Increasing Water Use Efficiency by Using Mulch under SRI (System of Rice Intensification) Management Practices in Northeast Thailand

A Challenge Programme for Water and Food (CPWF)-Funded
Small Grant Project No. 504.

Second Progress Report
Participatory Action Research Phase
1ST July to 30TH December 2006

By:

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CGIAR Challenge Program on WATER & FOOD

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List of abbreviations used

AIT	Asian Institute of Technology
cm	Centimetre
CPWF	Challenge Program for Water and Food
DAT	Days after transplanting
DNFE	Department of Non-Formal Education
DOAE	Department of Agriculture Extension
ELC	Experiential Learning Cycle
FAO	Food & Agriculture Organization of the United Nations
FFS	Farmer's Field School
FP	Farmer's practice
Fig.	Figure
GO	Governmental organization
GR	Glutinous rice
kg	Kilogram
LEISA	Low external-input sustainable agriculture
m^3	Cubic meter
NG	Non-glutinous rice
NGO	Non-governmental organization
NPK	Nitrogen, phosphorus and potash
PAR	Participatory Action Research
SRI	System of Rice Intensification
TEF	Thai Education Foundation

Summary

This is the second progress report of the CPWF small grant project 504 covering period of 1 July – 30 December 2006. As proposed, this phase of the project focused on an action research (PAR) phase along with farmer's field school (FFS) activities on aspects affecting water use in rice production. Weekly FFS were conducted for 18 weeks and each week, one or more topics related to water use in rice were discussed with participating farmers and non-formal education trainees. A detailed 16-week curriculum was developed that could be used during the second season of action research work, and also it will be shared with other programs and extension agencies in the Thailand.

On the action research front, systemic field data were collected and analysed for the key indicators as set forth at the time of the proposal. In experiment 1 – where the two water regimes, i.e., just-moist (JM) soil and water management was compared with the farmers' practice of flooding. No significant difference in crop yield was noticed, and JM produced similar rice yield per unit area with less supplementary irrigation. SRI and mung bean combination proved to be the best among all tested bean-intercropping systems, providing high foliage and ground cover as green mulch to the rice crop grown under SRI system of management. However, experiments will be repeated to learn more reliable patterns in the forthcoming season (February 2007 onwards). The report for this phase of work is divided into several headings as follows:

1. Results of wet-season experiments 2006
2. Dissemination of results through mid-term and field day workshop
3. Farmer's Field School on water and biodiversity
4. Participation of farmers in TV filming
5. Participation of farmers in Vientiane forum
6. Work accomplished and future plans

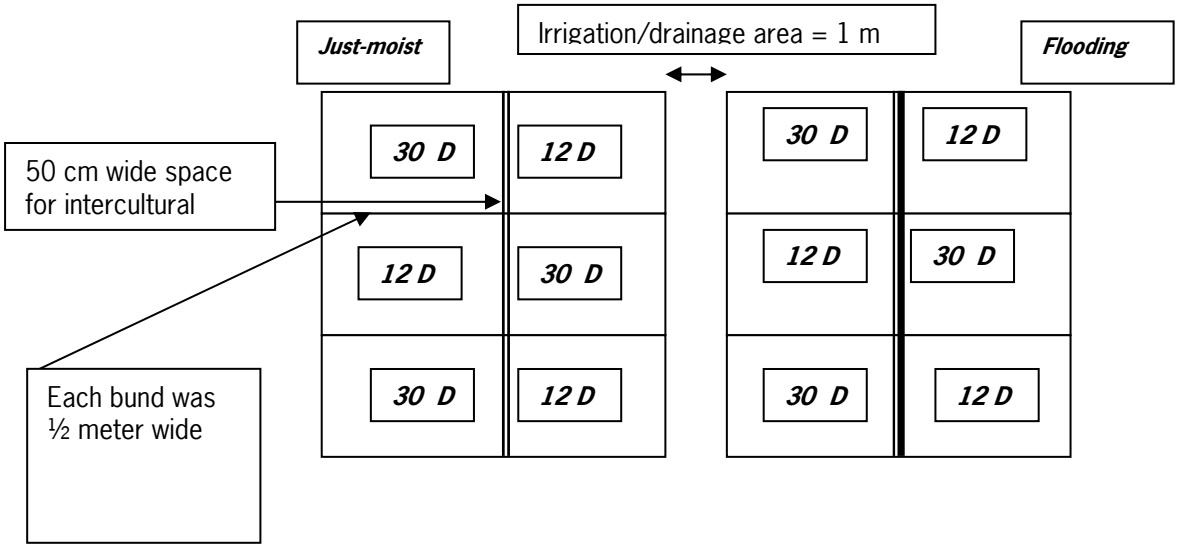
Key words: PAR, CPWF, Roi-Et Province, FFS, Ban Chaeng, AIT, TEF, Water-use efficiency

1. Results of wet-season experiment 2006

1.1 Experiment 1: Participatory Action Research: Effect of Different Water Regimes on Rice Yield under SRI (System of Rice Intensification) vs. Farmer's Management Practices

Background: Two single-factor experiments were conducted in the same large field under each of two moisture regimes (just-moist and flooding). Experiments were carried out as per the following experimental layout. The treatments and field operations followed are detailed in *Table 1*.

Experimental Layout:



Note: 12 D = 12-day-old seedlings grown as per the specification of SRI; 30 D – As per the farmers' practice. Just moist – field kept moist only, not saturated

Table 1: Treatments Details of Experiment 1

Attributes	Just Moist	Flooding (Farmer's Practice)
No. of seedlings/ hill	1 seedling	8 seedlings
Spacing	10 x 15	10 x 15
Irrigation	Just-moist: keep field moist, no standing water. Apply thin layer of water until flowering stage; then shallow water until harvest	As Farmers practice
Fertilizer	Same as per local farmers' practice (total of 50 kg NPK)	Same as per FP
Manure	Same	Same

1.2 Process and key results

The basic idea for this series of experiments stem was to test whether the just-moist and younger seedlings permit reduction of supplementary irrigation? To achieve this under practical farmers' field conditions, the experiment was split into two simple one-factor experiments, wherein on one end of large plot, just-moist experiments were carried out, and at the other end, flooded experiments were carried out. The details of the treatments carried out are listed in *Table 1*.

Fig. 1. The traditional wet-bed system (Pl. note that the roots and shoots of seedlings are clipped, which increases the transplant shock)

Fig. 2. The SRI seed-bed (dry seedbed) which requires much less space, time, and seed. Unlike in the traditional system, it is shorter in duration. Note also that no clipping of roots and shoots was done!

Fig.3. A conventional 30-day-old seedling (left) and SRI seedling (right). Pictures were taken before transplanting.

The experiments were totally different from traditional ideas of the rice cultivation, and some of the major pre-planting differences are highlighted in *Figure 1-3*. Most important were the seedling raising methods, the age of seedling, and the physiology and morphology of seedling at transplanting.

