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Final report

project

Diversification and intensification of rice-based cropping systems in lower Myanmar (MyRice)

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1 Acknowledgments

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We are grateful to the Ministry of Agriculture, Livestock and Irrigation (MoALI), especially the Department of Agriculture (DoA) and the Department of Agricultural Research (DAR), and local officials of the DoA region, districts, and townships of the Ayeyarwady and Bago regions for the support and technical assistance they provided to the project.

We highly appreciate the active participation of the farmers in the project’s selected villages and townships. Their assistance and enthusiasm for learning new practises were highly beneficial to the MyRice project.

2 Executive summary

The MyRice project conducted adaptive research on cropping options to increase and sustain productivity of both rice–rice and rice–pulse cropping systems in the Ayeyarwady Delta (Ayeyarwady and Bago regions) in Myanmar from 1 July 2012 to 31 December 2017. The project aimed to improve farmers' profitability through developing best practises for rice production, including postharvest management and innovative approaches to improve the productivity of rice–rice and rice–pulse cropping systems.

Best practises for rice and pulse production and new varieties of rice and pulses were tested under standard protocols in farmers' fields. Later, once the farmers had observed scientist-led field trials for 2–3 seasons, they selected and then tested new management practises and new varieties. The new varieties were introduced to farmers via farmer participatory varietal selection and the field data on the performance of the varieties fast-tracked the release of 12 new rice varieties over the 5.5-year study (Box 1). Following on from these studies, 1,796 farmer-cooperators from 39 townships received 49,581 kg of registered seeds of rice varieties they favoured during their participation in trials or based on recommendations from farmers who had grown the varieties. New pulse varieties also were tested and these were the first new varieties that most farmers had seen in 25–30 years.

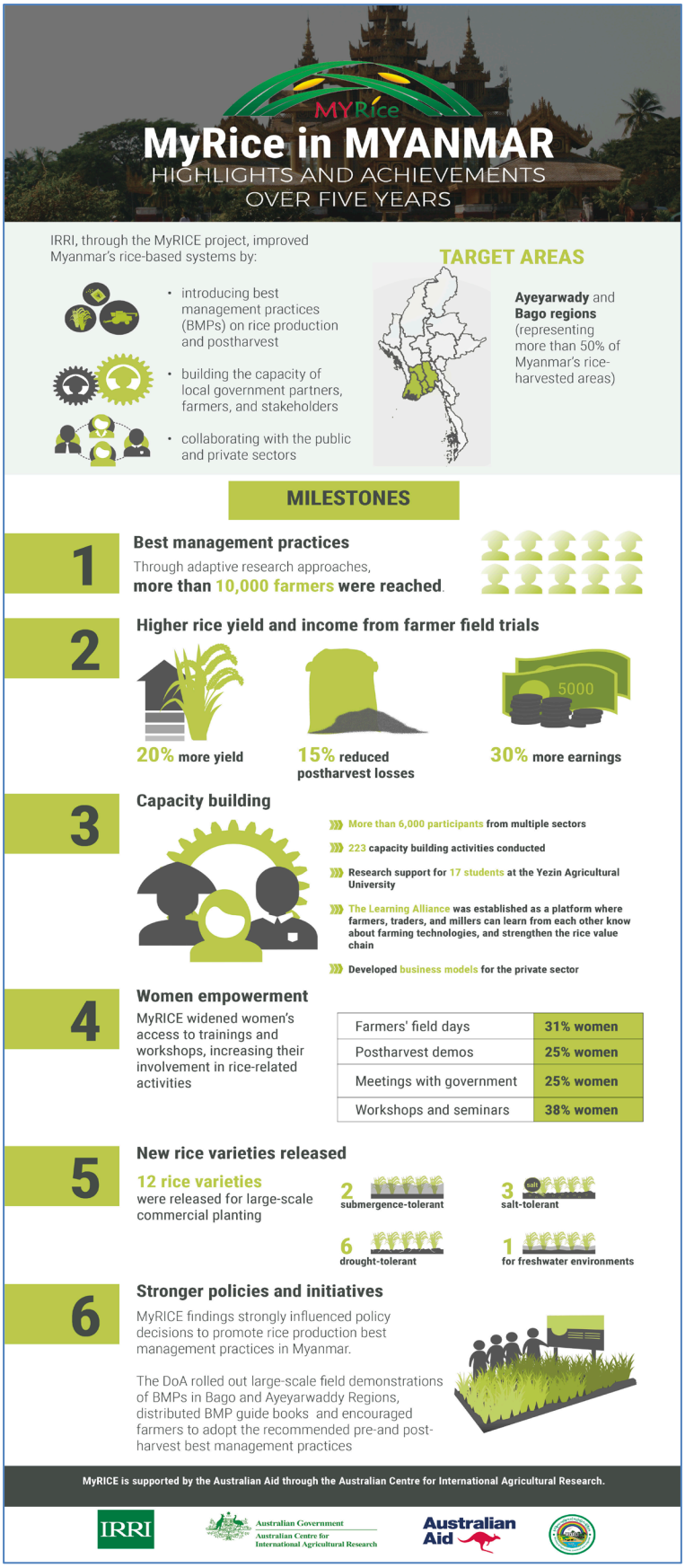
The MyRice project reached more than 10,000 farmers in the Ayeyarwady and Bago regions (Box 1). Some 3,670 farmers were directly involved in the field trials. In the last year of the project, the "best management practises" for lowland intensive rice–rice and rice–pulse systems were rolled out in a national initiative. Each of the main rice production districts had to establish 0.16 ha- (0.4-acre) demonstration plots in their farmer outreach camps.

Our detailed studies, established in farmers' fields with their participation in the implementation of best practises, indicated that yield increases were consistently more than 20% higher than farmers' practises. In addition, improved postharvest management reduced losses by, on average, 15%; this included reduced rodent losses. The improved postharvest management of rice also improved the quality of the rice and increased the sale price. Farmers who implemented best management practises pre- and postharvest increased their income by 30%.

Detailed baseline and endline household surveys were conducted in August 2012 and in August 2017 in Daik-U. Data from these surveys provided a clearer picture of the changes in management practise and increases in farmers' income. The adopters in rice–rice cropping system had a significant increase of net income over both crops of USD278 per ha. Adopters in rice–pulse system had a net annual increase in income of USD280 per ha.

In August 2017, we surveyed a subset of farmer households in Daik-U and Maubin that had adopted best management practises to determine the "most significant changes" (MSC) in their livelihoods resulting from the outcomes of the study. Around 30% of the households reported a significant net positive change in income. The mean increase for these households was USD94.36 per ha per year, with a mean area of 6 ha of rice production per family per year (3.5 ha in the wet season [WS] and 2.5 ha in the dry season [DS]). The impact of the outcomes of the study on livelihoods of these smallholder families was an increase in expenditure on their religious and sociocultural engagement in the village (38%), on food (21%), education (15%), healthcare (15%) and other expenses such as cellphone credits, transportation, electricity and apparel (10%).

Qualitative data on gender equity highlighted that women had strong involvement in decision-making at a household level but not at a village level. They also did not have the same level of access to training opportunities. Based on these findings, we made a concerted effort to change how farmer training events were planned and conducted in the last 18 months of the project.



Box 1: Overview of key findings in the MyRice project.

Specific project highlights follow:

1. **Influenced policy approaches at district, regional and national levels**: We held high-level meetings with the Department of Agriculture (DoA), the Department of Agricultural Research (DAR) and Ministry officials in Nay Pyi Taw at least every 4 months. In May 2016, we met with the new deputy minister of the new Ministry of Agriculture, Livestock, and Irrigation (MoALI); the DGs of DoA, DAR and the Department of Planning and the rector of Yezin Agricutural University (YAU). In the afternoon, these officials, together with more than 100 MoALI staff, attended presentations at DAR from IRRI, DoA and DAR staff on MyRice.

   In October 2016, the DoA Regional Directors of the Ayeyarwady and Bago regions presented the activities and accomplishments for 2015–16 activities and plans for the 2017 WS activities. The planned 2017 WS activities were to reach more than 2,000 new farmers in the two regions. Both directors committed to DoA covering most of the costs associated with the planned outreach activities and taking the lead in implementation and monitoring (see Appendix Table 4A).

