Technology Intervention and Policy Impact for Disaster Risk Reduction to Withstand Problems Associated with Climate Change and Aggravated by Human Intervention in Paddy Ecosystems Downstream of the Nilwala River in Southern Sri Lanka

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Project Summary

Background: Pilot studies were conducted in 2014 in the Ambagahawela paddy track upstream of the Nilwala basin in southern Sri Lanka in an ecosystem degraded by man-made structures for flood protection. This was an extension of a project implemented since 2012 by the University of Ruhuna and University of Peradeniya with the Asian Disaster Preparedness Center (ADPC) in the adjacent Kahaduwa track downstream. The aim of the project was to build the resilience of farmer communities to withstand weather/climate associated risks by introducing appropriate technology and livelihood options.

Methods: A local management committee with representatives of all stakeholders was formed to execute and monitor the project for policy impact, and a field center was established. Measurements of daily rainfall, temperature, and relative humidity were

combined with climate data from the University of Ruhuna Agriculture Faculty's meteorological station to assess the climate's potential to mitigate risks linked to agricultural practices. Farmers in three model sites were trained in technologies to enhance the protective functions of the Nilwala paddy ecosystem to withstand climate change-related hazards. These technologies included mulching, a parachute method of plant establishment, and paddy transplanting. First aid demonstrations were done with the Sri Lanka Red Cross Society Matara.

Results: Adjustment of cropping dates, use of different varieties, new plant establishment methods, appropriate solutions for irrigation during dry spells, water saving, and weed management through mulching yielded promising results. If each farmer could keep about 25–100 square meter plots under mulch, he could produce 25–70 kg of seed paddy to meet his individual needs. If technologies are incorporated to meet climate fluctuations, rice yields could increase by up to 5 tons/hectare.

Conclusions: Establishing a field research and demonstration center at problem sites was an effective model for active community interaction. It improved student-centered teaching, research, and learning and decision and policy making for technology adoption, testing, demonstration, and extension. The farmers were able to discuss problems among themselves and with officials from the Irrigation Department at the management committee meeting to find solutions. The main lesson of the project was that "transparency is an advocacy method for further replication."

1 Introduction

Pilot studies were carried out at Ambagahawela tract of the Nilwala River basin in southern Sri Lanka, beginning in April 2014 as an extension and continuation of an ongoing project implemented by the University of Peradeniya and University of Ruhuna with ADPCin Kahaduwa tract, Malimboda area. The ecosystem of the basin is continually subjected to disasters associated with coastal hazards such as sea water intrusion, floods, and dry spells. The basin is also threatened by human activities such as sand mining, large-scale extraction of irrigation and drinking water, industrial pollution, and man-made structures for urban flood protection.

Since 2012, the University of Ruhuna and University of Peradeniya have implemented a project with the ADPC in the Kahaduwa paddy track downstream of the Nilwala River basin. This study aimed to identify communities with similar problems to build their resilience to weather/climate associated by introducing appropriate technology and livelihood options. The Ambagahawela tract upstream was selected for the pilot.

The experience at the pilot sites in the Nilwala basin was simultaneously tested in the lower Mekong Delta in a pilot site in Tra Noc Province. Vietnam along with Can Tho University, regional political and administrative leaders, the Sub-institute of Hydro-Meteorology and Environment of South Vietnam (SIHYMET), the Institute of Meteorology, Hydrology and Environment (IMHEN), and relevant ministries.

2 Project Outputs and Outcomes

The project established a field research and demonstration center at problem sites. This was an effective model for active community interaction. It improved student-centered teaching, research, and learning and decision and policy making for technology adoption, testing, demonstration, and extension. Adjustment of cropping dates, use of different varieties, new plant establishment methods, appropriate solutions for irrigation during dry spells, water saving, and weed management through mulching yielded promising results.

The project showed the validity of the proper discussion forum and action through dialogue to reach win-win solutions to conflicts. The farmers learned to discuss problems among themselves and with officials from the Irrigation Department at the management committee meeting to find solutions. The main lesson learned from the project was that "transparency is an advocacy method for further replication."

3 How Did You Go about Achieving Your Outputs/Outcomes?

A field center was established in the site to facilitate the work. A questionnaire-based socio-economic survey of about 32 farmers and a brainstorming session were used to identify the problems and socio-economic situation of the Ambagahawela track. The brainstorming session was followed by a field visit with stakeholders to identify and catalogue problems and threats incurred in the area. The project studied farming systems, seasonality changes,

traditional farming practices, and current obstacles to those practices to understand the challenges faced by the farmers.

The project adapted the farming systems research and development (Collinson, 1984, 2000; FAO 2000) and participatory approach (Gonsalves et al., 2005) to link stakeholder institutions and farmer communities to an innovation system. Available literature was reviewed to assess historical changes on the ecosystems.

For climate analysis, the project used application data from the past 62 years (1950–2012) from the Agriculture Faculty's meteorological station in Mapalana. Equipment was installed in the field center to measure daily rainfall, temperature, and relative humidity to assess the climate's potential to mitigate the risk links to agricultural practices. Brainstorming sessions on climate change were held with farmers and officials to understand the local agricultural problems.

A local management and monitoring committe had already been formed for the initial study with AusAID and the ADPC. For the Kahaduwa pilot study, the committee was strengthened by adding a representative from the Sri Lanka Red Cross Society (SLRCS) Matara. This committee acted as the apex body to execute and monitor the project and its impact on policy formation. It was chaired by the Matara District Secretary, the administrative head of the Nilwala Basin, and included representatives of the University of Ruhuna; the Departments of Agriculture, Agrarian Services, and Irrigation; the Environmental Authority; the Disaster Management Center; the Meteorological Department; farmer organizations; and non-governmental organizations [NGOs]). Two management committee meetings were held, and decisions were made with other stakeholders on crop establishment dates. The management committee helped broker compromises between farmers, government departments, and farmer organizations.

Three farmer training programs and one 3-day stakeholder training were conducted for government officers and SLRCS Matara representatives on practices to address climate soil and social problems. The training workshops were on "Cultivation and Agronomic Practices of Rice," "Suitable Rice Varieties for the Wet Zone," and "Pest, Disease, and Weed Management for Rice." The SLRCS Matara also conducted first aid demonstrations for the farmers from the pilot sites.

