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Dissemination of Natural Resource Management Technology for Irrigated Rice in the Philippines: On-Farm Validation to National Extension

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ABSTRACT

Natural Resource Management (NRM) technologies, some of which include Site-Specific Nutrient Management (SSNM), Ecologically-Based Rodent Management (EBRM) and Alternate Wetting and Drying (AWD) for increased farm productivity and income in the irrigated rice ecosystem, have recently been generated through research. Guaranteeing that these technologies are properly disseminated and utilized by farmers is one of the challenges not only for researchers but for policymakers and various stakeholders as well. These need to be tested and evaluated on-farm to determine their appropriateness for wide-scale adoption of farmers, and the factors that may hinder their diffusion. In 2006, the Philippine Rice Research Institute (PhilRice) forged partnership with the International Rice Research Institute (IRRI) to implement a project enhancing the delivery of NRM technologies for irrigated rice ecosystem from adaptive research to nationwide implementation. Activities of the collaborative project included training of partners, stakeholders' workshop, establishment of demo farm cum learning field, information campaign and on-farm evaluation. Results revealed yield increases of 28.3% and 12.6% in the SSNM demo plots for DS and WS 2007, respectively; 3.17% yield increase in the EBRM field; and 18.8% reduction in production cost by utilizing the AWD technologies. These results encouraged farmers to continue using the NRM technologies and sharing them to others. Eventually, the NRM technologies were integrated into the National Rice Program through the *PalayCheck* system. Overall, the PhilRice-IRRI joint partnership has been proven to be a powerful instrument in facilitating delivery and adoption of NRM technologies, thus, improving the quality of life of Filipino farmers.

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INTRODUCTION

Rice is the staple food of about 100 million Filipinos. It is the agricultural commodity with foremost political and economic significance in the Philippines. Rice accounts for 45% of the calorie intake of the population and around 20% of the typical household's budget (FSSP, 2012). Rice farming is the primary source of income and employment of more than two million households.

Due to the high significance of rice in the life of the Filipino people, a continued increase in rice productivity is critically important for enhancing food security, reducing poverty and hunger, and enhancing environmental sustainability. Unfortunately, in the irrigated rice ecosystem, the road toward achieving growth in agricultural productivity is limited by diminishing natural resources, labor shortage, land conversion and climate change (IRRC News, 2010; Palis *et al*., 2010).

Given the critical role of agriculture to the overall development of the Philippine economy, ensuring that natural resource management (NRM) technologies and best practices in the irrigated lowland rice ecosystem are disseminated and utilized by farmers is imperative and should be done in a fast manner on a wider scale for farmer adoption. Campbell *et al*. (2001) define NRM as a conscious process of incorporating the multiple aspects of natural resource use into a system of sustainable management to meet the production goals of farmers and other direct users, as well as the goals of the wider community. It means sustainable utilization of major natural resources such as land, water, forests, etc. for the welfare of future generations. Some of these NRM technologies include site-specific nutrient management (SSNM), alternate wetting and drying (AWD), and ecologically-based rodent management (EBRM).

SSNM is a plant-based approach that provides principles for effective management of Nitrogen (N), Phosphorus (P) and Potassium (K). It provides guidelines, tools, and strategies that allow farmers to determine when and how much nutrients they need to apply to their rice fields under actual growing conditions in a specific season and location. On the other hand, Singleton *et al*. (2004) describe EBRM as a management strategy developed for rodent pests, which is anchored on environmental and socio-economic dimensions in the community. It means integration of different management actions based on understanding the ecology of specific rodent species and also the integration of ecology, sociology, and economics in rodent management. Moreover, AWD is a water-saving technology that farmers can apply to reduce their irrigation water use without reduction in yield (www.knowledgebank.irri.org). In AWD, the field is alternately flooded and non-flooded depending on a number of factors such as soil type, weather, and crop growth stage.