   In October 2016, Myanmar's Honorable Permanent Secretary for Agriculture launched manuals on best management practises for rice–rice and rice–pulse systems that were produced from the findings of the MyRice collaborative project. The manuals are available in both Myanma and English. In early 2017, the findings from our project strongly influenced a policy decision to promote a new national initiative to establish demonstrations on "best management practises" for rice production in each district within the main rice-producing provinces. The best practises are drawn from the findings of our project and replace the previous policy of promoting "good agricultural practises."

2. **Empowering women and girls**: In 2015, we conducted focus group discussions to identify issues across the five domains of the Women's Empowerment in Agriculture Index: production, resources, income, leadership and time allocation. Women appeared to have equal access to production resources, such as land and inputs, and greater control over household income than men. Importantly, women reported that they did not feel empowered at the community-level because they had little input into decisions made by farmer groups. Also, women reported that they had considerably less access to training opportunities.

   A journal article covering the study is published in *Food Policy* (see item 10.2 List of publications produced by the project).

3. **Field trials**: From 2013 to 2017, there were 48 field trials and other activities that involved the participation of 3,251 farmer-partners. The field trials focused on new best management practises, pre- and postharvest, and testing locally adapted early-maturing and high-yielding rice and pulse varieties. An additional 320 farmer-cooperators completed farmer diaries from WS 2014 to DS 2016–17. In the WS 2016, we placed key production data "instantaneously" on the cloud from interviews of 67 farmers using an "App" that we developed using CommCare. A partial list of field trials and other activities from WS 2016 to WS 2017 is in Appendix Table 1.

4. **Natural resource management**: In 2014–15, four new monsoon rice varieties provided a 0.6- to 1.0-t/ha yield advantage over the current variety used by farmers and two new summer rice varieties providing up to a 0.2-t/ha yield advantage over the main variety used by farmers. Moreover, postharvest technologies reduced losses by from 13 to 16%. The midterm review of MyRice (July 2015) provides details of these studies. In the 2015 and 2016 WS and 2015–16 DS, improved rice varieties and improved management practises were compared to farmer varieties and farmer management, both in replicated trials and in larger-scale field demonstrations (0.4 ha/farmer) both for rice–rice and rice–pulse systems. Nutrient management trials also were implemented in both crop systems. Partial cost-benefit analyses for the 2015 WS indicated that improved varieties (n = 3) and improved management (IV+IM) practises for monsoon rice in rice–rice systems increased

yield by from 7 to 56%. Farmers who used Yemyoke Khan2 plus IM increased their income by 81%; however, the other two varieties did not return increased profit because the total cost of production for improved management practises increased by more than 40%. For summer rice in rice–rice systems, yields increased significantly by 6 to 15% for three new varieties. Production costs for IM increased by approximately 7%.

In the 2016 WS, IV + IM practises for monsoon rice in rice–rice systems increased yield by from 23 to 33% for two new varieties. A 45% increase in income was obtained using SinThwe Latt variety and -2.3% using Inpara 3 compared to the farmer variety (Sin Thu Ka) (see Appendix Table 7A). For monsoon rice in rice–pulse systems, yield increased by 47 and 43% for IV1 (Pyi Taw Yin) and IV2 (Sin Thwe Latt), respectively. This resulted in income increases of 229 and 327%, respectively, compared to the farmer variety (Sin Thu Ka) (see Appendix Table 7B).

In the 2015–16 DS for pulses in rice–pulse systems, improved black gram varieties (n = 2) plus IM increased yields by from 30 to 55%. IM costs are considerably higher (>50%) and these need to be reduced before we roll out the IV and IM. For green gram, two IV + IM increased yield by 10%. More importantly, the improved varieties realised considerably higher prices in the market resulting in increased profits to farmers of greater than 130%.

The use of drum seeders compared with broadcast seeding led to a positive benefit-cost ratio (B/C ratio). This was more evident during the summer rice crop in rice–rice systems.

5. **Outreach to other townships and districts in two regions**: In 2016 WS, 2016–17 DS and 2017 WS, 683 large-scale best-management practise (BMP) demonstrations for rice in rice–rice and 1,045 demonstrations for rice in rice–pulse systems (@1 acre/farmer) were implemented. An additional 14 large demonstrations for green gram and 198 for black gram in the rice–pulse system were implemented in the 2016–17 DS (see Appendix Table 1).

   In the 2016 WS in the Ayeyarwady Region, IV + IM for monsoon rice in the rice–rice system increased yields by from 5 to 27% and increased income by from 11 to 37%, compared to FV+FM. The improved varieties included Manaw ThuKa 2, Sin Thwe Lattt, and Pyi Taw Yin (see Appendix Table 8A). In the same year, monsoon rice crops in rice–pulse systems had increased yields of from 1.5 to 13% and increased income by from 2.0 to 36.5%. The improved varieties included Sin Thwe Latt, Manaw Thuka 2 and Pyi Taw Yin (see Appendix Table 8B). In the Bago region, IV + IM for monsoon rice in rice–rice system had an increased yield of from 0.7 to 9% and increased income of from 17 to 40%. Improved varieties included Pyi Taw Yin and Shwe Pyi Tan (see appendix Table 8C). For monsoon rice in rice–pulse system, IV + IM had an increased yield of 4.8% and increased income of 5.7%. Improve varieties included Pyi Taw Yin and Sin Thwe Latt (see Appendix Table 8D).

   In the 2016–17 DS, IV + IM for summer rice in the rice–rice system increased yields by from 5.7 to11.5% and increased income by from -2.3 to 30.9% in the Ayeyarwady region, while there were increased yields of from 1.4 to 9.7% and increased income of from 3.1 to 21.6% in the Bago region. The negative values related to the increased costs incurred from additional inputs such as fertiliser. The improve varieties included Pyi Taw Yin and Yaenelo 7 (see Appendix Table 9A and 9C).

   For pulse crops in rice–pulse systems, an improved black gram varieties + IM had increased yields of from 3.6 to 8.3% and increased income of from 9.7 to 12.4% compared to FV+FM. Improve greengram varieties + IM increased yield by from 11.8 to 26.1% and increased income by from -15.6 to 14.2% (see Appendix Table 9B and 9D).

   Large-scale BMP demonstrations of monsoon rice in the rice–rice system (at 1 acre/farmer) in the 2017 WS were set up in 297 farmers' fields in the Ayeyarwady region covering seven townships and in 195 farmers' fields in Bago region covering 10 townships. In the same season, large-scale demonstrations of monsoon rice for the rice–pulse system (at 1 acre/farmer) were set up in 526 farmers' fields in the Ayeyarwady

region covering 17 townships and in 460 farmers' fields in the Bago region covering 13 townships (see Appendix Table 1). Maps showing the test sites in Maubin and Daik U townships plus the other townships in the two regions for the outreach sites are shown in Appendix Figures 12 and 13. The implementation and monitoring of these field demonstrations are now being led by the DoA with technical support from IRRI project staff.

In the 2017 WS in the Ayeyarwady Region, IV + IM for monsoon rice in the rice–rice system increased yields by from 6 to 17% and increased income by from 22 to 108%, compared to FV+FM. The improved varieties included Yaenelo 7, Pyi Taw Yin and Sin Thwe Lattt (see Appendix Tables 10A and 10B). Some farmers compared the performance of the farmer variety Sin Thu Kha and Paw San Yin with the farmer management and improved management. Results showed that with IM, yield increased by 8% using Sin Thu Kha variety and 35% using Paw San Yin variety giving an increased income of from 18 and 180%, respectively (see Appendix Table 10B). In the same year, monsoon rice crops in rice–pulse systems had increased yields by 6 to 10% and increased income by from 22 to 108%. The improved varieties included Yaenelo 7, Sin Thwe Latt and Pyi Taw Yin (see Appendix Table 11). In the Bago region, IV + IM for monsoon rice in rice–rice system had an increased yield of 9% and increased income of 7%. Improved varieties included yaenelo 7, Pyi Taw Yin and Sin Thwe Latt (see Appendix Table 12). For monsoon rice in rice–pulse system, IV + IM had an increased yield of 11% and increased income of 19%. Improved varieties included Yaenelo 7, Pyi Taw Yin and Sin Thwe Latt (see Appendix Table12).