Field Trials

A field trial called "Impact of Mulch and Plant Establishment Methods on Growth Development and Yield of Two Rice Varieties (New Variety Bg 357 and At362)" was conducted during the Yala (minor) growing season. An observational trial called "Performance Evaluation of Traditional Mawee and Improved Rice Varieties" was in progress at the time of this report. In three model sites with three farmers, the project demonstrated and tested technologies to enhance the protective functions of the Nilwala paddy ecosystem to withstand climate risks. These technologies included mulching, the parachute method of plant establishment, and paddy transplanting.

The field work continued until February 2015 because the Maha cropping season was delayed until the end of November 2014. The project wishes to continue the activities until April 2015 to monitor the results of the Maha planting. Once the final results are collected, a national dissemination conference will be held. The conference material will be printed and disseminated.

4 What Did You Learn?

Based on 30 farmer samples, it was established that the sector has both flood- protected and unprotected paddy fields. In the protected area, farmers cultivate rice in both the Yala and Maha cropping seasons. Most of the farmers cultivate the At 362 rice variety, and their average yield in the Yala season is around 2.8 tons/hectare (ha). Their total expenditure per hectare is Rs. 84,653. When selling at a rate of 50 Rs/kg, the farmers' total income is Rs. 140,000, which makes a profit of about Rs. 55,347/ha. If technologies are incorporated to meet climate fluctuations, the yield could increase by up to 5 tons/ha. In the unprotected area, farmers cultivate the traditional *mawee* photo-sensitive variety rice variety only in the Maha season. Cultivation is done in July and harvesting in February.

In the Maha season of 2014–2015, farmers received assistance to produce their seed paddy using polythene mulch. Because mulch controls 100% of weeds, mulching is a promising technology for seed paddy production. If each farmer could keep about 25–100 square meter plots under mulch, he could produce 25–70 kg of seed paddy to meet his individual needs.

Rice variety At 362 performed better under farmer conditions than the BW variety during the Yala season in terms of plant growth, development, and yield. The average yield of At 362 under experimental conditions was 7.43 tons/ha, with polythene mulch and 5.76 tons/hectare without mulch, which is nearly a 29% yield increment. Furthermore, the average dry matter content of weeds without mulch reaches about 0.7 tons/ha, which contributes to heavy contamination of paddy seeds with weeds, affecting farmers' seed paddy production. The yield of the BW variety was lower on average by about 1.67 tons/ha than that of At 362 when grown under mulch. At 362 is therefore recommended for the farmers in the pilot site. As seed broadcasting and transplanting will not significantly improve yields, seed broadcasting is recommended. However, specific low-lying fields with boggy soils require transplanting and the parachute method of planting to overcome problems associated with deep submergence.

5 Immediate Impact

The community-led farming practices carried out in the field with academic advice helped build the confidence of the farmers, develop community ownership, and empower the community with a new set of sound practices and technical solutions. The project team was able to link with different institutions to build the capacity of officials and farmers to apply proven technologies without project support.

The Hyogo Framework for Action (HFA) has provided an opportunity for the academic and scientific communities to explore how scientific approaches can be presented to farmer societies in a simplified and meaningful way. The project's contribution to the HFA was the field demonstration of disaster risk reduction (DRR) applications and introduction of sustainable cost-effective solutions to current problems with the possibility of replication.

The field observations of climate variations in the micro-catchment area helped demonstrate the effectiveness of mainstreaming new farming practices directly influenced by the climate/weather predictions of the Meteorological Department. The farmers are now convinced of the utility of using seasonal forecasting for decision-making. The Meteorological Department realized the need for accurate monthly forecasts so the farmers can get climate information in advance.

The monitoring and management committee (MMC) created a platform for all the stakeholders to take on-site decisions on important issues. Problem-based learning was a new approach for the participants. The collaborative effort made the end product acceptable to farmers, who are now convinced of the value of using seasonal forecasting products for decision making. Farmers in the downstream Kahaduwa track, and upstream Ambagahawela track usually had disputes over water sharing. Identifying the appropriate cropping calendar for the different farmers at a management committee meeting helped resolve resource sharing and water allocation problems. The meetings, field visits, and training sessions helped farmers and authorities who had negative views on irrigation change their opinion. Guidance to officials on using meteorological forecasts for decision making in *kanna* meetings before crops are planted facilitated operation of the drainage network to improve system efficiency while reducing the farmer conflicts and high fuel consumption that would have resulted from ad hoc decision making. Farmers continue to visit the field center to discuss their problems and consult weather information to carry out different activities. Other farmers nearby saw the pilot demonstrations asked for assistance in their fields.

The new technology proposed by the researchers was the result of collaboration between farmers and academia. The community-led farming practices carried out in the field with advice from academics helped build the confidence of the farmers and gave them a new set of sound practices and technical solutions. The farmers, students, stakeholder institutions, and NGOs learned how to deal with rice farming challenges under adverse climate, soil, and water conditions. Academics had an opportunity to understand and resolve actual field problems linked to ecosystem restoration.

The links the project established with the SLRCS by involving volunteers helped develop community resilience to day-to-day problems such as snake bites, field accidents, and handling pesticides.

Based on the research findings, a short course was developed for officials on "Ecosystems in a Changing Climate," with 1 day in the field site to observe and analyze the methodologies adopted in the study and 3 days of lecture, seminars, and practical sessions.

6 Future Impact

The collaborative work established during the project can serve as a good practice model for finding sustainable agriculture practices to adapt to climate risks. The management and monitoring committee helped provide strategic guidance for the smooth implementation of the project and will ensure sustainability beyond the project period by creating ownership among all the project stakeholders.

Links were made with industry to provide mulching materials and collect them back after the field applications. These linkages and capacity development will give the farmers an incentive to go ahead with the program. Once farmers produce their own paddy seeds, more than 50% of their problems in seed paddy availability will be solved. Even if new problems emerge, the university researchers are willing to look for appropriate solutions because they now have direct access to farmer communities.

7 Conclusions

The project's innovative approach of establishing a Management and Monitoring Committee under the leadership of the District Secretary, along with the academic leadership of Ruhuna University, was an efficient mechanism for results orientation in a short time period. The process involved all relevant government and state officials, community leaders, farmer organizations, and media for decision making, implementation, and impact at the policy level.