These NRM technologies need to be validated on-farm to determine whether they are appropriate for wide-scale adoption of farmers. The issue of adoption in most of the NRM technologies, however, is complicated since these are in the forms of knowledge and information, which are made accessible to end users in a less tangible form than physical products such as seed or machinery (Price & Balasubramanian, 1998). Most NRM technologies are considered knowledge intensive technologies because they are techniques to fine-tune farmer's management and cater for farmer's adaptation. Moreover, factors such as low information dissemination and lack of linkage and coordination among different extension agencies, among others, hinder the diffusion of sustainable agriculture innovations (Johnson & Lybecker, 2009). In reality, technology transfer and adoption has not met the needs of target beneficiaries despite the efforts in research and development (FAO, 2000). Adoption of NRM technologies by farmers, especially those with limited holdings as in the case of most Filipino rice farmers, is therefore a great challenge in order to realize the goals of sustainability, increasing profitability and environmental integrity.

Various stake holders work together in disseminating NRM technologies such as the Philippine Rice Research Institute (PhilRice), a government-owned and controlled corporation under the Department of Agriculture (DA) and the International Rice Research Institute (IRRI), one of the main providers of rice-related research in the country.

In 2006, PhilRice-IRRI forged partnership to enhance the delivery of NRM technologies and R&D exchange of information. Through this collaboration, the challenge of achieving food security at lesser cost and in a sustainable manner is expected to be better addressed.

OBJECTIVES

The main goal of this paper is to show the process of disseminating NRM technologies for irrigated rice production from adaptive research to nationwide implementation. In more specific terms, it aims to:

a. Describe the initial stage of disseminating the NRM technologies through on-farm testing and validation;

b. Illustrate the upscaling process in promoting the NRM technologies;

c. Demonstrate the strategies and approaches that facilitate delivery of the NRM technologies; and

d. Discuss the challenges encountered in the pathway toward nation-wide extension.

METHODOLOGY

The PhilRice-IRRI project was conceptualized because the two agencies felt the need to enhance extension mechanisms by which the NRM technologies can be disseminated for wide-scale adoption by farmers. At the project onset in 2006, a workshop on "Implementing Component

Technologies for Irrigated Rice" was conducted. The workshop aimed to orient some selected project stakeholders on the NRM technologies. Scientists from IRRI and PhilRice served as resource persons during the activity. The workshop ended with a work plan by identifying the NRM technologies that the stakeholders would be able to evaluate.

A. Capacity Enhancement

There were two levels of trainings conducted for partners. The first level was for stakeholders and partner agencies such as the Agricultural Training Institute (ATI), National Irrigation Administration (NIA) and Department of Agriculture-Regional Field Office (DA-RFO). After the training, these partners were the ones who did the community orientation about the project. The training duration was usually conducted 1-3 days. The other level of training was for farmers, which was done for one cropping season following the Farmer Field School (FFS) approach.

B. Defining technologies for testing and validation

The technologies to be tested and validated in the different localities were first identified by PhilRice Technology Promotion Project leaders who participated in the January 2006 workshop.

In order to determine whether the technology to be validated matched the needs of farmers, a focus group discussion (FGD) was conducted at each site. Through the FGD, the rice production practices and key production constraints of farmers were identified. The FGD results and information from LGU partners and farmers were used as bases on which NRM technologies would be deployed.

C. Establishment of demo farm cum learning field

Demonstration sites, owned by farmer-cooperators, were established in which about 20-25 farmer-participants observe and monitor. Seeds, sign boards and technical advice were provided to the farmer-cooperators. In return, he followed the recommended technologies of the project on his demo farm measuring about 1,000-2,500 sq m. Farmer-participants, on the other hand, were not compelled to change their farm practices but could freely adapt any that they deem applicable on their farms. There were no seeds provided to farmer-participants; only their regular attendance and participation in the discussion and sharing of knowledge and experiences to the season-long training were required.

The demo farm served as learning field and venue for training exercises and joint field monitoring. Half-day regular farmers' classes/meetings were conducted to facilitate farmer group discussions, sharing and learning. The meetings were centered on the farming practices that would help increase farmers' yield and served as venues to formulate or give immediate action to whatever problems or issues that cropped up during project implementation. The municipal agricultural technologists (AT) served as facilitators, while PhilRice experts

served as resource persons and technical assistance providers.