Fig. 4. The field layout of experiments 1 and 2 at early crop stage.
(Note the marked differences between SRI and traditional seedlings)

Fig. 5. Field visits and technical backstopping by AIT team to the experiments

Fig. 6. Field data collection by group of farmers and bumper crop at harvest by the group of farmers and officials

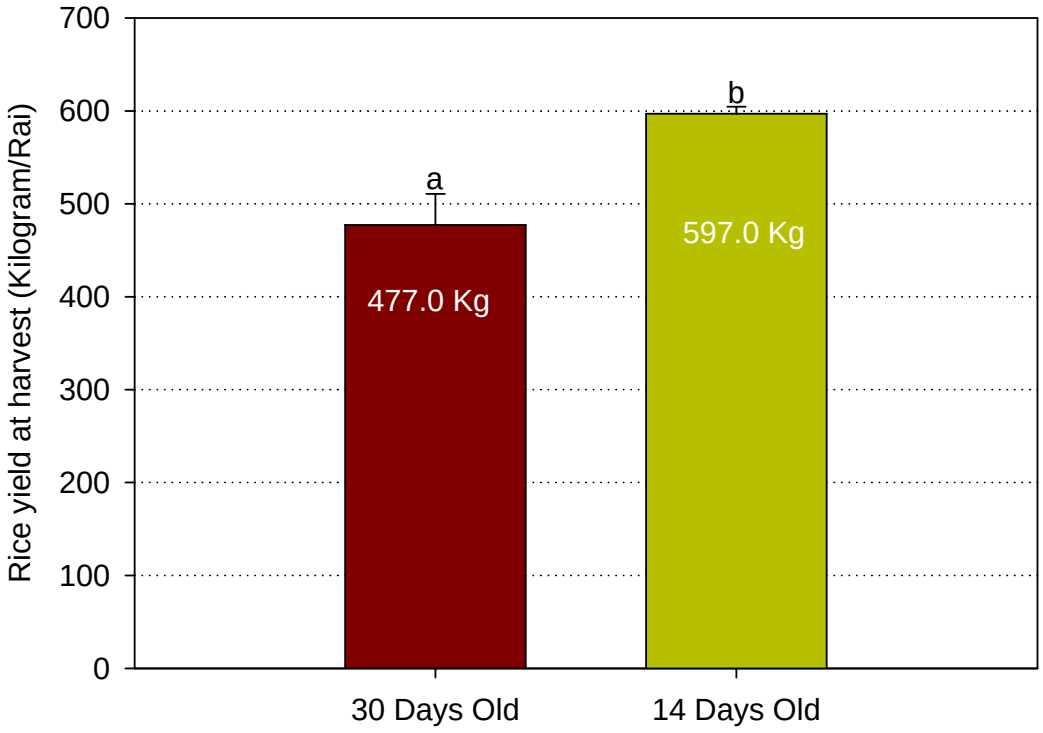


Fig.7. Rice yield per rai under just-moist (JM) conditions. 14-day-old seedlings performed better than 30-day-old seedlings under similar water and other management conditions. Bars sharing same small case letters are not significantly different (F = 12.33; df = 1, 5 ;P <0.0248), (Tukey's test [SAS Institute 1999]).

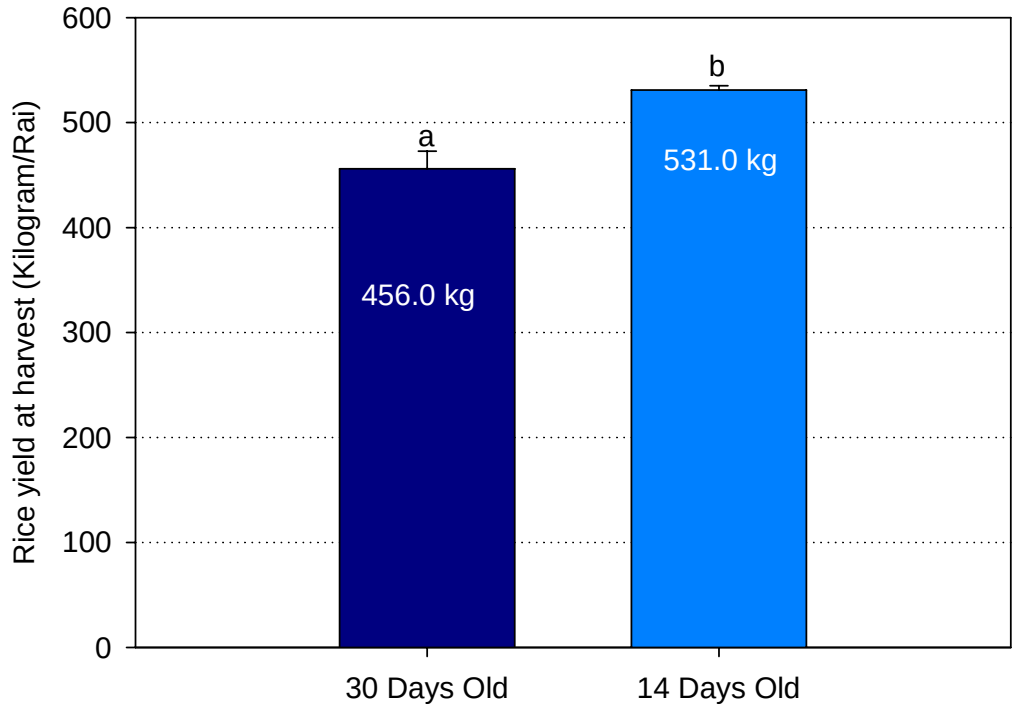


Fig.8. Rice yield per rai under flooding conditions. 14-day-old seedlings performed better than 30-day-old seedlings under similar water and other management conditions. Bars sharing same small case letters are not significantly different (F = 18.33, df = 1, 5, *P* <0.0123), (Tukey's test [SAS Institute 1999]).

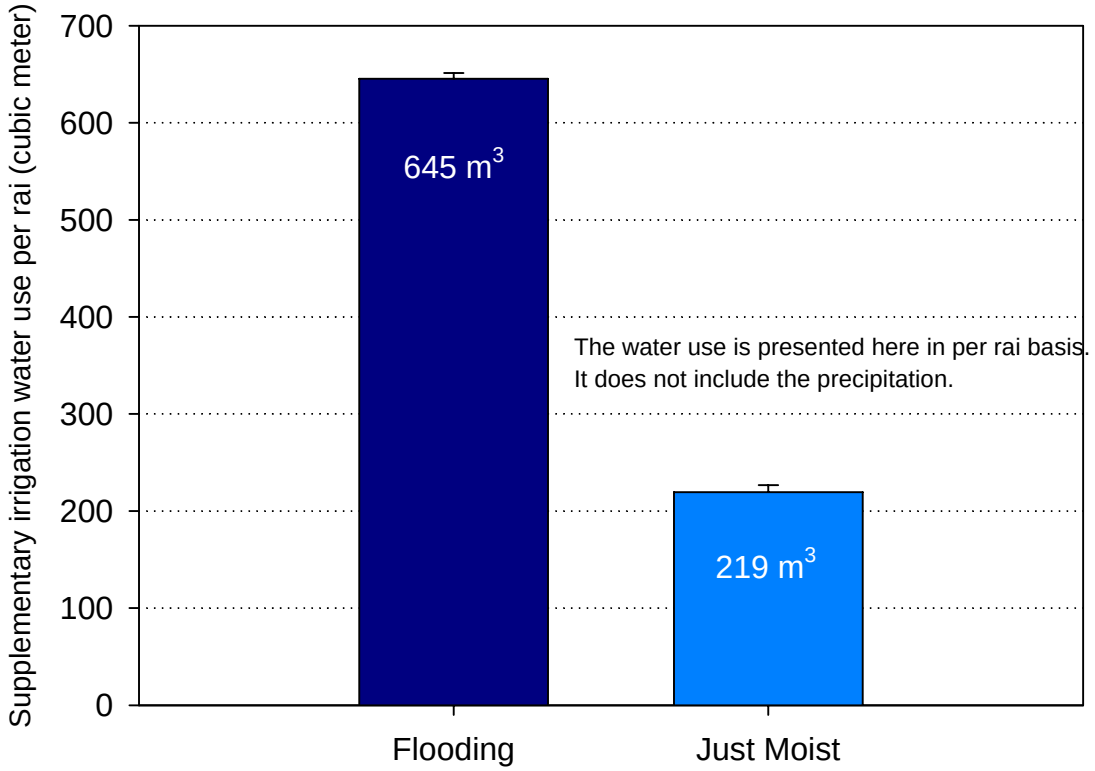


Fig.9. Total volume of supplementary irrigation water used under just-moist and flooded rice cultivation system. Note that this information is compiled to show the difference of water use in two systems of rice: flooding (traditional system) and just-moist (SRI method). No precipitation amount is calculated in this graph, and the amount of water used is calculated on a per-rai basis.