6. **Varietal trials**: Through partnership with DoA and DAR, participatory varietal selection (PVS) trials were implemented leading to the release of: (a) two varieties with increased tolerance for submergence in rice–rice systems (Yemyoke Khan 1 and 2), (b) six varieties with increased tolerance for drought (Yeanelo 2, 3, 4, 5, 6 and 7), (c) three varieties with tolerance for salinity (Saltol Sin Thwe Latt, Pyi Myanmar Sein and Swe ASEAN), and (d) one variety for favourable freshwater habitats in rice–rice systems (Pyi Taw Yin). Traits and characteristics of these varieties are listed in Appendix Table 13. Four promising lines were identified for registration in 2017 that are high yielding with tolerance for submergence (Inpara 3, IR85309-Sub1-156-1-1-1, IR85309-Sub1-28-1-1-1-1 and IR79207-52-2-3-3). The latter variety also has tolerance for stagnance.

7. **Seed distribution**: From the 2014 WS to the 2017 WS, 1,796 farmer-cooperators from 39 townships received 49,581 kg of registered seeds (RS) of improved monsoon rice varieties (Pyi Taw Yin, Yaenelo 7, Sin Thu Ka, Yadanar Toe, Shwe Phyi Tan, Manaw Thu Ka, Sin Thwe Latt, Thee Htat Yin, IR85309 Sub 1 156-1-1-1 and IR79207-52-2-3-3) (see Appendix Table 4A).

   From the 2014–15 DS to the 2016–17 DS, 184 farmer-cooperators from 10 townships received 5,229 kg of RS of improved summer rice varieties (Pyi Taw Yin, Pyi Myanmar Sein, Yaenelo 1, Yaenelo 4, Yaenelo 7 and Yn 3155-41-18-3-7-1) (see Appendix Table 4B). In addition, from the 2014–15 DS to the 2016–17 DS, 319 farmer-cooperators from 12 townships received 11,360 kg of RS of improved green gram and black gram varieties (Yezin 2, Yezin 3, Yezin 5, Yezin11, Yezin 14, Pale Tun) (see Appendix Table 4C). Seed production of these varieties was mainly managed on the DAR and DoA seed farms. Some DAR contact farmers also provided RS.

8. **Pest monitoring**: Monitoring of the major diseases and pests in rice crops was done for three consecutive years (2014–16). In Maubin, the most common disease and pest were bacterial blight and stem borer, respectively, while in Daik-U, the most common pests were weeds and rodents.

9. **Postharvest loss assessments**: Postharvest loss assessments were carried out over two WSs (2013 and 2014) and two DSs (2015 and 2016). All trials were conducted in Maubin Township. In 2015, combine harvesters caught the attention of rice farmers. The

use of combines was added as a BMP together with the flatbed drying and hermetic storage. We demonstrated that BMPs postharvest can reduce losses by 12%.

In all trials, the grains processed using BMPs consistently had higher milling recovery (from 1 to 12%) and head rice recovery (from 2 to 11%) than the grains processed using traditional farmers' practise. Field stacking or piling of unthreshed rice, delayed threshing, sun-drying and traditional storage all contributed to low-milling recovery and low-head rice recovery of grains using farmers' practise. Through a learning alliance (LA) established in Maubin, it was demonstrated that farmers can receive a higher price by selling better quality grain.

10. **Sustainability analysis for different postharvest management practises**: A life cycle-based comparative analysis, including energy efficiency and greenhouse gas emissions (GHGE), was modeled based on postharvest loss assessments conducted in Maubin Township in the 2014 WS and 2015 DS. In the 2014 WS, application of improved management practises (IMPs), which included short delays prior to threshing paddy in the field, use of flatbed dryers and hermetic storage, could cut losses by half or two thirds equivalent to from 20 to 30% of the milled rice produced, reduce costs by 30% (USD 50) and slightly reduce GHGEs during the postharvest operations. In the 2015 DS, postharvest loss of the IMP was lower by 5 times (25% of rice produced). The IMPs also saved energy consumed, reducing energy costs by half.
11. **Business models**: Farmers involved in the LA in Tar Pat West (rice–rice systems) and Nga Gyi Gayat (rice–pulse systems) villages of Maubin township organised themselves into small groups to develop business models around the demonstrated postharvest technologies (lightweight thresher, solar bubble dryer and grain safe) for rice and pulses. Farmers from Phaung Wae village of Daik-U township used the lightweight thresher for pulses. The LA also facilitated formation of networks that enhanced innovation. The laser-levelling demonstration in Maubin township brought together different sectors to discuss how the laser-levelling equipment could be optimally used to provide service to farmers. This resulted in the donation of one unit of laser-levelling equipment to the project to be used by the farmer group in Maubin from Trimble Co.
12. **Rodent losses in rice stores**: In the 2013 WS, the mean loss of grain in storage to rodents was 10.63% (±1.16% SE). Total grain loss over 6 months could feed five people for 4 months. In the 2014 WS, the mean loss of grain in storage to rodents was 1.22% (±0.42% SE). Total grain loss over 6 months could feed two people for 1 month. Rice grain also was contaminated with rodent faeces (ranging from 10 to 16 per 1,000 cc). The 2014 and 2015 trials generated the following findings: (a) mean cumulative losses from grain stores and in the field were 165.3 kg (enough to feed a family of five for 1.6 months) in Maubin and 34.9 kg (enough to feed a family of five for 18 days) in Daik-U; (b) a pilot study of community village-level rodent management in Maubin and Daik-U townships showed that farmers can benefit by USD 81/household. See published journal paper (Htwe et al. 2017) for details.
13. **Household surveys in Daik-U**: The household study confirmed that the Myrice project resulted in increased yields, lower production costs and higher net income for farmers in the study villages. The cost incurred for monsoon rice production for rice–rice and rice–pulse cropping systems of adopters were lower by USD 47 and 20 per ha. The production costs for summer rice was also lower by USD 19 per ha.

    There was a significant yield increase in rice for both rice–rice and rice–pulse cropping systems of adopters in both seasons. Yield increased by 572 kg per ha (23%) for monsoon rice under a rice–rice cropping system. There was also an increase in the monsoon rice yield of rice–pulse adopters of 291 kg per ha (9%). Adopters with rice–rice crop system had a significant increase in yield for summer rice of 25% (661 kg per ha) while their pulse yield increased by 39% (258 kg per ha).

    The adopters from rice–rice cropping system had a significant net increase in income during the monsoon season of USD 179 per ha, while adopters from rice–pulse system

had a net increase of USD 101 per ha. Adopters with rice–rice cropping system had a net increase of USD 99 per ha in their summer income; indicating a USD 278 net income for rice–rice production systems.

In two seasons, there was a significant yield increase in rice for both rice–rice and rice–pulse cropping systems of adopters. Yield increased by 23 and 9% for monsoon rice–rice and rice–pulse systems, respectively. Adopters with rice–rice crop system had a significant increase in yield for summer rice of 25% while pulse yield increased by 39%.

14. **Most significant change of increased income to household:** In the townships of Daik-U and Maubin, the influence of adopting MyRice technologies on the income and spending power of smallholder families was determined through a semi-structured interview. Partial budget analysis of farmers interviewed indicated that 30% of the 101 farmers interviewed for feedback on the most significant change (MSC) reported a substantial increase in net income; mean of USD 94.36 per ha. The farmers mentioned that 38% of this extra income was spent on their religious and sociocultural engagement in the village, 21% on food, 15% on education, 15% on healthcare and 10% on other expenses such as cellphone credits, transportation, electricity and apparel.

    There has been a great variety of changes for the families since the BMPs have been rolled out in the community. These changes are not only on a personal level but also on a community level. People invested back into farming, in their health through improved nutrition and in their children by enabling them to extend their time in education activities rather than spending time working on the farm. Furthermore, more time and finances were spent on community activities, which seemed to strengthen the communities and enabled communities to improve their infrastructure. People gained not only materialistic advances from the BMPs; they also broadened their own knowledge, which they were able to transfer into other areas of agriculture. Interestingly, parents generally wanted their children to become educated to work in high-profile positions, such as doctors or engineers, rather than follow a life of farming.

15. **Capacity building**: The MyRice project increased the capacity and awareness of partners by conducting 223 training events, workshops, farmers' field days and meetings with high-level officials. These were attended by 3,670 (16.7% women) farmers; 2,824 (58.7% women) staff from the DoA, DAR, DoF and YAU and 133 (58.3% women) partners from the private sector (see Appendix Table 2A). The MyRice project provided research thesis support to 16 MSc students and 1 PhD student (5 male, 12 female) from DoA and DAR. All were enrolled at YAU. Two MSc students graduated in November 2015, nine MSc students graduated in November 2016 and the rest graduated in November 2017 (see Appendix Table 5). One scientist, Ms. Ohnmar Myint, from DAR was successful in obtaining a John Allwright PhD Fellowship; she conducted her PhD on aspects of plant breeding at the University of Queensland.