The identification of a specific site as to where to test and validate the technologies was made by the project leaders of PhilRice in consultation with the officials and personnel of the Office of the Provincial Agriculturist (OPAg) and their respective municipal agriculturists. The site must be irrigated, visible and accessible so that more people, especially farmers will learn and know about the technology.

The criteria used in selecting farmer-cooperators were as follows: 1) they own and till their land to ensure that they are the decision-makers, 2) they commit to share what they have learned about the technology so it is diffused, and 3) they are capable of leading and persuading other fellow farmers within their social network and sphere of influence to try the technology.

D. Performance evaluation of NRM technologies

Farmers and facilitators from PhilRice and LGU conducted demo farm visits before each meeting to determine the performance of the introduced technology as compared to their farming practice. The field observations served as discussion points in the meeting where the strengths and weaknesses of the technology were highlighted.

Assessment meetings were also held at the end of every cropping season to report on progresses and feedbacks on the performance of technology and constraints in implementation. It was during these meetings that technology dissemination strategies and approaches were refined, and mechanisms developed to enhance impacts and sustainability and ensure that technologies were adapted to the locality and to farmers' circumstances. These were usually attended by field implementers from LGUs and PhilRice, some members of the IRRC team and selected farmers.

Also, field days and forums were held at maturity stage to inform the neighboring farming community about the technology's performance.

RESULTS AND DISCUSSION

A. Case studies for the specific NRM or integration of NRM technologies are presented below:

The following NRM technologies were validated on-farm starting wet season (WS) 2006: Site Specific Nutrient Management in Pangasinan, Sultan Kudarat, and Cotabato; Ecologically-based Rodent Management in Nueva Ecija; and Alternate Wetting and Drying in Apayao, Ilocos Norte, and Nueva Ecija.

Site-Specific Nutrient Management (SSNM)

In the three pilot provinces (Pangasinan, Sultan Kudarat, and North Cotabato) that participated in the SSNM on-farm testing and evaluation, nutrient management for rice was identified through FGD as one of the major concerns of the local farmers. The farmers usually do not have a scientific basis for their fertilizer application, which is usually done once or twice during the cropping season. Burning of rice straw after

harvest is commonly practiced. Farmers' average yield is below 3 t/ha.

The results generally showed higher yield in the SSNM plots across three locations for both WS and DS (Table 1). The average yield increase was 28.3% during the dry season and 12.6% during the wet season of 2007. In the SSNM plots, the rate of Nitrogen, Phosphorous and Potassium (NPK) fertilizer applied was 60-38-30 and 95-33-20 during the wet and dry seasons, respectively. The Farmer's Practice, on the other hand, applied fertilizer at the rate of 50-13-16 during WS and 48-13-14 during DS. Furthermore, the timing of fertilizer application on the SSNM plots was based on the leaf color chart (LCC) readings, while this was done arbitrarily in the Farmer's Practice plots. The yield increase is consistent with the findings of Pampolino *et al*. (2007) which showed that on-farm research comparing SSNM and farmers' fertilizer practiced showed increased yield with SSNM even with reduced fertilizer Nitrogen rates in some cases due to improved efficiency of fertilizer use.

After two cropping seasons of testing and evaluation, farmers have learned, as indicated in the assessment reports that using the right amount and type of fertilizer when applied at the right time can result in better yields, and that high quantity of fertilizer is not always equivalent to high yield. Seeing the effects of improved yield encouraged them to continue using the technology.

This result inspired most of the farmers to shift from their old farming practices to the new ones being promoted by the partnership project. This also made it easier for them to share the technology with other farmers. Even without much intervention from extension agents, farmers will follow visible example of those farmers whom they perceive as being successful in their farming operations (Genius *et al*., 2006; Siopongco *et al*., 2013). In Rogers' (1995) terminology, farmers learn from their "hemophilic neighbors" which are individuals with

TABLE 1
Yield comparison between farmer's practice (FP) and site-specific nutrient management (SSNM) during the wet season and dry season of 2007

Location	Yield, t/ha at 14%MC DS 2007		Yield, t/ha at 14%MC WS 2007	
	FP	SSNM	FP	SSNM
1. Kabacan, North Cotabato	5.24	7.21	5.48	5.58
2. Lambayong, Sultan Kudarat	4.34	4.08	4.32	4.09
3. Mangatarem, Pangasinan	3.57	5.57	4.51	6.44
Average yield across locations	4.38	5.62	4.77	5.37
Average amount of NPK fertilizer applied	48-13-14	95-33-20	50-13-16	60-38-30

whom farmers have close social ties and share common personal characteristics. Additionally, they have learned not to burn rice straw because of its importance in maintaining soil fertility.