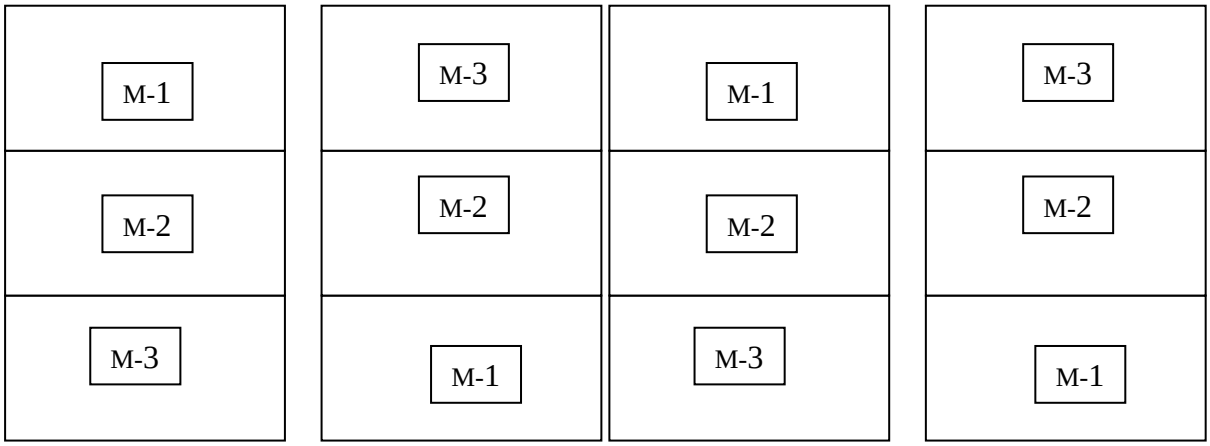
1.3 Conclusion:

Clearly the younger seedlings performed significantly better compared to the traditionally-used 30-day-old seedlings under both moisture regimes, i.e., flooding and just-moist. The yield increases were not many-fold as no additional fertilization was used (*Figs. 7 and 8*). Comparing the water use in both moisture regimes, the amount of supplementary water used in the just-moist system was remarkably less compared to the flooding / traditional rice growing systems (*Fig. 9*). The younger seedlings in just-moist conditions performed better, and even if they give just similar yield level, a significant amount of supplementary irrigation water could be saved. More experiments will be repeated in the coming dry season to learn the trends.

2. Experiment 2: Participatory Action Research on increasing water-use efficiency by using mulch under SRI (System of Rice Intensification) management practices in Northeast Thailand

2.1 Specific Objectives: Single-factor experiments were conducted to compare the relative performances of 3 different green manure crops on the water-use efficiency and yield performance of rice under SRI management

2.2 Experimental Layout:



Where: M1 – Mung Bean; M2 – Cow Pea M3 – Jack bean

2.3 Treatments and experimental details

Table 2: Treatments followed in Experiment 2.

Attributes	*SRI*
No. of seedlings/ hill	1
Spacing (cm)	25 x 25
Irrigation	Just-moist: keep field moist; no standing water; apply thin layer of water until 45 DAT Followed by incorporation of mulch into the soil and then maintain shallow water level (5 cm)
Fertilizer	16-16-8 46:0:0 12.5 kg 16:16:8 as basal dose 8 kg 46:0:0:0 each at 15, 30 and 45 DAT 12. 5 kg 16:16:8 at 60 DAT

Two experiments were conducted by the farmers group, one with a local long-duration variety (KD-6) and another with a short-duration, 90-day variety (Korat-4). Processes followed were similar for both experiments. However, yields obtained, etc., are discussed in separate figures (*Figs. 20 and 21*) in subsequent texts.

2.4 Process and key results

Fig.10. Field layout of the Experiment 2. Fields were ploughed and measured and then treatments were laid out. Farmers took the lead in setting up all the trials.

Fig.11. Data collection on number of grains per panicle by one of the participating farmers, and small chit-chat amidst lush rice field by participating farmers!!

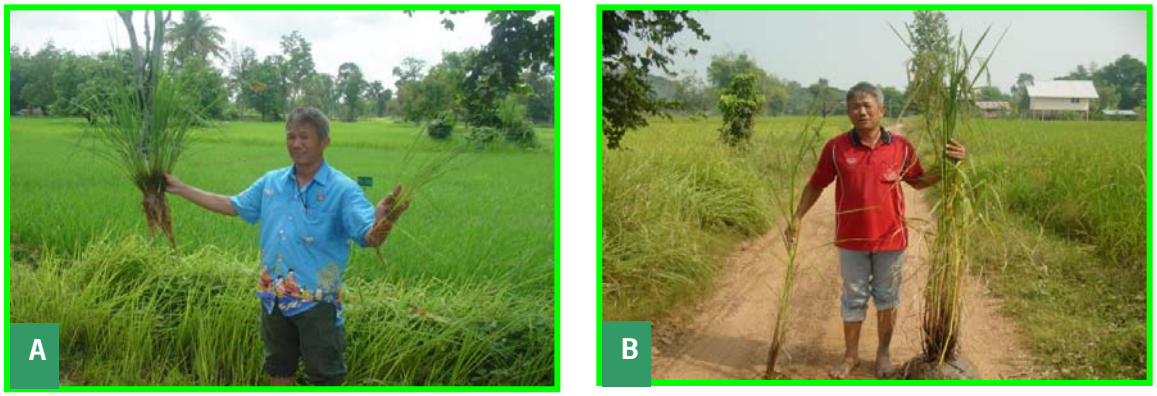


Fig. 12. Bumper crop of rice (RD 6), a traditional sticky-rice variety, as evident in early vegetative stage (A) and later at harvest (B). Picture shows field trainer, Mr. Manop with the results of single transplants at Ban Chaeng, AT Samart, Thailand.

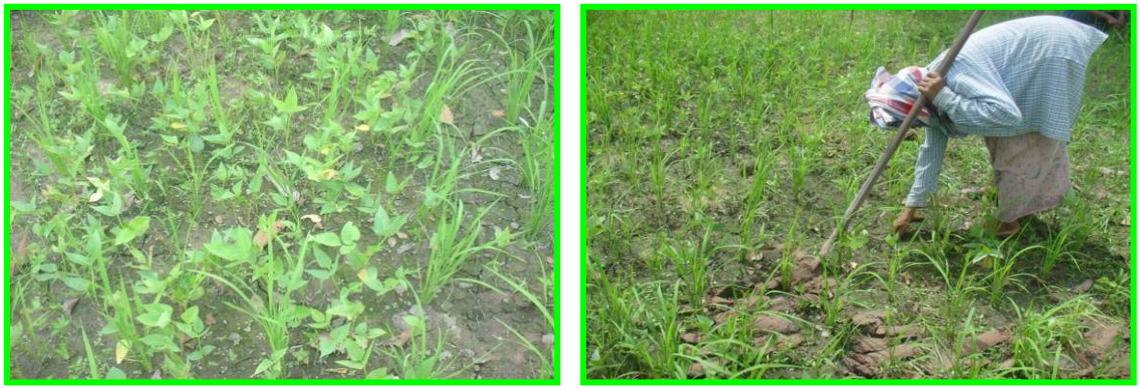


Fig. 13. The SRI rice crops with bean (in this case, mung bean) and method of incorporation of beans into the shallow level of upper soil. Note that mung bean was planted in the inter-row spaces and later incorporated at 35 DAT (days after transplanting)

Fig. 14. Data collection of plant height (over 1.7 meter tall, with no lodging) and other parameters like number of tillers etc. by farmer participants.