Using different agronomic practices (adjusting cropping dates, using different varieties and plant establishment methods, finding appropriate solutions for irrigation during dry spells, water saving, and weed management) yielded promising results. The field experiments yielded the following preliminary results: Rice variety At 362 performed better under farmer conditions than the BW variety during the Yala season in terms of plant growth, development, and yield. The average yield of At 362 under experimental conditions was 7.43 tons/hectare with polythene mulch and 5.76 tons/hectare without mulch, nearly a 29% yield increment. Furthermore in average dry matter content of weeds without mulch reaches about 0.7 tons/hectare, which contributes to heavy contamination of paddy seeds with weeds, affecting farmers' seed paddy production.

8 Implications for the Future

The experience from the Nilwala pilot site and its findings pertaining to the efficiency of mulching to address paddy issues and weed management in Sri Lanka could be extended to paddy track programs (during the Yala season) and seed paddy production programs in all districts to promote farmers' own seed paddy production.

The project team established closer links with the SLRCS Matara and hopes to continue the relationship by developing a joint research and development program. Collaboration is also

planned with the SLRCS and Faculty of Agriculture of the University of Ruhuna on joint courses and diploma programs on safety and health issues.

9 Publications

The project plans to publish a journal article and report and produce a video to highlight the activities and project outcomes. Findings were published as journal papers and abstracts presented in one international and two national conferences.

Journal articles

Weerasinghea, K. D. N., Basnayakeb, S., Arambepolab, N. M. S. I., Rathnayake, U., & Nawaratne, C. (2014). A local level technology and policy intervention approach to restore paddy ecosystems in the Nilwala downstream, affected due to Nilwala flood protection scheme, southern Sri Lanka. *Procedia Economics and Finance 18*, 336–344.

Weerasinghe. K. D. N., et al. Rebuilding of tsunami-affected areas in Southern Sri Lanka: Technological innovations and interventions in livelihood restoration and resilience building. Special themed issue of the *Journal of Disaster Prevention and Management* on Tsunami Recovery in Sri Lanka: Ten Years On (to be published).

Abstracts

Weerasinghe, K. D. N., Basnayakeb, S., Arambepolab, N. M. S. I., Rathnayake, U., & Nawaratne, C. (2014). A local level technology and policy intervention approach to restore paddy ecosystems in the Nilwala downstream, affected due to the Nilwala flood protection scheme, southern Sri Lanka. 4th International Conference on Building Resilience, 8–11 September 2014, Salford Quays, United Kingdom.

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Appendix 1. Technology Intervention Program


Supplementary Irrigation Appropriate pumps as effective technologies to combat dry spells
Barrel pump
Solar powered irrigation


farmers Awareness programmes.....

Forecast: 2014

Forecasts:

Aug 1982 to Aug 2013

Station	Below Normal	Above
Denegama	60%	23%	18%
Kekanadura	61%	21%	18%
Mapalana	67%	20%	13%

Monitoring of Climate Data

- Rainfall
- Max.& min. Temperature
- RH

Onsite monitoring of climate information and adaption of the information provided by the met Department for decision making

Farmers, students, academics, agronomists, engineers, and Sri Lanka Red Cross Society representatives meet Department representatives before a visit to the field center

Field learning on the impact of mulch at the experimental site

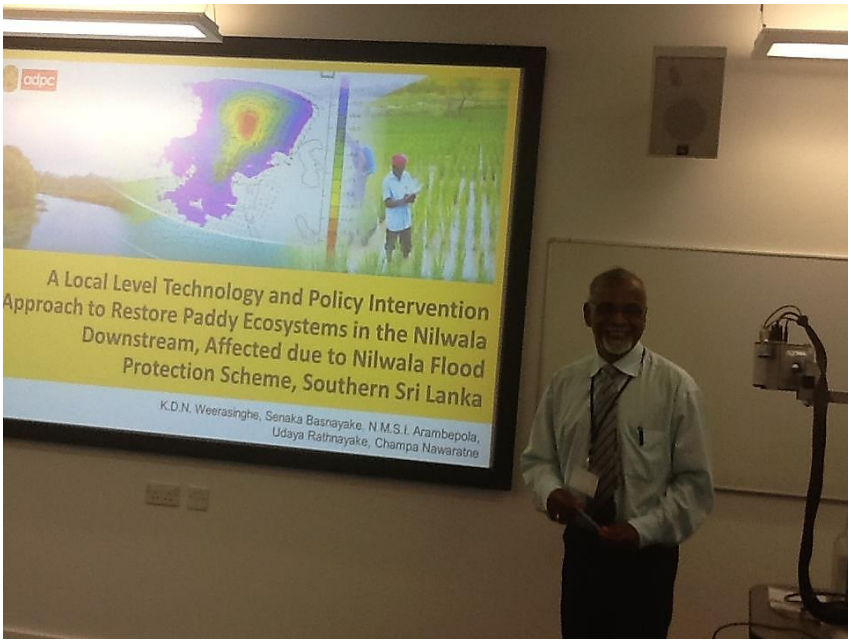
(student, farmer, and postgraduate students)

Field discussion and demonstration session for stakeholders

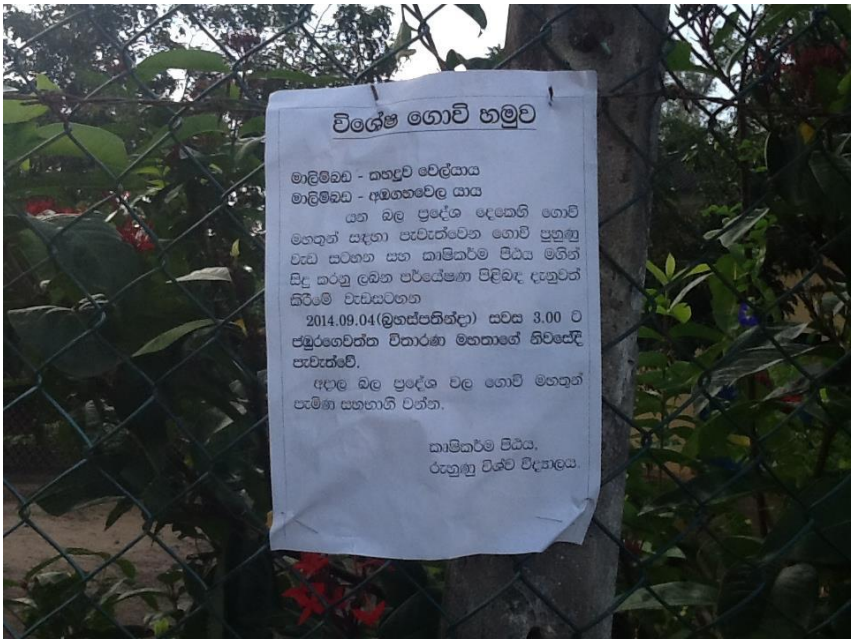
Field experiment plots with replicates to demonstrate the impact of mulch