Ecologically-Based Rodent Management

Zaragosa is one of the heavily rat-infested farming areas in Nueva Ecija, a major rice producing province of the Philippines. Local farmers use chemical and physical methods to control rats, which are spontaneous and conducted individually, making them less effective (Corales *et al*., 2010).

The Barangay Development Council (BDC) and the local government unit (LGU) of Zaragosa, Nueva Ecija in partnership with the Office of the Provincial Agriculturist (OPAg) and the Philippine Rice Research Institute (PhilRice) have joined a group of farmers to respond to the notorious rat problem. The interagency team laid down a stream of activities to promote effective rat management strategies. The campaign aimed to instil in the minds of farmers the following messages: community work, right timing to control rats, and the use of EBRM practices.

A 20-hectare contiguous farmland located in Sitio Mabilog served as the campaign's front. Also, a rat management technology called the Community Trap Barrier System (CTBS) was set up in this area. Farmers regularly conducted rat-hunting activities based on those recommended for specific crop stages of the rice crop such as monitoring of the CTBS, burrow digging and night hunting. Rat catches were recorded by the farmer-in-charge. This allowed farmers and local

TABLE 2
Yield data of farmer-cooperators in the EBRM site in Zaragosa, Nueva Ecija

Name of Cooperators	Actual Area (ha)	Yield, t/ha at 14%MC DS 2006	Yield, t/ha at 14%MC DS 2007
1. William Rafael	3.0	7.03	6.76
2. Eduardo Agustin	3.0	7.48	7.39
3. Larry Calderon	2.5	5.08	6.35
4. Angelito Calderon	1.0	5.44	6.58
5. Felipe Balutan	3.0	4.67	7.03
6. Danilo Madonza	1.0	7.89	7.62
7. Isaias Siobal	3.5	6.21	6.30
8. Romeo Tartado	1.25	5.62	5.31
9. Jerry Calderon	0.75	5.99	6.21
10. Arnold Villa	2.50	7.48	5.49
Total	21.5	62.89	65.04
Average	2.20	6.30	6.50

folks to see how the technology worked and provided them benefits.

Results gathered from the 20-ha rice farm in Sitio Mabilog revealed a yield increase of 0.2 t/ha or equivalent to about 5 cavans/ha from the baseline yield of 2006 DS (Table 2). The 10 farmer-cooperators used hybrid varieties in 2006 DS but have shifted back to inbred during the campaign period causing some reductions in yield. From this, it is clear that the reductions in yield were due to varietal difference and that the overall increase in yield can be attributed to the campaign. Likewise, rat damage assessment results showed that damage was down by 5% during the campaign period. This means around 19 cavans of palay were saved in the 20-ha farm due to CTBS, burrow digging, night hunting, and other campaign activities conducted. Results further emphasized the importance of community participation and understanding farmer knowledge, practices, and beliefs regarding rodents. These factors, according to Palis and Singleton (2006) largely influenced the farmers' perceptions on the effectiveness and feasibility of the EBRM technology in terms of economic profitability, social acceptability, and cultural suitability.

Alternate Wetting and Drying

The testing and validation of alternate wetting and drying technology were conducted in three sites in Northwestern Luzon, namely, Luna, Apayao; Flora, Apayao; and Currimao, Ilocos Norte; and one site in Central Luzon – Nueva Ecija. The AWD plots were set up side by side with the continuously irrigated plots.