Fig. 15. Data collection and observation on grain filling, number of grains, and weight of grains. (Note that rice produced under SRI management produced bolder grains; 1000-grain weight for SRI was 36 grams compared to 32 grams with farmers' practice).

Fig.16. Golden apple snail (*Pomacea canaliculata* (Lamarck) and yellow stem borer (*Scirpophaga incertulas*) (Lepidoptera: Pyralidae) were economically interesting topics that farmers covered in their FFS.

Fig. 17. Crop lodging is a serious problem in traditional rice varieties (A); SRI completely escaped any lodging problem. Similarly white-ear head (B), an insect-related (yellow stem borer) problem, was almost absent in SRI plots.

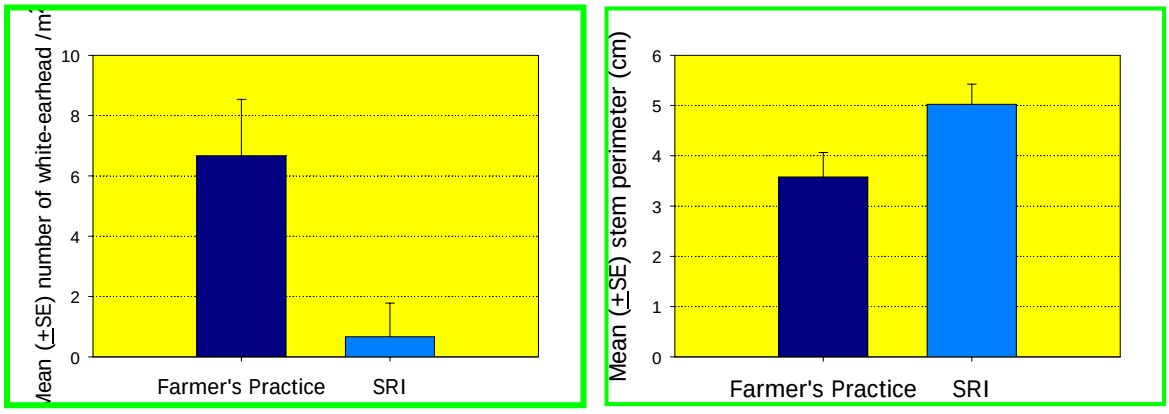


Fig. 18. SRI plots had fewer or nil white-ear head damage and thicker stems, resulting into no lodging of straw, a major problem with traditional rice crop production.

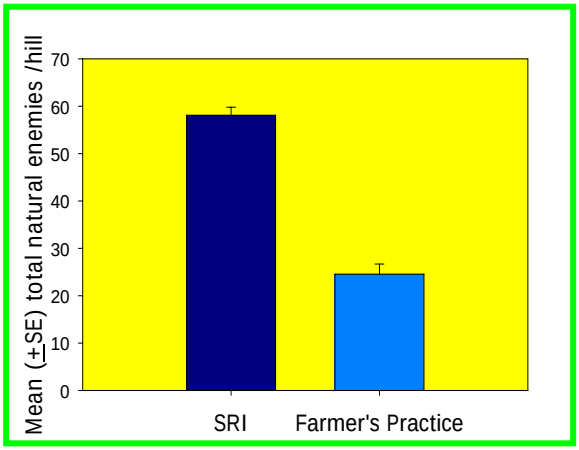


Fig. 19. SRI plots had abundant natural enemies (predators), a possible reason for fewer pest problems. This is an area that needs further investigation.

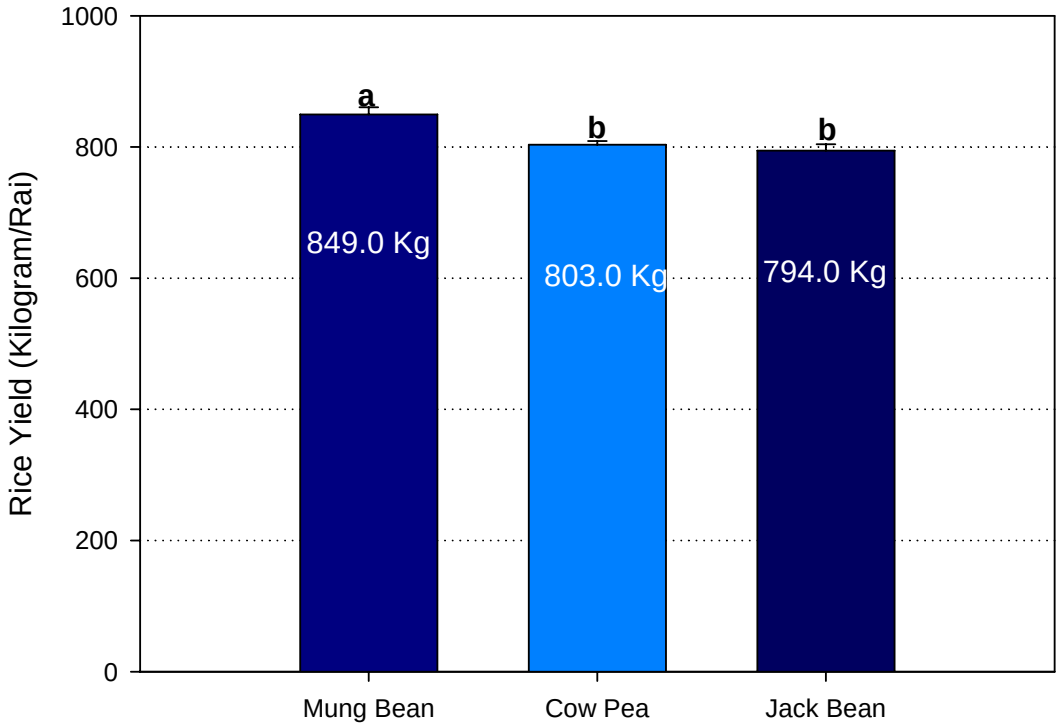


Fig. 20. Yield of rice (KD 6)[1] in kilograms/rai, when grown with intercrop of three local bean species (F = 10.61, df = 1, 11, *P* > 0.001; Tukey's HDS , SAS, 1999).

When the similar experiments were repeated with a short-duration (90-day) rice variety, similar yield increase was noted. However, when these yields were compared with a no-bean situation, no significant differences other than for mung bean were noted. This does not take into account improved soil health and other indirect benefits (*Fig. 21*).

[1] KD 6 is glutinous rice that grows for over 4 months and is photo-sensitive, normally grown during wet season in NE Thailand.