Appearance of the plants at the end of the vegetation. With polythene mulch (broadcasted) (left), with mulch (transplanted) (middle), without mulch (right)

Management committee meeting at the field site



Presentation at the4th International Conference on Building Resilience, 8–11 September 2014, Salford Quays, United Kingdom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මාලිම්බඩ - කහවුව වෙල්යාය
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යන බල ප්‍රදේශ දෙකෙහි ගොවි මෙතුන් සඳහා පැවැත්වෙන ගොවි පුහුණු වැඩ සටහන සහ කෘෂිකර්ම පීඨය මගින් සිදු කරනු ලබන පර්යේෂණ පිළිබඳ දැනුවත් කිරීමේ වැඩසටහන

2014.09.04 (බ්‍රහස්පතින්දා) සවස 3.00 ට ජඹුරගෙවත්ත විතාරණ මහතාගේ නිවසේදී පැවැත්වේ.

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කෘෂිකර්ම පීඨය,
රුහුණු විශ්ව විද්‍යාලය.

Notice of farmer meetings

Annex 2. Publication 1. (Elsevier)

4th International Conference on Building Resilience, 8-11 September 2014, Salford Quays, United Kingdom

A local level technology and policy intervention approach to restore paddy ecosystems in the Nilwala downstream, affected due to Nilwala flood protection scheme, southern Sri Lanka

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Abstract

Present paper discusses the innovative approach and the strategies adapted for policy impact by the Asian Disaster Preparedness Centre along with stake holder institutions to restore paddy ecosystems affected due to the introduction of a flood protection scheme for the down-streams of the Nilwala river basin located in the Matara District, southern Sri Lanka. The project helped in studying the problems and addressing the policy issues while mainstreaming climate information applications in order to reduce the vulnerabilities associated with paddy farming by rallying all stake holders (academia, local level government institutions, farmer organizations & media) under the leadership of the Matara District Secretary to form a local Management and Monitoring Committee which helped in identifying the most Effective policy framework. It has also helped in addressing the main issues related to climate, plant, soil, water and social problems through technology intervention and adapting them to improve farming systems.

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Keywords: Policy impact; Paddy ecosystems; Flood protection; Disaster management; Climate change

1. Introduction

Climate change has already made measurable impact on agriculture in a wide range of economies, crops and farming systems affecting crop productivity, food security, livelihood security etc. (http://www.http.//bit.ly/1irgt9k), resulting in higher demands for farm products, especially within the man-made modified ecosystems where land quality degrades over time. Thus technology intervention in such ecosystems to restore ecosystems services and functions for DRR are important. In the present paper a technology intervention program conducted by ADPC during 2012-2014 along with the stakeholder Institutions, to restore the degrading paddy ecosystem due to man-made structures, in Nilwala river basin, Southern Sri Lanka is discussed.

Nilwala River, the major river in Matara District, Southern Sri Lanka, originates at an altitude of 1,050 m, and traversing about 70 km to discharge to Indian Ocean at Matara. Often inundation of the river disturbed the human activities creating a chain of socio economic problems (Delpachitra 1996; Panabokke, 1996, Weerasinghe 1996 Weerasinghe et.al. 2000).

In 1968, the Government of Sri Lanka implement a flood protection scheme to protect the basin through, which drainage network of the 3960 ha of paddy fields in the downstream was improved for rapid evacuation of the flood water back to the river through pump houses (Delpachitra; 1996). This resulted in the formation of acid sulphate soils (ASS) in drying paddy fields, due to pyrite oxidation, as experienced in many parts of the world (Van Breeman, Pons L. J. 1978, Dent and Ponse 1995, Fenning 2002, Fitz Patrick et. al 2010, Sulivan et al 2012). Acid Sulphate formation occurs due to Pyrite oxidation, when drying fields are exposed to oxygen.

$$FeS_2 + 15/4\ O2 + 7/2\ H_2O \rightarrow$$
$$Fe(OH)_3 + 2SO_4 + 4H^+$$

The major soil problems encountered in ASS soils are acidity, iron and aluminum toxicity, phosphorous fixation, possible salinity, low base status and deficiencies in P,K,S, Zn and other nutrients such as Si, (Ponnamperuma 1972, Ottow et al 1991). Improved water management, to maintain a submerged water regime to prevent pyrite Oxidation is crucial for such soils.

Paddy transplanting, fertilizer application, adaption of more susceptible varieties are some of the recommendations made by us to solve above problems in Nilwala downstream. (Weerasinghe Et al. 1996). Even though academic research has demonstrated the way forward, there was a gap between the approach and the practice, and present Participatory Community-based Research program has been piloted initially with AusAID support to address the issue.

2. Materials and Methods

The project adapted the farming systems research and development (Collinson, 1984, 2000, FAO 2000) and participatory approach (Gonsalves et. al (2005) to link all stakeholder institutions farmer communities to an innovation system. Initially, a brainstorming session followed by a field visit with the stakeholders, was conducted to identify and catalogue the different ecosystems scattered in the Nilwala basin and threats incurred on them. Available literature was used to assess the historical changes on the ecosystems.

After completing the initial ecosystems survey in the basin, the project selected a pilot site in the "Kahaduwa paddy track" in Nilwala downstream to conduct a technology intervention program for ecosystem restoration and livelihood improvement along with farmer communities. A contour and land use map of the pilot site was prepared. Major problems associated with the farmers in the pilot site were identified through a questionnaire survey and a brainstorming session conducted on 10th July 2013. A sample of 30 farmers was selected from among the farmers at a meeting conducted with them and a training session was conducted with them on record keeping and field observation procedures. A data collection sheet was given to the farmers to record all agronomic practices adopted by them during the cropping season. A crop cut survey was conducted at the end of the cropping season and yield data were analyzed through Anova using SAS package. The yield collected by the farmers has been also recorded.