Results in Northwestern Luzon showed slightly lower yields in the AWD plots as compared to the farmers' practice (Table 3). However, the production cost was higher for the non-AWD sites. Farmers using AWD claimed that the reduction in the production cost was due to more efficient water use but the amount saved cannot be quantified at the field level due to lack of measuring instrument. In this case, the reduction in yield is inconsistent with several studies conducted in the past (Siopongco *et al*., 2013), which showed that the practice of AWD produced no yield penalty despite reduction in irrigation.

The experience in AWD testing in Nueva Ecija, on the other hand, showed that irrigation water reaches the downstream earlier by about 10 days when upstream farmers adopt AWD unlike before when it takes 30 days for the water to reach downstream. Consequently, farms which were traditionally not planted to rice during dry season were cultivated and planted to rice when AWD was adopted thereby increasing cropping intensity within the service area of NIA.

B. Upscaling: Integrating NRM technologies into the National Rice Programme

Evaluation of NRM technologies for two successive seasons revealed some improvements in farmers' productivity and encouraged the partners to upscale the technologies (refer to the tables). Scaling up

TABLE 3
Yield and production cost comparison between AWD and non-AWD practitioners in Ilocos Norte and Apayao

Location	AWD practitioner		Non-AWD practitioner	
	Yield, t/ha at 14%MC	Production cost/ha	Yield, t/ha at 14%MC	Production cost/ha
1. Currimao, Ilocos Norte	5.11	20,613	6.00	26,822
2. Luna, Apayao	4.82	18,550	5.20	20,750
3. Flora, Apayao	5.92	19,870	6.30	22,530
Average across locations	5.28	19,677	5.83	23,367

or upscaling means expanding, replicating, adapting, and sustaining successful policies, programs, or projects to reach a greater number of people; it is part of a broader process of innovation and learning (Linn, 2012). With NRM, it means intensifying dissemination efforts in order to bring the technologies and its benefits to a greater number of beneficiaries.

PhilRice started lobbying for the inclusion of validated NRM component technologies to the *PalayCheck* system, the technology platform being used by the National Rice Program. This was done through meetings with IRRI and key officials in the DA such as with the National Rice Program Director. Also, high ranking officials at the provincial level were informally informed about the PhilRice-IRRI project. The idea was conceived to enhance farmers' access to improved and environment-friendly technologies in rice production through some policy support. This implied putting some financial and manpower resources from the side of the Department of Agriculture in order to improve outreach and coverage of NRM technologies thereby more farmers benefiting from the NRM technologies.

Similarly, a committee for the nationwide promotion of AWD involving the Upper Pampanga River Integrated Irrigation System (UPRIIS), BSWM, NIA, IRRI, and PhilRice was created. The committee, after a series of meetings facilitated by the National Rice Program Coordinator who happened to be a PhilRice key staffer and a member of this collaborative project, was able to convince the office of the DA Secretary of the significance of increasing water-use efficiency. In April 2008, the DA Secretary issued Special Order No. 266 mandating the creation of a Technical Working Group (TWG) to study and formulate guidelines for implementing water-saving practices for irrigated rice areas in the country. The draft guidelines were presented to NIA personnel in the regional and system levels, officials of confederated water users and Irrigators' Associations (IAs), regional and provincial agriculture officials and representatives from state universities and colleges (SUCs) in four selected regions. In November 2009, more than one year after

the TWG was created, Administrative Order No. 25 mandating the nationwide adoption of water-saving technologies in irrigated rice production systems in the country was issued by the DA Secretary. Moreover, a memorandum was also issued by the Operations Manager of UPRIIS directing all NIS personnel to incorporate AWD at all levels in system management. This means adopting AWD in all five divisions of the system and targeting 80% of all farms in the service area to adopt AWD by 2015. After UPRIIS adopted AWD, NIA Regional Offices 1, 2, 3, 12, CAR and the Magat River Integrated Irrigation system (MARIIS) followed suit, thereby expanding the rice areas following AWD practices.

Furthermore, a year after EBRM implementation, upscaling of its activities was conducted in eight other municipalities of Nueva Ecija: Cabanatuan City, Sta. Rosa, San Leonardo, Peñaranda, San Isidro, San Antonio, Cabiao and Jaen. The activity was incorporated in the Farmer Field School program jointly implemented by the LGUs and the Regional Crop Protection Center (RCPC).