16. **Visit of high officials from Australian government:** One of the key project sites was visited on two occasions. On 27 February 2017, Mr. Andrew Campbell, the chief executive officer of ACIAR; Ms. Esther Sainsbury, first secretary of the Australian Embassy in Myanmar and ACIAR commissioners Don Heatley (commission chairman), Catherine Marriot, Lucinda Corrigan, Tony Gregson and John Cook visited the project. Other accompanying delegates were Eleanor Dean (general manager, Outreach and Capacity Building), Peter Horne (general manager, Country Programs), Suzanne Gaynor (executive officer), Maree Livermore (executive officer, Country Programs), Dulce Simmanivong (regional manager) and Ohnmar Khaing and Myo Thura (ACIAR Myanmar program manager and program coordinator, respectively), visited the rice–fish, rice–rice and rice–pulse project and met with some farmer beneficiaries and DoA and DoF staff. On 14 March, H.E. Senator Concetta Anna Fierravanti-Wells, Australian Minister of International Development and the Pacific (www.aph.gov.au/Senators_and_Members/Parliamentarian?MPID=e4t), visited the project site in Tar Pat West Village and met some farmer-beneficiaries and DoA and DoF officials. Other Australian officials were Ms. Michelle Pendrick (advisor to the minister), H.E. Mr.

Nicholas Coppel (Australian Ambassador to Myanmar), Mr. Philip Green (first assistant secretary, Department of Foreign Affairs and Trade, DFAT, Canberra), Ms. Jo Ronalds (assistant director, Myanmar Section, DFAT, Canberra), Mr. Nick Cumpston (counsellor, Australian Embassy Yangon) and Ms. Esther Sainsbury (first secretary, Australian Embassy Yangon).

17. **Cross-project collaboration**: MyRice established active collaboration with the Legume (MyPulse), Fisheries (MyFish) and Livelihood (MyLife) projects. These activities included: (a) improved nutrient management system in rice–pulse cropping systems through input from MyPulse colleagues; (b) implemented a rice–fish farming project in collaboration with MyFish colleagues and piloted the solar tunnel dryer for drying fish; (c) LA meetings included observations and inputs from MyLife colleagues; (d) cosupervised and funded MSc students from the Socioeconomics Department, YAU (MyLife); (e) trained YAU colleagues on survey techniques to assess the Women's Empowerment in Agriculture Index (MyLife) and (f) assisted at the inception workshops of SMCN/2014/044 ("Management of nutrients for improved profitability and sustainability of crop production in central Myanmar") and LWR/2014/075 ("Land resource evaluation for productive and resilient landscapes in the Central Dry Zone of Myanmar").
18. **Collaboration with other IRRI projects**: The MyRice project actively collaborated with other IRRI projects in Myanmar, including two LIFT UNOPS-funded projects in the lower Ayeyarwady delta, SDC-funded CORIGAP project and USAID-funded STRIVE project, with joint in-country activities on training, seed multiplication and gender-equity analyses.
19. **MyRice executive committee**: The executive committee of the MyRice project was composed of representatives from DoA, DAR and IRRI. Two meetings were held every year in May and October.
20. **Engaging the private sector**: Linkages of farmer groups with the private sector were facilitated through LA meetings and business model development.
21. **Publication and extension materials**: Nine publications in refereed journals, one book chapter, 15 news articles, 16 sets of extension materials, and 17 theses were completed. One of the key products of the MyRi**ce** project is the development and distribution of production and postproduction techno-guides for rice–rice and rice–pulse systems, written in English and Myanma. These guidelines are available from the ACIAR and MoALI websites. In 2016, 3,000 copies of the production techno-guides and 6,000 copies of 2-page leaflets were produced by the DoA and DAR. These were distributed during the 2016 ACIAR DFAT annual meeting and to DoA staff and farmers in the two regions. In 2017, the DoA Rice Division produced an additional 1,000 copies of the production techno-guide (in Myanma only) and 2,000 copies each of the 2-page leaflets (in Myanma only) for distribution to farmers in other regions.

3 Background

Rice is the most important agricultural commodity in Myanmar with a population of over 52 million. In 2014–15, rice was grown on about 7.17 million ha, occupying about 64% of the arable land. Only 20% of the rice is irrigated because the water supply is ample during the monsoon season. Myanmar's per capita consumption of rice is about 155.14 kg per year (Myint et al 2016) and rice provides 71% of their daily calorie intake. During the 2001–11 period, mean rice yield increased about 20%, from 3.42 to 4.07 t/ha. However, during the 2011–15 period, yield declined about 3.2%, from 4.07 to 3.94 t/ha. During the 2001–11 period, the land area under rice production increased by about 33%, but declined 14% during 2011–15 (Myanmar Agriculture in Brief 2015).

This study focused on lower Myanmar in the Ayeyarwady and Bago regions where rice and pulses are commonly grown. In the monsoon season, some 3.22 million ha are planted with rice followed by either pulses (1.45 million ha of mainly black and green gram) or summer rice. Increasing rice and pulse production in lower Myanmar represents a major opportunity to alleviate poverty and malnutrition and to improve the livelihoods of the rural poor.

The project concentrated on rice-based systems in the Ayeyarwady Delta because there are exciting opportunities to increase the diversification and productivity of lowland rice-based systems for smallholder farmers. The adoption of new rice varieties and alternative crop management options advanced the rice harvest and provided options for post rice crops and greater diversification. Further, tens of thousands of farmers harvest their monsoon rice crop and then stack it on levee banks to await threshing 2–4 weeks later. Farmers conducted this practise to allow them to concentrate on preparing their land and then sowing pulse crops on the residual moisture. A recent study indicated that postharvest rice losses associated with this practise could reach 47%; we aim for a reduction in losses of 10%. Just as important, such delays in threshing lead to low quality of the rice, and could be avoided through earlier harvest combined with better postharvest practises.

The project had two phases: Phase I was from June 2012 to July 2016; Phase II, an extension of the project, was from July 2016 to December 2017. Phase I of the project conducted research on cropping options and postharvest management to increase and sustain productivity of both rice–rice and rice–pulse cropping systems in the Ayeyarwady delta (Ayeyarwady region; Yangon region) in Myanmar. The main focus of the Phase II project extension was the scaling out and scaling up of the outputs of the project and capacity building. Therefore, the balance of our research and development effort was 35% research, 25% extension and 40% capacity building (training of trainers, support for MAgSc students, LA and farmer visits to rice markets and demonstration sites).

The collaborators are IRRI, DoA and DAR. There are significant linkages to the pulse component of the ACIAR research program. This project was within Theme 3 "Ecological and sustainable management of rice-based production systems" in the CRP of the Global Rice Science Partnership (GRiSP) and Flagship 3 in the Rice CRP.

The MyRice project is actively collaborating with the CORIGAP project, particularly through the LA, developing business models, joint in-country training activities and the gender study. MyRice also collaborated with the USAID STRIVE project for seed multiplication.

We established active collaboration with MyPulse, MyFish and MyLive projects. The MyRice team also provided assistance in the inception workshop of SMCN/2014/044 (Management of nutrients for improved profitability and sustainability of crop production in central Myanmar) and LWR/2014/075 (Land resource evaluation for productive and resilient landscapes in the Central Dry Zone of Myanmar).

The engagement of the MyRice project with the private sector was facilitated through LA meetings and business models development during 2015–17. We had a strong partnership with Pioneer Agrobiz Co. Ltd. The president of this company (Dr. Myo Aung Kyaw) provided expert advise on business model development for our new postharvest technologies. We also had links with the Myanmar Rice Federation; Martin Gummert, IRRI senior scientist for postharvest development, facilitated a 1-day workshop for them on how to progress capacity building on postharvest technologies for their members and key farmer groups.

The MyRice project engaged in empowering women and girls. In 2015, Pieter Rutsaert, IRRI social scientist, conducted a household survey to identify the five domains of the WEAI: production, resources, income, leadership, and time allocation

As part of the monitoring and evaluation of the project, CommCare was piloted for application management and reporting of the MyRice project. CommCare is an open-source platform that enables organizations to take advantage of the power of mobile phones (https://wiki.commcarehq.org/display/commcarepublic/Home).

4 Objectives

Phase I – June 2012 to June 2016

The aim of the project is to improve farmers' profitability through developing best practises for rice production, including postharvest management and innovative approaches to improve the productivity of rice in rice–rice and rice–pulse cropping systems.