In order to facilitate the field program, a field research extension and demonstration center was established at the research fields. For daily observation of the weather pattern, a rain gauge and Stevenson screen with thermometer and a dry and wet bulb psychrometer were installed at the station. Farmers were trained to make weather observations and use them for their day to day practices for decision making.

The field research and demonstration program commenced in Sep. 2013, during the major (Maha) season with the selected highly vulnerable communities. The farming systems, seasonality changes and traditional farming practices, current obstacles in continuing the traditional farming practices, etc., were studied in detail at the site to understand the challenges faced by the farmers due to natural and man-made changes that occurred in the past.

A monitoring and management committee was formed under the chair of District Secretary (Government Agent) of the Matara District, to provide strategic guidance for the smooth implementation of the project and to ensure long term sustainability beyond the project period by creating ownership by all the project stakeholders (local governments, Disaster Management Centre, provincial and district officials from various Departments such as Agriculture, Irrigation, Forestry, Environment, academia, farming community etc. The committee met periodically to convey the findings of the project and to discuss the approach that should be taken to address different challenges. (Fig. 1).

(a) Management committee meeting in progress, (b) farmers with the ADPC Chairman after inauguration of the field center, (c) ADPC Chairman and Vice Chancellor of the University of Ruhuna greet each other after the opening of the Field Research and Demonstration Centre

Final decision on crop commencement was arrived during a brainstorming session conducted with all the farmers along with officials of the Irrigation Department, Field officers of the Agrarian Development Department, University academics, etc. at the Management Committee meeting, using the forecast information given by the Met Department and the Disaster Management Centre. The climate predictions received were used to decide on the cropping seasons to avoid high floods. Accordingly, selected farmers of the pilot study program commenced the field activities on the stipulated date (18th Oct. in “Maha 2013"). Certain local level measures were also taken to ensure water supply by developing appropriate low cost pumps (Fig. 2).

The above decision making process and the decision made, were accepted as the policy decision to be placed at the annual Kanna meeting"(Official meeting for decision making on cropping dates, water allocation etc. where all the decision making bodies and farmer organizations of the scheme are participating to decide on the cropping calendar).

2.1 Training and capacity building (Training of the farmer community)

The training to the farmer community is provided through the Pilot Research program and it is more hands-on training through on site activities. The farmers were trained to use the seasonal forecasting information as a decision making tool as well as to observe weather parameters and water level fluctuations within the field. They were also trained in undertaking different farming practices, ways of coping up with acidity, salinity, etc. to suit the prevailing conditions in the field.

They had opportunities to interact with the officials of the Irrigation Department and other government officials to get their support when and where necessary. The Academia provided technical inputs by working closely with the farmer community using farmer fields as learning and teaching laboratories. Based on the experiences gathered, a short term training program was designed on "Climate change and paddy ecosystems” with the objective of enhancing the existing knowledge and skills of officials and professionals on ecosystems management, and restoration of degraded ecosystems, as an appropriate action for DRR in river basins.The project activities were extended to the adjacent paddy track "Ambagahawela" in April201 4with the support of the small grants project by International Red Cross society, (IRC) and Post graduate Institute of Science, (PGIS) University of Peradeniya, Sri Lanka.

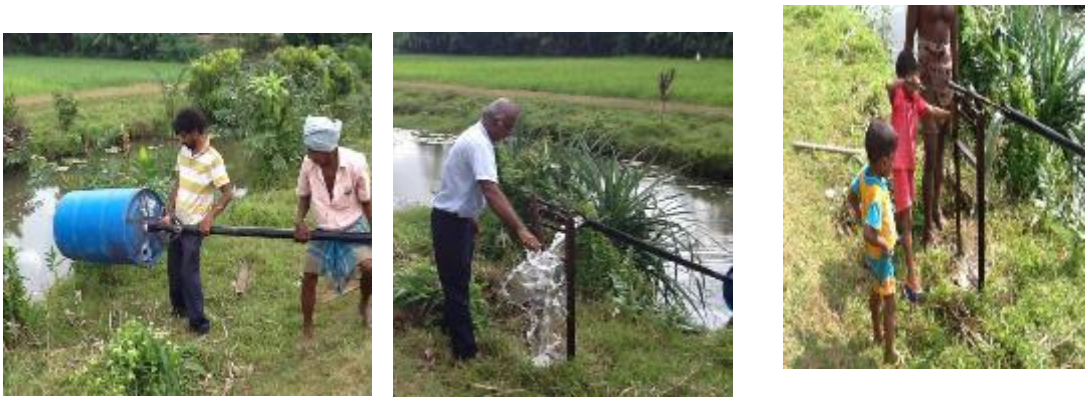


Fig. 2. (a) Installation and testing of hand operated Barrel (Archimedean) pump designed by the university; (b) Children enjoy the water pumping while learning

1.3. Field research and demonstration program

1. The objective of the field research program was to, a) address the major problems associated with soil acidity, water scarcity, fertilizer practices and weeds and; b) identify suitable crop varieties, and cropping practices, to meet the climate change and associated changes, in a participatory manner with the farmers of the two pilot sites ("Kahaduwa "and Ambagahawela") where the undergraduate and the post graduate students were also taking part in Maha (Oct. 2013-Feb 2014) following field experiments have been conducted.