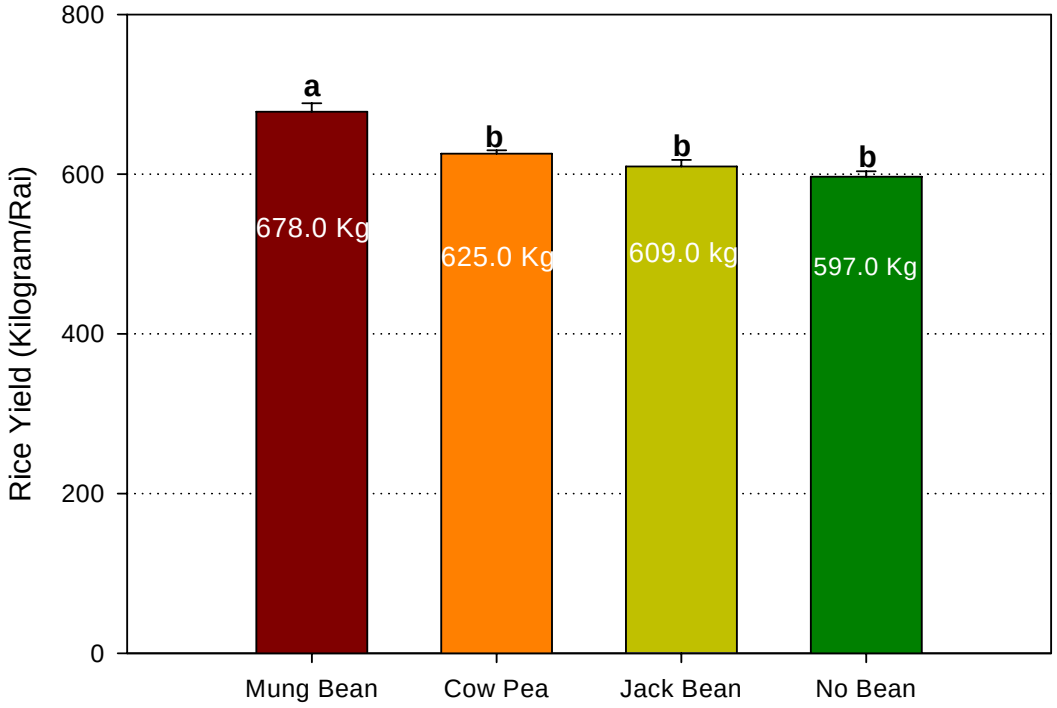


Fig. 21. Yield of rice (Chianat-4) in kilograms/rai, when grown with intercrop of three local bean species (F = 21.02, df = 3, 15, *P* > 0.001; Tukey's HDS , SAS, 1999).

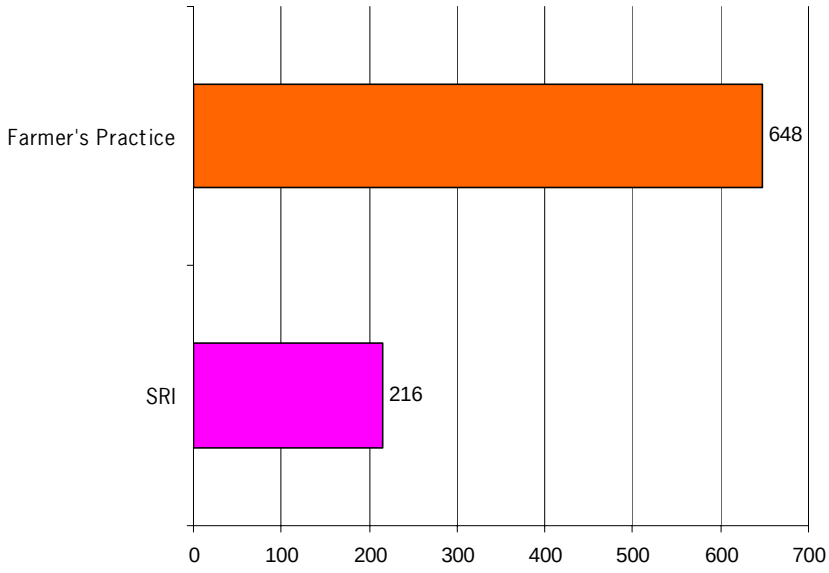


Fig. 22. Water use in SRI and local farmers' practice plots. Data for farmers' practice were calculated from the average water use by participating farmers in their own fields and for SRI from Experiment 2 of this action research.

2.5. Conclusion:

The incorporation of bean in the inter-row space helped to further enhance the rice yield as evident in the second SRI experiment (Fig. 21). When comparing the choice of bean species, mung bean outperformed the other three bean species. This could due to the faster growth rate and easy decomposition of bean biomass over others. Clearly, the SRI management practices provided higher yield and excited the entire community of farmers and officials.

The following key points are based on farmers' observations on the results of the first season of work:

- The supplementary irrigation water use – 216 cubic meters with SRI against 648 cubic meters for traditional practice – could be reduced by more than half;
- Yield increase with SRI was almost double – 450 kg in farmers' practice vs. 849 Kg with long-duration traditional variety and over 650 kg with a 90-day short-duration variety;
- Since no extra cost was incurred in practicing SRI, the economic returns almost increased by double. better and clearer picture will emerge out after repetition of experiment;
- Even a traditional variety like RD 6 gives excellent response to the SRI management practices;
- Weeds posed a serious problem in non-bean plots at early growth stages with SRI, and a range of strategies including use of post-emergence herbicide may be needed in some cases;
- Mung bean provided the best soil cover and gave heavy competition to the germinating/growing weeds;
- Jack bean was not at all suitable as it did not produce enough foliage, and a large quantity of seeds of this bean is hard to obtain.

Box 1: The Beans & Rice

Bean crops are integral part of cropping system for Northern Thai farmers, and these three species were selected by farmers themselves to be used as intercrop with rice:

- Jack bean (*Canavalia ensiformis*), family Papilionaceae
- Cowpea (*Vigna unguiculata*); family: Papilionaceae
- Mung bean (*Vigna radiata* (L.); Family: Fabaceae

Mung bean performed best compared to others, possibly due to easy decomposition ability and more foliage-producing ability.

3. The Extension of the Action Research

3.1 Mid-Season Workshop

As proposed and planned during the beginning of the PAR program, a mid-season workshop was organized to evaluate the performance of the experiments, the FFS, and overall development of the program at Ban Chaeng. It was held 17 August 2006. Present were the all 30 participating farmers, DNFE officials, DNFE trainee and the provincial head of the DNFE. Farmers' group leader of the program presented the data in graphic forms to other groups (see *Fig. 22)*, and guest farmers followed by an open discussion and learning from the exercise so far.

Fig. 23. Some of the data presented by the farmers' group leader on the mid-season evaluation day to the participating farmers and farmers guests (A-D). Lush SRI crop (E); Project leader Prof. V. M. Salokhe with participating farmers (F)

Box 2: Leading questions used during mid-season evaluation workshop.

Following leading questions were used to facilitate the session:

1. What are the major learning experiences from the project activities until now?
2. Which rice cultivation system is performing better, and why?
3. What about use of various agri-inputs in these experiments?
4. What about water use in the two methods?
5. How you assess the weed problems in these two systems?
6. Which weeds are most aggressive?
7. What are the major constraints facing the experiments, and how could we overcome them?
8. Which area of rice problem you would like to focus more on coming days?
9. Any suggestions to improve the overall coordinator, management, and reach of the project to the farmers?

Based on the farmers' discussion and observations, newer topics like golden apple snail management, seed germination testing, weeds and their classification, etc. were incorporated. The mid-term workshop was extremely successful, as the lush growth of rice under SRI management drew a considerable number of farmers, and our participating farmers were only too happy to share what they learned through activities of the project.

3.2 End-of- Season Farmers' Evaluation Workshop

The harvesting of the crop was done in the last week of November, and accordingly a field day was organised on 30 November 2007. Present were the Deputy Governor of the Province, THE head of partner NGO, 100 farmers, DNFE trainees, and local media. List of important person who attended this meet is attached in *Annex-1* and list of attending farmers is in *Annex-2*.