The objectives are to:

(i) Develop best practises to increase the productivity of smallholder farmers by at least 15% for rice–rice and rice–pulse cropping systems in lower Myanmar;

(ii) Demonstrate practises and support the introduction of options to reduce postharvest losses of monsoon rice by 10% and to increase the value of milled rice by at least 10%;

(iii) Target new technologies based on constraints analysis and then develop effective dissemination strategies; and

(iv) Strengthen the capacity of project staff in natural resource management of rice-based cropping systems.

The expected outputs are:

(i) New short- and medium-maturing, high-yielding rice varieties and crop management options (rice–rice, rice–pulse) available to farmers to increase the cropping intensity of target areas by 20% and improve farmers' economic returns by 15%;

(ii) Improved postharvest options available to farmers to improve their rice productivity by at least 10% and to improve their livelihoods;

(iii) Technology delivery pathways identified via assessment of challenges and opportunities, and strategies developed to disseminate improved options; and

(iv) Strengthened capacity of project staff in natural resource management of rice-based cropping systems.

Phase II – July 2016 to December 2017

Key objectives are:

(i) Reduce high postharvest losses of the monsoon rice crop caused by delays in threshing, drying and processing. Losses occur because farmers rush to take advantage of the subsoil moisture for their pulse crops and thus harvest the rice, stack it in the field and thresh it 2–5 weeks later.

(ii) Increase rice yields and reduce the yield gap of rice. In Daik Oo, the top 10% of farmers have a yield of 4.1 t/ha, whereas the mean yield is 2.6 t/ha, a 37% differential (n = 100).

(iii) Establish stronger linkages of farmer groups with the rice value chain.

(iv) Provision of objective advice to high-ranking MoAI officials.

(v) Build capacity of local partners (at least 40% females).

5 Methodology

The project focused on research and delivery of new cropping and postharvest practises through farmer participatory adaptive research. The project conducted research on cropping options and postharvest management to increase and sustain productivity of both rice–rice and rice–pulse cropping systems in the Ayeyarwady Delta (Maubin township, Ayeyarwady region and Daik U township, Bago region) in Myanmar. We established two treatment villages and two check villages in each of the Daik U and Maubin townships. Different crop and postharvest management options, as well as the training needs of the farmers in the community, were critically evaluated following these six processes (Figure 1):

(i) Conducted biophysical and sociocultural participatory rural assessment of the target community through household surveys and focus-group discussions (FGDs).

(ii) Benchmarked these options in farmers' fields (scientist-managed plots).

(iii) Assessed farmer-selected varieties and management options, pre- and postharvest (farmer-managed plots).

(iv) Established large (2–5 ha) farmer-managed field demonstrations in the final year of the project with DoA partners taking the lead role and IRRI project team providing technical support.

(v) Obtained feedback from farmer groups during farmers' planning meetings and field days at the end of each cropping season; feedback from millers on the milling and market quality of rice produced via new management options.

(vi) Conducted high-level official consultation meetings regularly to establish proper linkages and have project visibility at the township, regional and national levels.

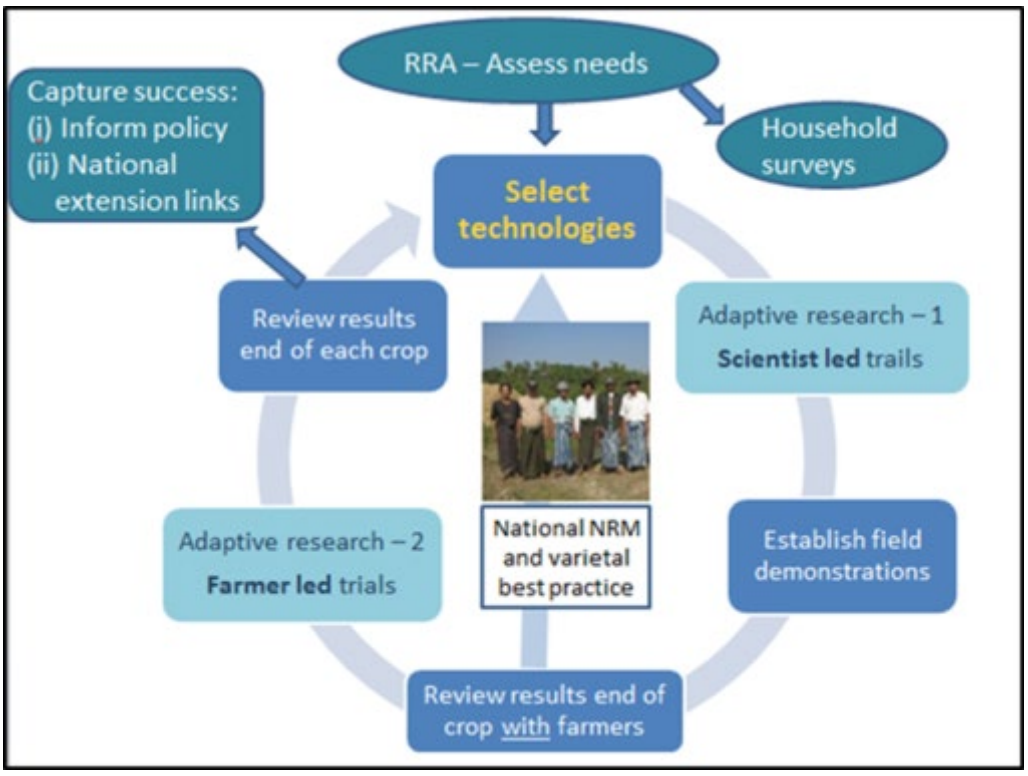


Fig. 1. Process flow in the implementation of on-farm adaptive research of the MyRice project.

The four communities directly involved in the project benefited through a 20% increase in agricultural productivity of land and/or labour. Farmers' planning meetings and field days were held at the end of each cropping season to get feedback and agreement on plans for the next cropping season. The outscaling of chosen varieties and associated best management practises commenced in year 5 with the DoA partners taking the lead in the implementation, while the IRRI project team provided back-up support (Figure 2).

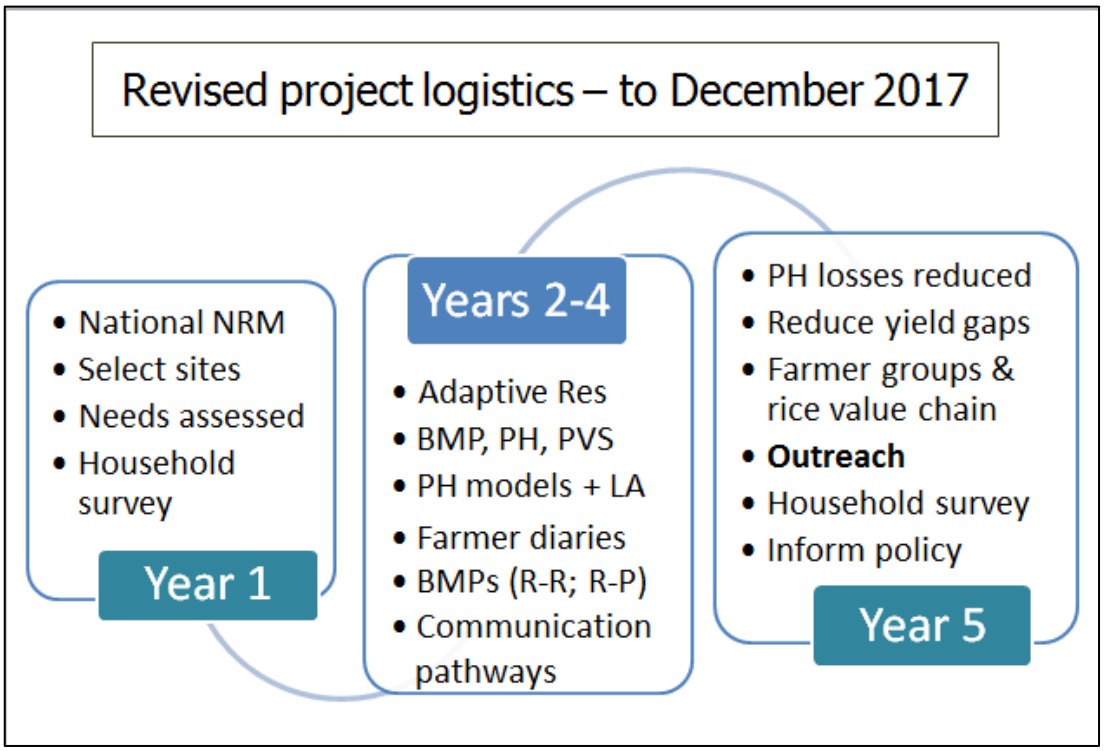


Fig. 2. Project logistical framework, 2012–17.