Eventually, the *PalayCheck* system was upscaled to the National Rice Program of the Department of Agriculture named FIELDS (Fertilizer, Irrigation, Extension, Loans, Dryers, and Seeds) in 2008. The NRM technologies were eventually included in the *PalayCheck* platform of PhilRice, thus, facilitating upscaling and outscaling.

C. Strategies and approaches that facilitated delivery of NRM technologies

The following strategies and approaches were utilized in improving the dissemination of NRM technologies:

Forged/revitalized partnerships with stakeholders

One of the main goals of the ICOP project was to help in enhancing the productivity of farmers through the use of improved and environment-friendly technologies in rice production. In order to achieve this goal and to ensure that resources were managed well, partnerships with other extension providers such as LGUs, NGOs, farmers' associations, private companies and other government agencies were revived and or forged.

Among these partners included the Office of the Provincial Agriculturist (OPAg), Municipal Agriculture Office (MAO), Agricultural Training Institute (ATI), National Irrigation Administration (NIA), Department of Agriculture-Regional Field Office (DA-RFO) and Alalay sa Kaunlaran, Incorporated (ASKI). Partner organizations shared their resources – farmers provided labor counterpart; LGUs provided staff to oversee field activities; NGO-partners conducted social preparation and credit assistance; and PhilRice provided technical and some seed assistance. The partnership with ASKI, a microfinancing NGO, enabled farmers in Mangatarem, Pangasinan to discover the comparative advantage of SSNM against their fertilizer application practice.

Several other partnership projects branched out or were further strengthened owing to the collaborations established. Through these networks, innovation and information sharing on the best practices in rice production were shared, thus, facilitating technology delivery and dissemination. The good relationships among partners were brought about by the knowledge that the project was being done for a common purpose – to enhance the productivity and profitability of farmers through the use of improved and environment-friendly technologies in rice production. Without these partners who have been PhilRice's network in its technology promotion activities, it would have been difficult for the project to accomplish the targeted activities at community, provincial, and national levels. Although the linkage strategy sounds simple, according to Ruaysoongnern (n.d.), the practices were extremely delicate and requires continuous goodwill at all levels.

Established technology demonstrations and employed community-based information campaign

In the wet season of 2006, 23 demonstration farms showcasing NRM technologies were established; these were managed both by farmers and PhilRice. These demonstration farms were maintained and about 50 more were added in 2007. Through the demonstration farms, farmer-cooperators were able to put their newly acquired skills into practice and have seen for themselves the performance of the technologies and how these benefited them.

There were times when technology demonstration is not enough such as rodent management. This was what happened in the promotion of ecologically-based rodent management (EBRM) in Nueva Ecija. The project team members resorted to a community-wide information campaign in order to enhance awareness and improve technology dissemination. Creative campaign materials were developed and distributed not only to farmers but to school teachers, students, and agricultural workers as well using different media. The campaign was featured in a documentary TV program with nationwide network coverage. The Philippine Agricultural Journalists Inc. awarded it the Agricultural Information Campaign of the Year.

Provided assistance in capacity building

Enhancing the capacity of partner researchers and extension workers through trainings and technical briefings was conducted by PhilRice and IRRI at the start of the project to ensure that there was common understanding of the technologies for evaluation and dissemination. Partners were also given chance to attend workshops and exposure trips that provided opportunities for knowledge sharing or meaningful interactions with IRRI scientists. They were also given chances to present their outputs during assessment meetings, all of which contributed in building and strengthening the capacity of partners in doing research and development work, thus, contributing to better project implementation and enhanced technology delivery.

Mobilized local champions to actively participate in the technology testing and evaluation process

The local leaders have been very important in the project for they were responsible in ensuring that farmers were available during the scheduled meeting. The leaders made things easier in the field. Ground working activities were carried out by them together with the LGUs. In other words, through the local leaders, project activities were directly communicated to the community, thus, contributing to enhanced technology delivery.