2. 2.1 Impact of mulching, lime application, and fertilizer materials on growth, development and yield of the rice plant

3. Design of the experiment was split plot design, with three replicates (Gomez A. Gomez K. 1983). There were 16 combinations in the trial with straw mulch andrtilizer combinations. Phenological observations such as plant height, number of tillers per plant, number of filled and unfilled grains in plants, their weight, and average yield per $1m^2$, were measured. Soil data such as pH, EC, total N and available phosphorus were also measured at the beginning and at the end of the season. Based on the results of soil analysis, and yield observations, the most appropriate technologies have been recommended.

   b)

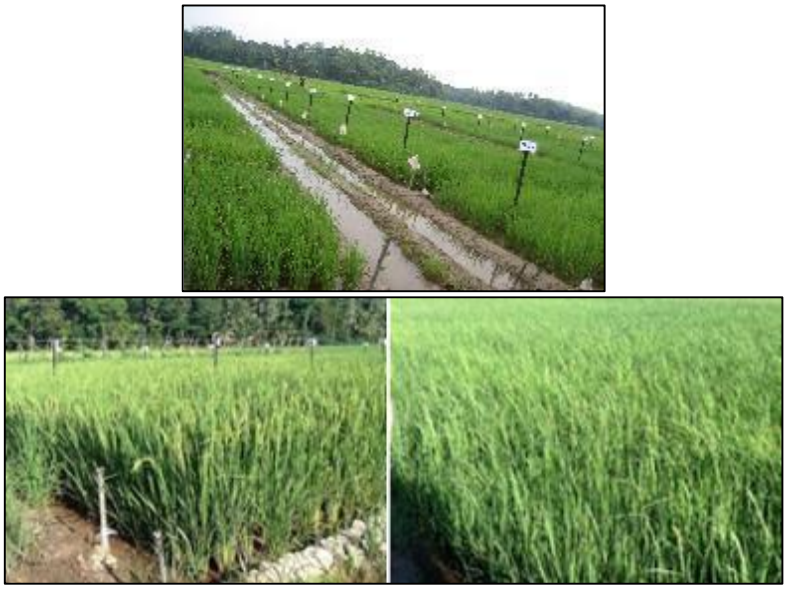
   c)

4. Fig. 3. View of the experimental plots in December 2013; (b) View of the transplanted plots; (c) View of the paddy field broadcast by the farmers

5. 2.2. Impact of plant establishment methods on growth, development and yield of the rice plant

6. The objective of the experiment was to identify a more suitable establishment method for rice, for rain-fed farming in boggy soils. Here, the parachute method of

transplanting was experimented, in the boggy fields with submerged water regime. (Fig. 5)



2. Performance Evaluation of Different Rice Varieties in the Nilwala Basin (Observation Trial in Farmers' Fields)

Objectives of the experiment was to identify the most suitable rice varieties for rainfed farming under acidic soil conditions. Following widely used varieties, viz. (1) AT 362, Ld 368 (3), Mg 369 (4), Bg 357 were tested in the farmer fields during the major (Maha) season. Farmers were given the seed paddy and they established the new varieties in their fields by themselves. Most appropriate varieties will be further tested in the 2014 minor (Yala) season in two pilot sites.

1.1. Impact of mulching, lime application, and fertilizer on growth, development, and yield of the rice plant

Table 1 shows the final results of the field experiment conducted in farmer fields to test the performance of rice variety At 379/2, with respect to plant height, number of tillers, and the yield at harvest. Mulching with straw along with lime application to neutralize the soil gave promising results. The low rate of lime application (1.8 tons/ha) will be more economical than higher application rates. Based on the results, farmers were advised to apply lime to acidic fields at the rate of 1.8 tons/ha, to combat acidity development from pyrite oxidation. Ploughing back organic residues into the soil as a mulching material for the rice fields was also recommended to maintain a high yield.

Table 1. Performance of the rice plants at harvest (Maha) and yield (tons/ha), 2013–2014

	With straw mulch			Without straw mulch		
	Plant height (cm)	No. of tillers/ha	Yield tons/cm	Plant height (cm)	No of tillers/ha	Yield (tons/ha)
1. No fertilizer	92.2 a	6.3 a	5.63 a	84.4 b	5.8 a	3.75 b
2. DOA recommended chemical fertilizer	94.7 ab	9.0 a	7.0 ac	92.3 a	8.4 a	4.35 c
3. DOA rec. + lime (CaO at the rate of 7.5 t/ha)	104.4 c	8.5 a	8.14 c	99.0 c	8.1 a	7.91 c
4. DOA rec.+ lime (CaO at the rate of 1.8 t/ha)	96.7 ab	7.2 a	7.31 ac	94.4 a	8.6 a	6.62 c
5. DOA rec.+ Rice husk charcoal (400 g/ha)	93.5 ab	7.2 a	6.26 a	90.8 ab	7.3 a	5.71 a
6. DOA rec. + lime (CaO at the rate of 1.8 t/ha) + rice husk charcoal (400 kg/ha)	99.1 c	7.1 a	7.19 ac	95.4 c	7.1 a	6.52 ac
7. DOA rec. N and K+ 2 times of DOA rec.P by Eppawala rock phosphate (ERP)	94.1 ab	6.6 a	6.10 a	88.8 b	8.4 a	5.85 a

DOA = Department of Agriculture, Sri Lanka, recommendation 2013 in a column means followed by a comm letter are not significantly different at 5% by DMRT LSD for plant height = 6.65; no of tillers

1.2. Impact of plant establishment methods on growth development and yield of rice plant

The parachute method of plant establishment gave convincing results, especially for boggy paddy fields with submerged water regime (Fig. 4). In demonstration plots, plant vigor was much better and it was a very convenient method for the farmers to practice. After observing the method, farmers have seen the advantage and many farmers are expecting to adopt the method in the next season. Farmers in two pilot sites will be given parachute trays and technical support for wider adaptation.

a) b) c)

Fig. 4. (a) Nursery preparation for the parachute method of transplanting; (b) View of the paddy fields planted by the parachute method; (c) View of the paddy fields planted by seed broadcasting

In Fig 5, appearance of the transplanted experimental plots, with broadcast adjacent farmer field during the intense flowering and panicle formation stage (12 Jan 2014) is demonstrated. In transplanted fields, tillering was better and plant growth was much ahead compared to the plant growth in the broadcast fields. The usual practice adopted by the farmers is to broadcast with very high seeds rate to control the weeds. However, weed population was also high in the farmer fields, which inhibited plants growth and development, resulting in poorly developed panicles and low number of tillers.

1.3. Performance evaluation of different rice varieties in the Nilwala Basin

Out of the different varieties, Rice variety At 362 performed well, compared to other varieties (Fig 5). The farmers were well convinced with these technologies. Measures, will be taken to popularize these practices, through farmer training and demonstration methods. The experiments are continuing and final results will be submitted to a scientific conference to take appropriate decisions for policy interventions.