A management committee (MC), composed of representatives from DoA, DAR and IRRI, met every May and October. The MC's tasks and responsibilities were: (1) oversee the implementation of field activities of the project and provide technical and administrative guidance; (2) serve as focal team on matters of interest in the pursuit of adaptive research activities and degree and nondegree training of the project; (3) maintain regular contacts with local and international institutions with similar thrusts, objectives and activities of the project; (3) prepare recommendations and endorsements to the steering committee (SC; DGs and DYDGs of DoA and DAR, project leaders of IRRI and ACIAR) that may need immediate action; (4) prepare annual highlights of accomplishments and plans for submission to the SC and (5) meet regularly to plan, implement and assess related activities of the project.

Annual meetings with the partners from the DoA and DAR were held every October in the DoA regional offices during the first 3 years and in Nay Pyi Taw during the 4th and final year, where the national office of the Ministry of Agriculture, Livestock and Irrigation (MoAII) is located. An intensive communication campaign was conducted during the final year.

The MyRice project, together with four other ACIAR DFAT-supported projects under the MyFarm program, presented the highlights of accomplishments and plans for the coming year during its annual meeting every October.

6 Achievements against activities and outputs/milestones

Part I – July 2012 to June 2016

Objective 1: To develop best practises to increase the productivity of smallholder farmers by at least 15% for rice–rice and rice–pulse cropping systems in lower Myanmar.

No.	Activity	Outputs/milestones	Completion date	Comments
1.1	Conduct needs assessment and implement adaptive research with farmer groups on technologies/ approaches they choose to test.	*Survey results compiled and analyzed; needs documented and prioritized; demonstration sites established* Farmer diaries with 160 farmer-respondents in eight villages each in Maubin and Daik-U townships (10 farmer-respondents per village) were collected in the 2014 WS to 2015–16 DS. *Farmers trained by local extension staff in four villages (two in each district); farmers identified approaches to evaluate in consultation with DoA staff; adaptive trials implemented; benchmarked improved crop management options for rice–rice and rice–pulse. Met with farmers at end of each crop season; implemented revised practises based on their feedback.* Two hundred eighty-three (283) on-farm trials on natural resource management were implemented during the 2012–13 DS to 2015–16DS (145 in Maubin township and 138 in Daik U township): *Farmer meetings held at the end of the monsoon and dry seasons prior to planning for activities for the DS WS seasons, respectively*.	August 2012 Yr3, m12 (repeated each season) Yr4, m12 (reiterated for each season)	Paper presented at the 9th National Agricultural Research Conference in January 2016. . Field testing of agronomic options in 283 farmers' fields in Maubin and Daik U townships Meetings held with farmers after WS and DS cropping, and presented results of field trials and plans for the next cropping season activities.
1.2	Test agronomic options to advance rice harvests to increase opportunities for DS pulse crop.	*Best agronomic options identified and these do not compromise grain quality of freshly harvested monsoon rice.* Replicated trials of BMPs) vs farmers' practise (FP) in two farmers' fields. FP was determined from farmer diary data collected in the previous DS, while BMP followed the protocol of previous adaptive research results. *Large-scale demonstrations were completed of improved monsoon rice and summer rice varieties and improved pulse varieties plus improved management, and compared with FP. Improved monsoon rice varieties included Yemyoke Khan 2, Manw Thuka 2 and Sin Thwe Latt while the farmer varieties are SinThuka and HnanKar. Improved summer rice varieties included Pyi Taw Yin and Sin Thwe Latt and were compared with the farmer variety Sin Thu Ka. Improved green gram (Yezin 11, Yezin 14) and black gram varieties (Yezin 2, Yezin 3) were compared with farmer varieties (planted to 1 acre for each farmer).* Large-scale demonstrations (8–10 ha for each township) to demonstrate and validate new crop systems were completed in 2015 WS and 2015–16 DS crop.	Yr3, m12 Yr4, m12	Best agronomic options increased grain quality of freshly harvested WS and DS rice.
1.3	Identify high-yielding rice varieties tolerant of prevailing stresses to provide best flexibility and	*Yearly PVS trial results compiled and documented.* Six PVS researcher-managed trials (RMT) with 11–12 submergence-tolerant, high-yielding varieties and a farmers' variety in rice–rice systems and seven (RMT) in rice–pulse systems were implemented during the 2013, 2014 and 2015 WS in one to two villages each of Maubin and Daik-U townships.	Yr2, m10 Yr3, m10 Yr4, m10	PVS of monsoon cropping from June–July to Nov–Dec. and summer cropping from Dec–Jan to April–May.

No.	Activity	Outputs/milestones	Completion date	Comments
	productivity gains for a rice–rice or a rice–pulse system.	Five PVS researcher-managed trials with 11-12 drought-tolerant, high-yielding summer rice varieties and a farmers' variety in rice–rice systems were implemented during the 2013-14 DS and 2014-15 DS in one to two villages each of Maubin and Daik-U townships.		
Details on benchmarking activities are in Section 7 Phase I A.				

Objective 2: To demonstrate practises and support the introduction of options to reduce postharvest losses of monsoon rice by 10% and to increase the value of milled rice by 10%.

No.	Activity	Outputs/milestones	Completion date	Comments
2.1	Quantify post-harvest losses (shattered grain, quality loss) associated with delays in threshing the harvested crop for up to 6 weeks.	*In-field losses from shattered grain and quality loss at milling quantified* Postharvest loss assessment along the value chain was implemented for five treatments: (1) BMP and four versions of FP, (2) threshing and storing 1 week after harvest, (3) threshing and storing 2 weeks after harvest, (4) threshing and storing 4 weeks after harvest, and (5) threshing and storing 6 weeks after harvest. Results: (1) Use of IRRI lightweight thresher had lower threshing loss than the farmers' practise; (2) postharvest losses were significantly higher by 19–25% in FP than in BMP; (3) piling grains for 4 weeks lowered milling recovery by at least 10%; (4) BMPs led to highest head rice recovery (48%). Mean losses caused by rodents of grain stacked in the field were 2% in 2013 and 1% in 2014. The total grain removed by rats from stacks in the field in 2013 was estimated to be 268.8 kg/6 ha and in 2014 was 133.2 kg/6 ha.	Yr2, m9	All data have been collected and analyzed, publication in an international journal is in process
2.2	Characterise which postharvest technical options are most effective for reducing postharvest losses and maintaining the quality of rice for milling.	*Evaluated options for reducing postharvest losses; losses reduced by at least 10% in the field; value at milling increased by 10%* Postharvest losses along the whole postharvest chain ranged from 10 to 30%. The biggest contribution usually came from drying and storage. Using BMP, the physical losses can be reduced to less than 10%. Depending on the season the loss reduction achieved was between 3 and 25%. It is quite notable that field activities, such as stacking, significantly affected quality and physical losses of rice when the rice was milled. Depending on the season, 2–10% higher head rice recovery was achieved in the BMP and additional prevention of yellowing and spoilage ensures that best quality rice can be consistently produced and marketed. Millers and traders are willing to pay up to 28% more for this better quality.	Yr4, m9	Implemented in WS 2013, WS 2014, DS 2015 and DS 2016 in Maubin township
2.3	Quantify the impacts of rodents postharvest, and develop and test management strategies.	*Rodent impacts in rice and pulse stores quantified and better management options recommended* (i) In Maubin and Daik-U, measurements were completed for loss of quality and pest damage of seeds and grain in stores in the 2015 WS and DS (see detailed results in 2014–15 annual report). (ii) In Maubin and Daik-U, a community village-level rodent management system was tested. (a) This system reduced rodent losses from 4 (28	Yr2, m12 Y4, m12	Implemented in DS 2014–2015 Implemented in DS 2015–16

No.	Activity	Outputs/milestones	Completion date	Comments
		kg) to 1% (7 kg). The cost for managing rodents was 16,250 kyats (USD 14); farmers can benefit by 94,770 kyats (USD 81/house). (b) The contamination rate declined significantly from 0.1% (mean of 5 faeces in one cup of 480 mm^3) to 0.002% (mean 1 faeces per cup).		
2.4	Develop business models for postharvest (thresher, flatbed dryer) usage and application of best practises for postharvest management of rice by farmer groups.	*Developed a market model for mechanical dryers and threshers that includes local service providers* Cost-benefit assessments for solar bubble dryers for individual farmer use and the flatbed dryer for farmer groups were conducted using data from project sites. Supported local manufacturer in making lightweight thresher. Identified business model for best practises for postharvest of rice (I, PC). *Developed business model for best practises for postharvest of rice.* Organised farmer groups that will assess and pilot business models for best postharvest management practises (threshing, drying and storing)	Yr2, m12 Yr4, m12	Initial data on the locally developed business model on lightweight thresher documented. Farmers in Maubin were interested in modifying the lightweight thresher. Farmers group organised and developed mechanisms on equipment management and service provision. Process of organization and challenges documented
Details on reduction of postharvest losses are presented in Section 7 Phase I C.				