Utilized participatory approach in project monitoring and evaluation

A project monitoring system was designed to keep track of activities and achievements not only at the project level but in the field as well. For example, in Zaragosa, Nueva Ecija where EBRM was promoted, regular visits to check progress of the campaign activities were done. Farmers monitor EBRM implementation by completing CTBS rat catches monitoring sheets, and through open discussion and games. Knowledge, attitude, and practices monitoring were facilitated by PhilRice through dialogue, quizzes, or fun activities. Program of activities were modified based on feedbacks gathered.

At project level, end-season reviews were conducted to analyze performance and formulate refinements of plans. This also gave key project implementers the chance to share their learning, shortcomings and other accomplishments related to project implementation.

D. Challenges encountered in the pathway towards nationwide extension

The following were some of the challenges met during the project implementation:

1. Documentation. Most often, only the technology performance such as yield was documented by partners. Documenting the constraints and facilitating factors in adoption, the lessons learned in dissemination and the social aspects of the outreach should be emphasized, as well as the project intended to learn the different pathways that lead to nationwide extension. Establishing proper monitoring, evaluation, and documentation of the activities could result in more innovations to improve the system of implementation.
2. Limited capacity of partner-LGUs. Partners, particularly local government units have very limited capacity and resources when it comes to doing development and extension work, as indicated by the weak linkage between research and extension system in the Philippines. They cannot conduct regular monitoring of demo farms and their participation to end-season reviews, meeting, and planning workshops was very limited due to budget constraints.
3. On partnerships. The multi-stakeholder partnerships of farmers and farmer-groups, DA government agencies, PhilRice, IRRI, and LGUs enabled the upscaling and out-scaling of

technologies from the farmer's field through technology demonstration to DA nationwide extension through the *PalayCheck* extension platform. During the initial phase of the project particularly in the conduct of campaign activities in Nueva Ecija, implementation was weak because the roles of partner agencies were not clearly defined. As a result, there were difficulties in achieving project deliverables. A clear hierarchy of roles and responsibilities was then established with partners for effective community campaign. Thereafter, the local government unit took leadership and worked closely with the BDC, farmer groups, and other sectors in the community. This led to an effective campaign implementation.

CONCLUSION

In view of the above results and discussion, the following conclusions are being put forward:

Evaluating the NRM technologies through on-farm testing and evaluation for two successive seasons revealed some improvements in farmers' productivity. This was shown in the yield increases in the SSNM plots due to the application of the right amount of fertilizer when the crops actually needed it, as well as the timing of fertilizer application based on the leaf color chart readings. Similarly, by promoting rodent management technologies, a yield increase of 0.2 t/ha or equivalent to about 5 cav/ha was obtained in the 20-ha demonstration plot due to CTBS, burrow digging, night hunting, and other campaign activities conducted. Rat damage assessment results further showed that damage was down by 5% during the campaign period. Moreover, testing and evaluation of AWD showed yield increases in the upstream and midstream across time but not in the downstream.

The above results as observed by the farmers encouraged them to continue using the NRM technologies as well as sharing it with others. The favourable results paved way to integrating NRM technologies into the National Rice Program by lobbying for their inclusion to the *PalayCheck* system thereby more farmers benefiting from the NRM technologies.

Strategies and approaches that facilitated delivery of NRM technologies included forging partnerships with stakeholders, establishing technology demonstrations and employing community-based information campaign, providing assistance in capacity building, mobilizing local champions in actively participating in the technology testing and evaluation process, and utilizing participatory approach in project monitoring and evaluation. Each approach significantly contributed in the enhanced dissemination of the NRM technologies.

Among the challenges encountered in the pathway towards national extension were documentation, limited capacity of partner-LGUs and role definition. Documentation became an issue since partners usually only managed to document just the technical performance of the project. Roles of partner agencies were not clearly defined at the initial phase of the

EBRM campaign resulting in difficulties in achieving some project deliverables. Limited capacity and resources of partner-LGUs also became a problem since these did not always allow them to conduct regular monitoring of demo farms and to participate in the end-season reviews and meetings. In spite of these challenges, the overall project implementation is deemed successful as it has benefited Filipino farmers and achieved its aim to enhance the delivery of NRM technologies and R&D exchange of information.

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