Fig. 5. Performance of different varieties at the end of flowering (24 Jan 2014)

The project has assembled all the stakeholders at the problem location and win- win solutions could be found by collaboration through discussions in the field. Usually farmers in low lying areas demand to drain additional water without knowing its impact on other farmlands located in relatively high elevations which led to certain misunderstandings and conflicts in the past. The Irrigation Department as an authority for water management, faced problems of resources allocation in terms of man power and money, to extend assistance to farmers year round. The project interventions with different agronomic practices, in terms of adjustment of cropping dates, varieties, plant establishment methods, appropriate solutions for irrigation during dry spells, etc. demonstrated promising results. The farmers learned to discuss the problems among themselves with the participation of the officials from the Irrigation Department, which helped the parties to find the best solutions. The project approach created decision-making and action through dialogue which has been proved to be effective.

Farmers use traditional farming practices, The new methodologies that are generated through academic research often are not acceptable to traditional farmers due to various social and cultural reasons, especially if they are not convinced of the effectiveness, in terms

of yields, or uninterrupted farming during the flood/drought-affected seasons. Therefore, it is important to have ownership-building to undertake appropriate solutions that will help to sustain the practices in the future even after the project period. The community-led farming practices carried out in the field through academic advice was a good initiative that helped to build the confidence of the farmers, develop community ownership and empower them with a new set of sound practices and technical solutions. The new technology package proposed by the researchers came out as a result of joint collaborative work, since farmers worked hand-in-hand with the academia.

The management approach adopted by the project team for mainstreaming the new farming practices directly influenced by the climate/weather predictions by the Meteorological Department and field level observations of climate variations in the micro-catchment area, helped in demonstrating the high effectiveness, even with some draw backs in correct predictions of weather due to different constraints. The Department realized the need for perfection of the forecast in future deals.

The management committee set up by the project with government officials, academia and farmer communities, gave direct assistance to farmers which was not possible in the past due to bureaucratic procedural setbacks. Since the outcome of the project is through a collaborative effort, the end product was acceptable to farmers. Farmers are now convinced of using seasonal forecasting products for future decision-making practices.

The technology applications proved to be easily replicated in areas within the lower catchment area with similar problems. Even if new problems emerge, the academia are willing to undertake research to come up with appropriate solutions, since they now have direct access to farmer communities. Other farmer communities in nearby locations have seen the pilot demonstrations and requests have been made by them for assistance. The project was able to negotiate a new project with PGIS and IRC to replicate it in a new project site.

Even if new problems emerge, the academia are willing to undertake research to come up with appropriate solutions, since they now have direct ccess to farmer communities. Other farmer communities in nearby locations have seen the pilot demonstrations and requests have been made by them for assistance. The lesson learned is "transparency is an advocacy method for further replication."

The lesson learned is "transparency is an advocacy method for further replication". The main contribution to HFA is the field demonstration of DRR applications and introduction of sustainable, cost effective solutions to current problems with the possibility of replication. The HFA has provided an opportunity for the academic and scientific community to think and act how scientific approaches can be presented to farmer societies in a simplified and meaningful way. The effectiveness of collaborative work is evident and this can serve as a good practice model for problem solutions in the agricultural sector linked to climate risks, and to come up with sustainable adaptation practices.

2. Conclusions

Risk identification, assessment, monitoring and impacts on the policy frame-work through knowledge management and education in a participatory manner with state agencies, academia, communities, media, the private sector and policy makers is being piloted for DRR adaptation by the ADPC in the Nilwala river basin in southern Sri Lanka since December 2012. Initially with the support of AusAid funding and subsequent funding from International Redcross society through PGIS, University of Peradeniya. The innovative approach experimented by the project by establishing a Management and Monitoring Committee under the leadership of the District Secretary, along with the academic leadership of the Ruhuna University, incorporating all relevant government and state officials, community leaders, farmer organizations and media for decision making, implementation and impact at the policy level, appeared to be an efficient mechanism for result orientation within the shortest possible time.

The establishment of the field centre for community interactions at the problem sites with academia and decision and policy making for technology adoption, testing, demonstration and extension could be recommended as a good model for active community interaction and to improve stuent-centered teaching research and learning processes.

The experience gathered on the Sri Lankan situation at two pilot sites was simultaneously tested in the lower Mekong delta in a a pilot site in Tra Noc Province along with Can Tho Unversity, regional political and administrative leaders, SIHYMET, IMHEN and respective Ministries.

Annex 2. Publication 2. (Abstract 2)

Tsunami Recovery in Sri Lanka: Ten Years

5th December 2014
08:30 - 16:30

"Rebuilding of tsunami-affected areas in Southern Sri Lanka: Technological innovations and interventions by University of Ruhuna in livelihood restoration and resilience building.

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Key words: Biogas technology, hydroponics, livelihood, resilience building, technological interventions

The paper revisits and discusses the outcomes and the experiences gathered in sustainable livelihood development programs developed by the Faculty of Agriculture, University of Ruhuna in tsunami-affected areas of the Matara District in collaboration with several national and international agencies during the period of 2004–2014.

The programs helped to develop successful stories in livelihood restoration as community participation projects of pilot scale in two peri-urban villages, Madiha and Gandara, and in paddy ecosystems in the Nilwala downstream. The technological interventions for livelihood restoration have been made primarily through undergraduate and post-graduate training and research programmes with community engagement, for which field research and demonstration centers have been established in the said villages.

The Sustainable Rural Livelihood (SRL) framework and Farming Systems approach was deployed in all the programs as a means of resilience building and livelihood restoration. Technological interventions and innovations such as small scale bio-gas technology as a source of household energy and manure, model home gardens with appropriate hydroponics techniques, household waste management through composting, mushroom culture, animal farming, solar-energy based fish drying technology, rainwater harvesting and ground water restoration programmes for sustainable water availability and development of rural marketing channels have been well integrated into the villagers' lives to improve their home economies, social lives and environment. CIDA (Canada), AusAID (Australia), Std. Werke Karlsruhe (Germany), ADPC (Bangkok), the American Red Cross Society, PGIS, the University of Peradeniya, and NSF (Sri Lanka) are thanked for the assistance offered in different ways to implement the above programs.