Objective 3: To identify and evaluate effective dissemination strategies.

No.	Activity	Outputs/milestones	Completion date	Comments
3.1	(a) Initiate and facilitate LAs among stake-holders; assess the effectiveness of LA and adaptive research in promoting adoption of new technologies and/or cropping. processes. (b) Farmer group visits to different demonstration sites. (c) LA members met twice a year and reviewed progress against impact pathway.	*LA established and there is active participation from both public and private sectors.* Four meetings were conducted with learning agendas progressing to new topics about varieties and postharvest. Through the LA meetings, farmers shared their experiences in using Sin Twe Latt (rice) and Yezin (pulse) varieties with different crop production management techniques. Good postharvest practises were also shared among the group. A lightweight thresher demonstration was conducted to show how threshing can immediately reduce postharvest losses. LA members who attended the demonstration provided feedback. *At least two farmer group visits were undertaken.* New farmers from the project site villages visited the Wardan Wholesale Market in Yangon in February 2014. The LA also facilitated farmer-to-farmer sharing; farmers from Shwebo Province were invited to share their practises. Three farmer groups from rice–rice and rice–pulse villages were organized to participate in developing village-level business models on new postharvest technologies introduced by the project.	Yr1, m12 Yr4, m6 Yr4, m9	6-month delay because the lead scientist at IRRI had a major leg injury and could not travel for 9 months. We have caught up on the schedule. Active participation during LA meetings and activities like demonstrations received support from the DOA and some selected private sectors. Farmer groups visited different demon-stration sites. LA is an ongoing process and we will continue facilitation throughout the project.
3.2	Identify likely effective	*Assessed effectiveness of adaptive research, LA, and other pathways for diffusion of technologies.*	Yr4, m12	LA was assessed as a platform where

No.	Activity	Outputs/milestones	Completion date	Comments
	dissemination routes of new technologies.			farmers could openly discuss about their assessment on the use of technology. Farmers could openly share their thoughts what they like or don't like about a technology and what makes them feel hesitant to adopt it. Some have shared their stories of success in improved practises by participating as farmer-cooperators.
Details on the identification and evaluation of effective dissemination strategies are in Section 7 Phase 1 D.				

Objective 4: To strengthen capacity of project staff in natural resource management and participatory varietal selection for rice-based cropping systems.

No.	Activity	Outputs/milestones	Completion date	Comments
4.1	Training conducted on NRM best practise management of rice (primarily) and pulses and on participatory varietal selection.	*Training completed; township staff well equipped to pass on this training.* Ten training courses were completed in the past year (see Appendix Table 2).	Yr1, m12	Completed to schedule
4.2	LA established (see 3i); training provided on market models.	*DoA township staff and key farmers trained on market model.* Learning Alliance in Daik-U established and local DoA staff are being trained to assist with the facilitation of the LA.	Yr4, m6	See Objective 3.
4.3	Formal (MSc, PhD, internships) and informal training undertaken to develop skills and capacity of partners.	*Sixteen MSc students and 1 PhD student graduated at YAU; at least two people recommended for PhD studies.* Seventeen grants for theses provided to DoA and DAR staff for them to undertake research for a MAgSci and PhD enrolled in Yezin Agricultural University (see Appendix Table 5). The project target was eight.	Yr4, m12	One DAR project staff was granted a PhD fellowship under the John Allwright Scheme that started in 2016 at University of Queensland.
Details on capacity building of farmers and partners are in Section 7 Phase I E.				

Part II – July 2016 to December 2017

Objective 1: Reduce high postharvest losses of the monsoon rice crop caused by delays in threshing, drying and processing.

No.	Activity	Outputs/ Milestones	Completion date	Comments
1.1	Continue post-harvest demonstrations, verify business models	Demonstrations conducted in both townships	Dec. 2016	Demonstrations successfully conducted in Maubin and Daik-Oo. Farmers organised into groups that aimed to manage equipment and gain profit from its use.
		Business models documented for threshers, dryers and storage	Dec. 2016	Business models documented for threshers; solar bubble dryers and storage were used for used only for testing and demos.
		Training materials developed (PC).	June 2017	Training materials developed.
		Activity on verifying business models on lightweight thresher, solar bubble dryer, and GrainSafe	March and October 2017	Technical backstopping provided for the equipment; organizational support provided for farmer groups to manager the group they have agreed to establish to manage the equipment. Also provided support on follow up activities that were agreed upon during the LA meeting.
1.2	Conduct sustainability assessment for different postharvest management practises.	SIMAPRO simulation results for farmer practise and improved management practises. Best practise postharvest recommendations developed (PC).	June 2017 Dec. 2017	The analysis illustrated that the mechanized practise is more sustainable than FPs in terms of reducing losses, cost and energy consumption while not increasing GHGE of rice production. Application of improved practises with avoiding delay of paddy in the field, using combine harvester, flatbed dryer and hermetic storage can cut losses by half or two thirds, equivalent to 20–30% of milled rice produced, reduce costs 30–50% (USD 50–80 per ton of rice produced), save energy consumption 40–50% (2–3 GJ per ton of rice produced) and slightly reduce GHGE during the postharvest operations. (Manuscript on process of submission to *Field Crops Research Journal*)

No.	Activity	Outputs/ Milestones	Completion date	Comments
1.3	Assist MyPulses and MyFish in evaluating the potential of the SBD, hermetic storage for fish and pulses.	Tests with fish and pulses conducted in program partners' sites. Modification needs identified and fed back to technology provider. As part of the complementary rice–fish pilot project, we designed a solar tunnel dryer for fish drying, constructed a unit, verified with farmers and conducted two demonstrations.	June 2017 Dec. 2017	The SBD turned out not to be suitable for fish, a smaller, elevated solar tunnel dryer was therefore developed and verified. Demonstrating the adding of value to dried fish by packaging in ongoing.
Details on reducing high post-harvest losses of the monsoon rice crop are in Section 7 Phase II A.				

Objective 2: Increase rice yields and reduce the yield gap of rice. In Daik Oo, the top 10% of farmers have a yield of 4.1 t/ha, whereas the mean yield is 2.6 t/ha, a 37% differential (n = 100; data from MyRice).

No.	Activity	Outputs/ Milestones	Completion date	Comments
2.1	Scaling up BMPs and farmer-selected varieties of rice and pulses in both systems	Large-scale trials (5–10 ha) to demonstrate. new BMPs completed (PC).	Dec. 2017	150 farmers in 2016 WS, 312 farmers in 2016–17 DS and 1,478 farmers in 2017 WS.
2.2	Pilot and demonstrate laser-assisted land levelling	Demonstrated laser leveling system. Demo conducted in Maubin. Data on benefits and cost collected and business model for contract service provision drafted (PC). Laser leveling round table discussion about continuation of business models conducted with public and private sector partners.	Dec. 2016 June 2017 Oct. 2017 Dec. 2017	Training & demonstrations conducted on 23 March 2017 with 70 participants (16% women) from DoA, farmers, private sector, NGOs. Business for contract service provision models outlined and discussed with private partners.
2.3	Test the effectiveness of rodent-proofing of grain stores and community management strategies for rodents.	Rodent losses to grain in rice and pulse stores reduced to <3% because better management options adopted (I, PC).	July 2017	
2.4	Meet with farmer groups at end of each cropping season to review results of field trials and modify where necessary.	Met with farmers and project staff at end of each crop season; implemented revised practises (I, PC).	Dec. 2016, June 2017, Dec. 2017	Twice in 2016 and once in 2017, consultation meeting in Daik U, Maubin and outreach townships of the two regions.
Details on increasing rice yields and reducing the rice yield gap are in Section 7 Phase II B.				