Fig. 24. Opening of the field-day at Ban Chaeng, 30 November 2006. The Deputy Governor of the Roi-Et province opened the day and participated in the crop harvesting.

The farmers' group prepared extensively for the day under overall coordination of the field trainer, Mr. Manop Saiphet. A series of presentations, Agro Ecosystems Analysis (AESA) posters, model of SRI crop, etc. were prepared in close collaboration with the local DNFE. The director DNFE herself was present in each activity of the program.

Fig. 25. The provincial head of the Department of Non Formal Education with Thai posters about the project (A); and a model of SRI and conventional rice display (B) during the field day

Fig. 26. Display on the water-holding capacity and mineral translocation simulation studies recreated by participating farmers for the field day.

A ceremonial crop–cut of 1 meter square was performed, and respective yields for SRI and farmers' practice were calculated in full public presence and view. Later, the grain harvested was weighed, and average yields per rai were calculated. SRI yield was over 850 Kg /rai, almost double in comparison with the traditional rice yields in the village, causing great excitement among farmers. The most striking features of SRI that attracted the scores of farmers were the low water use, no change in agri-input use, and higher yield with a traditional rice variety, which otherwise is highly prone to lodging problem.

Fig. 27. Deputy Governor observing displays and weekly FFS AESA posters during the field day, led by field trainer Mr. Manop Saiphet, the Thai Education Foundation, our partner NGO, and local DNFE officials

Fig. 28. The crop cut ceremony. Present were farmer participants, the deputy governor, NGO head, and invited farmers

Fig. 29. The final data from the experiments were presented and discussed with farmers. Also work plans for the next season of experiment were developed

4. The farmers' field school (FFS) on water and biodiversity

As planned and proposed earlier in the first report; a 16-week-long weekly farmers' field school was organised in conjunction with the action research in the same village. A total of 30 women and men rice farmers participated in the FFS. The detailed curriculum developed (*Annex- 3*) was used in the FFS. The basic idea stemmed from the fact that 'water use for rice' is too complex a subject to be dealt with in an action-research platform; interaction time needed to discuss the various aspects of crop growth and soil system dynamics were greatly enhanced as every week, 4-5 hours were spent discussing various technical and other topics with farmers.

A pre and post ballot box test was conducted to evaluate the change in knowledge level of the farmers (see *Annex 4* for detail individual scores), and most farmers improved their understanding on various topics for which tests were conducted. For details on this, see the earlier report. The details of marks obtained by farmers are attached in *Annex 3*. A list of NEF participants who completed their training with the program is attached in *Annex 5*.

Fig.30. Farmer group in FFS: (A) drawing AESA posters, (B) presenting AESA to the group

Fig.31. Farmer group in FFS: (A) individual record-keeping, (B) drawing AESA posters

For example, weed ecology and management was one of the major topics at an early FFS as weeds are a major yield constraint, and participating farmers first identified the weed species present in their rice field and then discussed how to manage them.

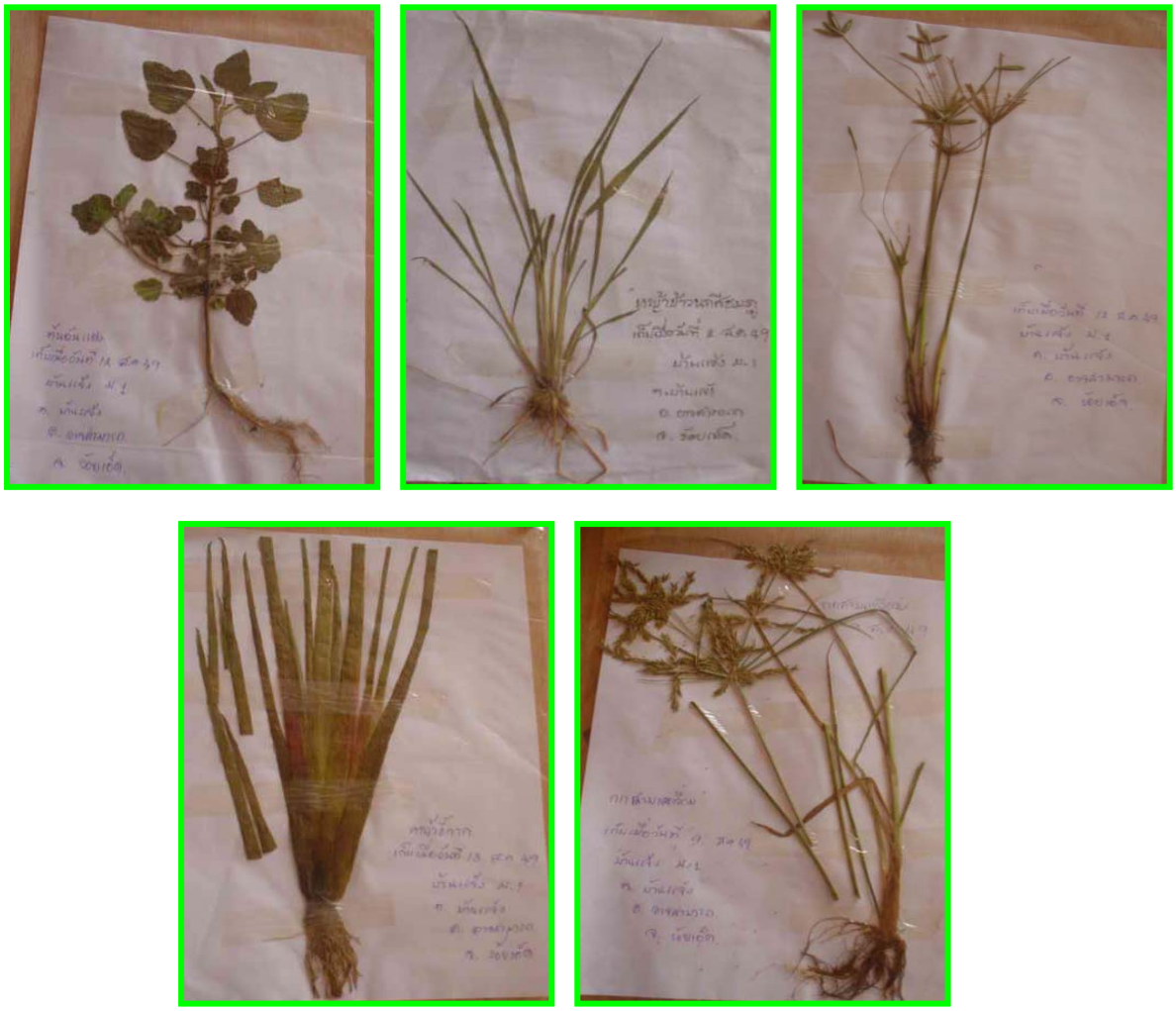


Fig.32. Some of the common weeds prepared by farmers for FFS herb arium for identification purposes.

Fig. 33. Comparison of the growth and development of rice in FFS.
Project was presented by the local DNFE to the then-PM of Thailand

4.1 Conclusion of the FFS activities

One of the major outputs of the FFS was that it resulted in a detail curricula for any future FFS on the topic besides training 10 persons from DNFE on the process and tools. This curriculum would be widely shared with other like-minded project and extension agencies for future training of farmers on these issues.

For the second season of action research and other possible FFS, efforts are underway to secure more funds to further spread the benefits of this project work in NE Thailand and elsewhere in the Mekong region.

5. TV Filming and Participation of the Farmers

The project farmers and their collaborators in Roi-Et Province hosted a TV film crew from the CPWF for their workshop and other extension work coinciding with the mid-term evaluation of the FFS on 17 August 2007. Project farmers and collaborating departments right from the Provincial Governor down to the village head enthusiastically supported the filming.