Annex 3. Publication 3

Disaster Management CONFERENCE 2014
The future we want - A safer Sri Lanka
24-26 September 2014 | BMICH, Colombo - Sri Lanka

A local level technology and policy intervention to main- stream climate information application to restore paddy ecososrems. Case studies in the Nilwala downstream, southern Sri Lanka and Mekong Delta, Southern Vietnam

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Background

Risk associated with paddy farming has been aggravated due to vulnerabilities linked to climgta risk and dominance of man-made structures. Immedigta attention has been re- quested among authorities, communities, science and prac- tices to address these issues, to build resilience in order to avoid conflict situations among communities and authori- ties, as well as to restore ecosystem degradations. The fol- lowing pilot study paper conducted down stream of the Nilwala Basin (Sri Lanka) st eamekong basins (Southern Viet- nam) funded by AusAID aims to address the above issues.

Program

The objective of the project is to fill the social and policy gap through stakeholder networking and fill the science and practice gap by climate information application and technol- ogy adoption in order to c ed d wn nt communities.

The farming systems research and development (Ca e inform tion applicAO 2000) and participatory approach (Gon- salves et. al 2005) are adapted to link all stakeholder institu- tions. A survey has been conducted to identify and catalogue the different ecosystems scattered throughout the two ba- sins, and threats incurred on them. Two pilot sites worbae- lected in "Kahaduwa paddy track" in Nilwala basin Sri Lanka, and Tranoc commune in Canto Province Vietnam to conduct stakeholder intervention and technology intervention pro- grams. A research extension and demonstration center has

been established at been established sites. Monitoring and Management Committees (MMC) were formed under the leadership of the District Squres ed among Matara District in Sri Lanka, and under the leadership of the SIHYMET and Tranoc Commune in Vietnam to provide strategic guidance for smooth implementation of the project. The MMCs hold periodic meetings to convey the findings of

the Nilw ct and to discuss challenges. Climate c red d wn received from the meteorological department and on site Agro Mc tedrin "gical observations were used to decide on cropping practicand t avoid risks. Coni oring and ate technologies were adapted to ensure small-scale water management where applicable. These processes and decisions were accepted as the policy decision for the annual "Kanna" meeting in Sri Lanka, and an- nual communal meetings in Vietnam.

Farmers were trained to use seasonal forecasting informa- tion and observe weather parameters and water level fluc- tuations within their fields. Based on the experiences gath- ered, a short term training program on "Ecosystem resilience in changing climCt r" was designed and offered to officials and professionals.

Outcome of the Program

Lessons Learned (Nilwala Program)

> The project assembled all stakeholders at the problem loca- tion in order for a win-win solution to be found through col- laborative discussions in the field.

The Irrigation Department faces problems of resource al- location in terms of manpower and money. When farmers in low lying areas demanded additional drainage water, farmers in high elevations reacted in contrast. This led to cer- tain misunderstandings and conflicts in the past. Therefore, the project interventions focused on different agronomical practices, in terms of adjustment of cropping dates, va, Sri Lan a nt establishment methods, appropriate solutions for irri- gation during dry spells etc., which demonstrated promising results. The farmers learned to discuss the problems among themselves with the officials, which helped parties find the best solutions. The project approach created decision-mak- ing and action through effective dialogue. The management committee set up by the project with government officials, academia and farmer communities, gave direct assistance to

farmers which was not possible in the past due to bureau- cratic procedural setbacks. Since the outcome of the project was collaborative in nature, the end product was acceptable to farmers.

Current Status

The community-led farming practices carried out in the field through participatory approaches created a strong initiative that built the confidence of farmers, developed community ownership and empowered them with a new set of sound practices and technical solutions.
The management approach adapted by the project team for mainstreaming the new farming practices was directly influ- enced by the climate/weather predictions by the Meteoro- logical agency and field level observations of climate varia- tions in the micro-catchment area.

Challenges / Gaps Encountered

The main challenge was associated with the accuracy of short-term Agro climate predictions, specifically in terms of onset of the season, duration and repetition of dry and wet spells for the farmers to orient towards different agro opera- tions. There was a gap in translating the climate informa- tion from the Meteorological Department to authorities and farmers on time, and in an understandable manner for them to take appropriate decisions.

Vietnam Program

Assessment of climate change scenarios on rice production in different regions of the Mekong delta using different mod- els demonstrated a reduction in the production level in the delta region due to salinity, weather extremes and sea level rise, which may reach 30 per cent by 2100. Land decrease due to sea level rise will be very prominent and the country has to advocate adaptation measures in the context of Climate Change Project intervention in order to help recommend a new variety AP2010 to replace the commonly adapted va- riety IR50404. It must withstand the climate etit emes and it has been also recommended to continue with weather and tide forecast for farmers to arrange their crop establishment programs accordingly.

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Conclusions

The innovative approach experimented in this pilot scale project by ADPC in Sri Lanka and Vietnam, by establishing a Management and Monitoring Committee, incorporating all the stakeholders under the leadership of the provincial au- thorities and academia appeared to be an efficient mecha- nism, resulting in orientation in climate information and technology application for DRR and resilience building in vulnerable agro ecos. ꝛ ems within a shorter period of time. The establishment of the field center for community interac- tions at the problem sites could be recommended as a good model for active community interaction and technology catch, for both farmers and students, which is a Champa N w rant-catered teaching, research and learning process as well.

The project contributed to HFA through field demonstration of DRR applications and introducing sustainable, cost ef- fective solutions to current problems with the possibility of replication. The effectiveness of collaborative we solutionsnt and this can serve as a good practice model for problem so- lutions in the agricultural sector linked to climate risks, and to come up with sustainable adaptation practices.

Opportunities for Improvement

The technology applications proved to be easily replicated in areas with similar problems. Even if new problems are encountered, academia is willing to undertake research to come up with appropriate solutions. As a result of this, the project initiated a second project adjacent to the paddy track in Nilwala with funds received from the International Red Cross society, under the small grants project to expand the project concept.

Better collaboration between the Meteorological Depart- ment and the Department of Agrarian Services is encour- aged in order to provide on time climate information for the er solutionsvel, as it has been practiced in neighboring India and Vietnam.

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The authors wish to acknowledge AusAID and the Interna- tional Red Cross society for funding the present research and development of this program. Honorable Minister of ogdu t- ture in Sri Lanka, Mr. MahindaYapaAbeywardena, Scientists of the IMHEN, SIHYMET and Dragon Institute of the Cantho University, and all members of the management committee rst ongnting stakeholder institutions, both in Vietnam and Sri Lanka, farmers staff and the students of Ruhuna (Sri Lan- ka) and Cantho (Vietnam) Universities are thanked for their active involvement with the project activities.