerobic and anaerobic soil environment conditions have effects on growth of rice?
a. rice is susceptible if aerobic
b. rice is susceptible if anaerobic
c. rice grows well if aerobic
d. rice grows well if anaerobic

19. What condition is best for rice growth?
a. warm b. warm and moist c. cold d. cloudy

20. From where most of oxygen do plants take?

a. soil b. water c. air d. all correct

21. Which is correct for the cycle of water?
    a. water comes from living and non-living things on the earth and goes up to the sky
    b. earth – sky – cloud – rain
    c. from the sky to the earth
    d. all incorrect

22. From where can you have water for rice cultivation?
    a. river
    b. canal
    c. rain
    d. all correct

23. What is a name of insect ?
    Bag 1 Bag 2 Bag 3 Bag 4

24. Which one is damaged by rice leaf rollers?
    Bag 1 Bag 2 Bag 3 Bag 4

25. Which one is brown planthopper?
    Bag 1 Bag 2 Bag 3 Bag 4

26. Do you know what kind of insect that causes the rice shoots dead and easily pulled out?
    a. brown planthopper
    b. rice stem borer
    c. rice army worm
    d. rice leaf roller

27. What and how many groups of insect can you classify?
    a. 2 groups: beneficial insects and enemies
    b. 3 groups: insects with wings, without wings, and with hair
    c. 4 groups: caterpillars, wasps, grasshoppers and butterflies
    d. all incorrect

28. Which kind of root system would be better for rice for better water use efficiency?
    a. shallow
    b. deep
    c. none
    d. both

29 What kind of situation in rice field enhances methane flux?
    a. Waterlogged condition
    b. Dry condition

30. Which of the following gases are responsible for global warming?
    a. Methane
    b. Amonia
    c. Carbon di-oxide
    d. Nitrous di oxide
    e. All
    f. None

31. Which of the following actions by you as a rice farmers could reduce global warming ?
    a. Using water judiciously
    b. Maintaining aerobic condition in rice field
    c. Both
    d. None

Table 1: Pre and Post Ballot Box Tests of the participating farmers

No	Name	Scores (in %)	
		Pre Test	Post Test
1.	Mr. Chamnan Munkong Head of Village	a*	55
2.	Mr. Prasan Kuylhong Head of Village	a	40
3.	Mr. Sangworn Yangsouy	30	70
4.	Mr. Jaroon Tebuiemtat	a	55
5.	Mr. Attaporn Praksen	25	70
6.	Ms. Sripai Sriprasert	30	50
7.	Mr. Pon Thong-On	25	70
8.	Mr. Winai Munkong	35	60
9.	Ms. Sawart Munkong	a	55
10.	Mr. Boontham Kunha	30	60
11.	Mr. Prayad Lheeluan	a	45
12.	Klun Lamoon Maneerat Assistant to	10	45
13.	Ms. Kitiya Sornpan	35	65
14.	Ms. Boonchu Inthorn	30	55
15.	Ms. Chamang Chada	10	50
16.	Mr. Wean Jaidee	30	55
17.	Ms. Preeyaporn Jaitieng	35	70
18.	Ms. Warn Jaicheun	a	55
19.	Mr. Mon Panma	25	a
20.	Mr. Paisarn Sungrit	50	65
21.	Mr. Aer Sawatjun	60	70
22.	Ms. Manop Suansieat	30	55
	Mean	**32.00**	**57.86**
	Std. Error of the means	**2.30**	**1.90**

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Annex 4: Financial Record

Activities			
	$ Total APFED fund	Expenditure	Remarks
Activity 1: Inception Workshop	***2275.***00	***1200.00***	
Activity 2: Baseline Survey	***3900.***00	***3900.00***	
Activity 3: Participatory Problem sensing and analysis using crop calendar	***3550.***00	***3550.00***	
Activity 4: Participatory Trial Development workshop	***3750.***00	***3750.00***	
Activity 5: Participatory Action Research and learning	***10250.***00	***10250.00***	
Activity 6: Weekly farmer's meeting	***8500.***00	***8500.00***	
Activity 7: Mid-season and end-of-season evaluations of farmers. Monitoring and evaluation of project activities	***1800.***00	***1800.00***	
Activity: 8 Data analysis and result preparation	***1500.***00	***1500.00***	
Activity 9: Result-sharing workshop	***3200.***00	***3200.00***	
Activity 10: Farmer meeting (post project implementation)		***500.00***	Additional activity undertaken to access dissemination of project ideas among farmers
Total	***38725 (agreement for 30,00.00 US$ only from APFED)***	***38150.00***	