Fig. 34. Filming of project activities in Ban Chaeng, Roi-Et. Seen are the Governor, Project Leader Prof. Salokhe, farmers and others.

6. Project Farmer Participation in the "International Forum on Water and Food," held in Vientiane, Lao PDR, November 12 – 17, 2006

A group of 8 project farmers along with translator and field trainer participated in the IFWF for the period of 2 days of sessions. The farmers participated in two sessions of the workshop, namely, 'The Future of Irrigation' and 'Matching Land-Use Ecologies.' They enriched the horizon of discussion at the workshop by putting forward farmers' perspectives. Clearly, there was interest among the farmers group in learning new and better land and water improvement ideas – as they had spent the previous 4 months discussing soil and water in greater depth.

The farmers' group displayed their posters, some from previous sessions of the FFS, and some fresh ones that they prepared for the Forum. They also brought along with them a huge SRI-grown rice plant for display purpose.

Fig. 35. On left, Prof. V. M. Salohke (on right) with workshop participants; on right, Prof. Norman Uphoff, Cornell, center, with a SRI-grown rice plant and participating farmers

Fig. 36. Farmers at IFWF in Laos showing their posters and enjoying group discussions

7. Major Project Activities Accomplished & Future Plans

The project activities began in March 2006. In April and May, several preparatory activities were undertaken so as to start the PAR experiments in the main wet season. Following a full season of action research trials, the crop was harvested on the last week of November 2006.

Table 3: List of Activities undertaken (1 March – 30 December 2006) by the AIT-TEF for the CPWF Project

Sl.	Activity	Date	Remarks
1.	Project proposal to CPWF	October 2005	
2.	Revisions and negotiations with CPWF	Nov 05 – January 2006	
3.	Funding available	March 2006	
4.	Project operation consultation meeting	March 2006	AIT and TEF
5.	Preliminary consultation with farmers	March 2006	
6.	Field office set-up and appointment of field officer form TEF	March 2006	
7.	Informal exchanges and selection of village	April 06	
8.	Baseline survey, crop-calendar development	April 06	
9.	Inception meeting	May 06	
10.	Baseline information analysis, crop-calendar preparation, presentation, re-validation of information, and cause-effect analysis		
11.	Pre-PAR Ballot Box test		
12.	Development of the PAR design and seedling raising for farmers' practice	May-June 06	
13.	SRI seed bed establishment	June 06 (2ND June)	
14.	Transplanting and opening day for the PAR	15-18 June 06	
15.	First FFS day	28 June	
16.	Weekly FFS meetings (14 weeks)	4 FFS /month	
17.	PAR data collection & backstopping	July – Nov.	
18.	Mid-season PAR and FFS evaluation	September 06	
19.	All data collection, entry and analysis (statistically as well as for farmers)	October 06	
20.	Organisation and preparation or the final field	November 06	

	day		
21.	End-of-season field day	November 06	
22.	Planning for the next season	November 06	December 2006
23.	Report to CPWF	Mid December 06	Jan 2007

For the coming months of the project, the following major activities are planned:

1. Second season of experiments (Mid Feb- June 2007)
2. Data analysis and reporting – July 2007
3. Final workshop – September 2007

Acknowledgements

The project partners, farmers and others associated acknowledge the brilliant technical support from Ms. Abha Mishra (abha_rau@yahoo.co.in) , PhD student, Agriculture Systems and Engineering Field of Study, School of Environment Resource and Development, Asian Institute of Technology, Bangkok, Thailand. Ms. Mishra supported the project since, project writing phase by contributing towards the technical theme and later towards the development of the technical parts of the action research, data collection and ideas on analysis and presentation. She has helped the trainers and other resource persons engaged in this research to understand the rice science in relation to the SRI and water productivity.

Annexes

Annex 1. List of some attendees for the Field Day Ceremony, 30 November 2006

Sl.	*Name*	*Position*
1.	Mr. Nophon Chanthrathong	Governor, Roi Et Province
2.	Mr. Somkiat Ratanametathon	At Samart District governor
3.	Ms. Wilawan Sonsin	Director of provincial NFE Office
4.	Mr. Pinit Yutikarn	Director of At Samart NFE Office
5.	Mr. Chalermchai Chanwichit	At Samart District Developer
6.	Mr. Somporn Kiangsri	Representative from At Samart Agriculture Office
7.	Mr. Kampad Pimchaisri	Head of Tambol* Administration Office
8.	Mr. Boonchu Boriboon	Head of Tambol* Banchaeng
9.	Mr. Tawee Chaisit	Head of village (Moo) 2
10	Mr. Prapat Khankhaeng	Head of village (Moo) 3
11	Mr. Prasit Koteboonmee	Head of village (Moo) 4
12	Mr. Charoen Srisongkram	Head of village (Moo) 5
13	Mr. Chalee Maiwan	Head of village (Moo) 6
14	Mr. Boonriang Moonmanat	Head of village (Moo) 7
15	Mr. Tongdee Wongchampa	Head of village (Moo) 8
16	Mr. Likhit Wacharakawisin	Head of village (Moo) 9
17	Mr. Marut Jatikit	Thai Education Foundation
18	Dr. Prabhat Kumar	AIT

The AIT-Thai Ed Project Team for CPWF Project Work

Sl.	Person	Organisation	Address
1.	Prof. V. M. Salokhe Project Leader, Lead Institution	Asian Institute of Technology	Professor & Coordinator Agricultural Systems and Engineering FOS School of Environment, Resources & Development Postal Address: Klong Lunag, PO Box – 4; Pathumthani 12120, Thailand Email: salokhe@ait.ac.th Telephone number: : +66-2-524-5479 Mobile: +6618330209
2.	Dr. Prabhat Kumar Research Specialist	Asian Institute of Technology	Agricultural Systems and Engineering FOS School of Environment, Resources & Development Postal Address: Klong Lunag, PO Box – 4; Pathumthani 12120, Thailand Email: pkipm@ait.ac.th Telephone number: : +66-2-524-5477 Mobile: +6660978283
3.	Mr. Marut Jatiket Director Partner Organisation	Thai Education Foundation	Postal Address: 28, Piboonwattana 7; Rama VI Road, Samsen-nai, Phayathai, Bangkok 10400 Email: thaied@inet.co.th Telephone number: (land line and mobile):+66-2-279-1381, 618-6694 Fax - +66-2-811-9644
4.	Mr. Manop Saiphet Farmers' Trainer	Thai Education Foundation	Field Office for the CPWF Project c/o At Samart District Non-Formal Education Office, At Samart, Roi-Et Province Mobile: +6662370150 Email: saiphet_manop@hotmail.com
5.	Mr. Aroon Jitsamorn Lecturer (Translator between Thai and English)	Thai Education Foundation	C/o Thai Education Foundation 28, Piboonwattana 7; Rama VI Road, Samsen-nai, Phayathai, Bangkok 10400 Email: frogfoxen@yahoo.com Mobile: +6646199196

Annex 2. List of Participating Farmers on Field Day

Sl	Name	Age	Education	Address
1	Mr. Charoen Boonchan	60	Grade 4	18 Moo 1, BanChaeng
2	Mr. Sunee Teehuatone	67	Grade 4	15 Moo 1, BanChaeng
3	Mr. Satit Wongchandaeng	42	Diploma	17 Moo 1, BanChaeng
4	Mr. Sing Suksamer	64	Grade 4	7 Moo 1, BanChaeng
5	Mr. Yian Boriboon	56	Grade 4	118 Moo 1, BanChaeng
6	Mr Prapong Srinonyang	55	Grade 6	58 Moo 1, BanChaeng
7	Mr. Prapat Noibudee	37	Grade 9	157 Moo 1, BanChaeng
8	Mr. Serin Wongchandaeng	65	Grade 4	100 Moo 1, BanChaeng
9	Mr.Buddee Promsorn	64	Grade 4	104 Moo 1, BanChaeng
10	Mr. Chaowalit Thongsit	36	Grade 6	21 Moo 1, BanChaeng
11	Mr. Samarn Sarayota	47	Grade 4	93 Moo 1, BanChaeng
12	Mr. Wasana Wongchandaeng	58	Grade 4	72 Moo 1, BanChaeng
13	Mr. Amnuay Silpaksa	60	Grade 4	119 Moo 1, BanChaeng
14	Mr. Uaychai Saket	35	Grade 9	11 Moo 1, BanChaeng
15	Mr. Kaew Wandee	69	Grade 4	39 Moo 1, BanChaeng
16	Mr. Moon Khankhaeng	62	Grade 4	70 Moo 1, BanChaeng
17	Mr. Somwang Potong	52	Grade 4	50 Moo 1, BanChaeng
18	Mrs. Fuangfa Promsopa	42	Grade 4	98 Moo 1, BanChaeng
19	Mrs. Supee Pimpan	51	Grade 4	52 Moo 1, BanChaeng
20	Mrs. Sommart Supeekam	56	Grade 4	85 Moo 1, BanChaeng
21	Mrs. Bubpha Yatsamrong	45	Grade 4	130 Moo 1, BanChaeng
22	Mrs. Boonpeng Muangkudrua	38	Grade 6	3 Moo 1, BanChaeng
23	Mrs. Suchitra Suksamer	42	Grade 6	88 Moo 1, BanChaeng
24	Mrs. Dao Prommongkon	33	Grade 6	140 Moo 1, BanChaeng
25	Mrs. Boonmee Wongchandaeng	47	Grade 4	68 Moo 1, BanChaeng
26	Mrs. Somporn Saengsisom	58	Grade 4	122 Moo 1, BanChaeng
27	Mrs. Thongda Khunhom	53	Grade 4	66 Moo 1, BanChaeng
28	Mrs. Puttra Boriboon	47	Grade 6	113 Moo 1, BanChaeng
29	Mrs. Noo Khunhom	59	Grade 4	97 Moo 1, BanChaeng
30	Mrs. Wan Titapornma	50	Grade 4	91 Moo 1, BanChaeng

31	Mrs. La-iad Silpaksa	51	Grade 4	119 Moo 1, BanChaeng

Annex 3: Selected Contents of Rice Biodiversity-Based FFS Curricula used in Ban Chaeng, Roi-Et Farmer Field School

Topics	Objectives	Contents	Ban Chaeng PAR
Rice Morphology & Physiology	-To understand the rice plant morphology throughout the rice plant's life cycle -To Identify elements of the rice plant's physiology -To understand the relationship of the rice plant's physiology and the other components in the rice field ecology	-Rice plant physiology -Elements of rice plant's physiology -Relationships of rice plant's physiology and the other components in the rice field ecology	-Study rice plant morphology -Study relationship among components of rice field ecology
Soil & Soil Management	-To understand attributes of soil quality -To understand the role & function of soil in the rice field -To understand the meaning & function of living soil -To be able to improve soil quality to more appropriate to grow rice	-Soil quality -Role & function of soil in the rice field -Living soil -Soil nutrients -Soil management	-Study role and function of soil in the rice field -Study living soil -Study function and soil for rice plant morphology
Water & Water Management	-To understand role and function of water in the rice field -To manage water levels appropriately in the rice field	-Role and function of water in the rice field -Water management	-Study role and function of water in the rice field - water cycle - Role of small ponds - Mulches and their role - Green and other mulches
Plant Nutrients & Fertilizer	-To understand the importance of plant nutrients -To understand the different types of fertilizer containing different nutrient elements that have different effects on plant growth & soil structure -To understand the role and function of nutrients for the rice plant and rice field ecology -To be able to know and apply the right kind and amount of fertilizer needed by the rice plant	-Plant nutrients -Role and function of plant nutrients -Kind amount of fertilizer needed by rice plant -Fertilizer application - Organic manures and possibly sources of it. - Methods of composting	-Study the importance of plant nutrients -Study the role and function of plant nutrients -Study the kind and amount of fertilizer needed by the rice plant - Study of methods of composting
Rice Biodiversity and Pest Management	- To understand functional biodiversity in the SRI and farmers' rice field - To understand the insect-biodiversity in the rice /SRI rice ecosystem - To understand biology and management aspects of key pests, e.g. army worm, stem borer, golden apple snails, rice bug, etc. - To understand weed flora in the rice field		- Study of biodiversity dynamics in weekly Agro-ecosystem Analysis - Insects-zoo and other small studies to strengthen the individual knowledge - Study of occurrences and densities of the common weeds - Weed management - Insect-pest management

Annex 4 : Pre- and Post-PAR Ballot Box Test Scores of the Farmers

Sl.	Name of the farmers	Pre-PAR Ballot Box Test Score (%)	Post-PAR Ballot Box Test Score (%)	Difference (+)
1	Mr. Charoen Boonchan	32	67	35
2	Mr. Sunee Teehuatone	32	56	24
3	Mr. Kammee Suksamer	48	78	30
4	Mr. Sing Suksamer	40	87	47
5	Mr. Narong Wongchandaeng	28	45	17
6	Mr. Chatree Kaentao	56	67	11
7	Mr. Prakaad Noibuddee	68	78	10
8	Mr. Serin Wongchandaeng	48	87	39
9	Mr. Buddee Promsorn	40	78	38
10	Mr. Wichian Wongchandaeng	44	67	23
11	Mr. Wasana Wongchandaeng	36	89	53
12	Mr. Amnuay Silpaksa	32	87	55
13	Mr. Uaychai Saket	40	67	27
14	Mr. Kaew Wandee	32	87	55
15	Mr. Moon Khan khaeng	40	89	49
16	Mr. Somwang Pothong	36	90	54
17	Mrs. Fuangfa Promsopa	52	84	32
18	Mrs. Supee Pimpan	32	89	57
19	Mrs. Sommart Supeekam	40	90	50
20	Mrs. Boonpeng Muangkudrua	52	95	43

21	Mrs. Suchitra Suksamer	60	90	30
22	Mrs. Dao Prommongkol	64	94	30
23	Mrs. Ery Supeekam	32	87	55
24	Mrs. Somporn Saengseesom	48	89	41
25	Mrs. Tongda Khunhom	44	78	34
26	Mrs. Puttra Boriboon	80	87	7
27	Mrs. La-iad Silpaksa	36	87	51

Annex 5: List of DNFE Farmer-Trainers Who Completed their Training with PAR Project on FFS on Water and Biodiversity

Sl	Name	Age	Education	Address
1	Mr. Charoen Boonchan	60	Grade 4	18 Moo 1, Ban Chaeng
2	Mr Prapong Srinonyang	55	Grade 6	58 Moo 1, Ban Chaeng
3	Mr. Prapat Noibudee	37	Grade 9	157 Moo 1, Ban Chaeng
4	Mr. Wasana Wongchandaeng	58	Grade 4	72 Moo 1, Ban Chaeng
5	Mrs. Boonpeng Muangkudrua	38	Grade 6	3 Moo 1, Ban Chaeng
6	Mrs. Boonmee Wongchandaeng	47	Grade 4	68 Moo 1, Ban Chaeng
7	Mrs. Puttra Boriboon	47	Grade 6	113 Moo 1, Ban Chaeng