Objective 3: Establish stronger linkages of farmer groups with the rice value chain.

No.	Activity	Outputs/milestones	Completion date	Comments
3.1	Pilot-test the business models for production and postharvest usage and application of BMPs of rice farmer groups.	Production and postharvest business models verified and documented (I, PC).	Dec. 2017	Business models for threshers successfully piloted in Daik-Oo township. LA members provided collective assessment of the equipment.
		Verification activity of business models for lightweight thresher, solar bubble dryer, and GrainSafe	March and Oct. 2017	Technical back-stopping provided for the equipment; organizational support provided for farmer groups to manage the group they have agreed to establish to manage the equipment. Also provided support on follow-up activities that were agreed upon during the LA meeting.
3.2	Establish and help facilitate farmer-led LAs in Daik Oo; provide training.	Farmer-led LA established in Daik Oo.	Dec 2016	Farmer-led LA established in Daik-Oo; now managing lightweight thresher.
		LA facilitated and on-the job training for farmers during verification of business models provided by project staff.	Dec. 2017	Thresher left with farmers for continued use.

No.	Activity	Outputs/milestones	Completion date	Comments
3.3	Further support marketing high-quality paddy with higher price through the Maubin LA, collaborate with MyLife on capturing the lessons from the LA concept.	Two LA meetings conducted.	June, Dec. 2017	LA meeting conducted in May 2017 when LA members revealed that they are keen to try flatbed dryers. Use of lightweight threshers are needed for monsoon season and for late harvesting; use of SBD needs more testing and collective storage using GrainSafe has been initiated for pulses and should be further supported by the DOA in 2018.
		Farmers assisted in selling high-quality rice to premium markets.	Dec. 2017	Completed. Some farmers have reported selling improved varieties such as Yaenelo 7 to local traders and millers at higher price.
		LA approach assessed with MyLife.	Dec. 2017	Masters' student from the YAU in Myanmar conducted a study on the assessment of LA in Maubin township.
3.4	Household surveys to quantify the impact of LA and the promotion of BMPs	Household survey conducted and findings compared with baseline study from 2013.	July 2017	Household survey was conducted in August 2017. LA questions sought to determine if there were significant changes in practises and learnings out of the topics discussed in LA. Mini survey on most significant change of increased income was conducted in August 2017 in Daik-U and November 2017 in Maubin.
		LA, adaptive research approaches assessed (PC). In collaboration with MyLife.	Oct. 2017	See MyLife project reports.
Details on establishing stronger linkages of farmer groups with the rice value chain are in Section 7 Phase II C.				

Objective 4: Provision of objective advice to high ranking MoAI officials.

No.	Activity	Outputs/milestones	Completion date	Comments
4.1	PMC continues to oversee implementation project activities and provide technical and administrative guidance.	Executive committee created; regular meetings conducted (PC).	July, Nov. 2016 May, Nov. 2017	Executive committee meeting in May and Oct 2016. Executive committee meeting in May 2017.
4.2	Regular meetings with high ranking MOAI officials.	Key outputs presented annually to the DGs, Deputy DGs of DoA and DAR. Meet at least twice a year with Directors of Rice, Plant Protection and Training (CARTC) Department, and Regional and District DoA staff.	Dec. 2016 Dec. 2017	14 meetings in 2016 (44% women) and 16 meeting in 2017 (45% women).
4.3	Participate in development of operational guidelines of Myanmar Rice Sector Development Strategy (MRSDS).	Key output of project contributed to implementation of the MRSDS operational guidelines (PC).	Dec. 2016	Two meetings with DG, DoA and directors of different divisions of DoA.
Details on provision of objective advice to high ranking MoALI officials are in Section 7 Phase II D.				

Objective 5: Build capacity of local partners (at least 40% females).

No.	Activity	Outputs/milestones	Completion date	Comments
5.1	Formal training (MAgSc research) of young rice scientists.	Seventeen MSc students graduated; at least two students progressed to PhD studies (I, PC).	Dec. 2017	Two graduated in 2015; eight graduated in 2016; seven graduated in 2017.
5.2	In- and out-of-country training undertaken to develop skills and capacity of partners and key farmers on BMPs and varieties of rice and pulses.	Training completed; township staff well equipped to pass on this training (PC).	Dec. 2016	One farmers' training in 2016 with 23% women participants. Five training of DoA staff and partners in 2016 with 44% women participants; One training in 2017 with 43.4% women participants.
Details on capacity building of local partners are in Section 7 Phase II E.				

7 Key results and discussion

Phase I: June 2012 to June 2016

A. Development of BMPs to increase the productivity of small holders

Four control and four treatment sites were selected in each township—a set of two for rice–rice and two for rice–pulse. Needs assessments were conducted in these 16 villages.

In August 2012, baseline household surveys in Daik Oo township in two control and two treatment villages for both rice–rice and rice–pulse cropping systems were completed. In each of eight villages, 25 households were surveyed (n = 200). The mean rice yield was 2.2 t/ha for rice–rice farmers growing monsoon rice and 2.4 t/ha growing summer rice. The mean rice yield was 3.1 t/ha for rice–pulse crops; the pulse mean yield was 339 kg/ha.

For the 2012–13 summer rice cropping, BMPs (three in Maubin Township and two in Daik Oo Township) were assessed in farmers' fields. We benchmarked alternate wetting and drying (AWD), nutrient management, four different herbicides and direct seeding using a drum seeder. For the summer pulse cropping, we monitored the weeds present and measured their impact (one site in Maubin; one site in Daok Oo) in farmers' fields and assessed the yields of two new black gram varieties (one site in Daik Oo).

Three on-farm trials of agronomic options (seedbed management, fertiliser management and grain-loss assessment in grain stores) were implemented during the 2013 WS crop (June–July to Oct.–Nov. 2013) in Maubin and Daik Oo townships involving 98 farmers. Four on-farm trials of agronomic options (fertiliser management for black gram, fertiliser management for summer rice, a direct-seeding trial combined with weed management and alternate wetting and drying (AWD) and grain-loss assessment in grain stores) were implemented during the DS crop (Dec.–Jan. 2013 to April–May 2014) in Daik Oo and Maubin townships involving 88 farmers.

The field trials indicated that seed rates could be considerably reduced and yields improved with better fertiliser management. Three participatory varietal selection (PVS) mother trials, using 12 rice varieties with submergence and drought tolerance and high yield and a farmer check variety, were implemented during the 2013 WS involving six farmers. Based on the preference and sensory analyses, farmers' most preferred varieties in flood-prone areas of Maubin are Sin Thwe Latt, Manaw Thu Ka, Sin Thu Ka and BR11-Sub1. In Daik Oo, the preferred varieties are Sin Thwe Latt and HmamBi-2 in addition to their existing farmers' varieties. Farmers' most preferred varieties in rainfed rice areas of Maubin are IR57542-90-1-1-1-5, Manaw Thuka 2, Saltol Sin Thwe Latt and RMNTK-UL-16.

Another two PVS mother trials were implemented during the DS of 2013–14 in Maubin and Daik Oo townships involving four farmers. Data analyses are in progress. PVS mother trials using four varieties of black gram (12 farmers) were implemented in Maubin and Daik Oo townships and another PVS mother trial with four varieties of green gram (four farmers) was implemented in Daik Oo Township only during the 2013–14 DS. In Maubin, the most preferred black gram variety selected by farmers based on its performance was Yezin 2. Farmers were excited to test new higher-yielding varieties; they have had no new germplasm for their pulses for more than three decades. No preference analysis was conducted in Daik Oo.

In the 2014 WS, improved seedbed management and nutrient management were implemented in the rice–rice and rice–pulse systems. In both systems, partial cost-benefit analyses were positive. In the same monsoon rice crop, drum seeding and integrated weed management in the rice–pulse system in Maubin Township indicated a gross margin benefit of USD 15/ha compared with the farmers' practise of transplanting. During the

2014–15 DS, row seeding of rice using a drum seeder indicated a gross margin benefit of USD 100/ha.

Participatory varietal selection (PVS) “mother” trials in the 2014 WS were implemented in two flood-prone areas and two favourable rainfed areas in Maubin and Daik Oo townships. Twelve high-yielding rice varieties were tested against farmers’ varieties, with three replicates per site. In both the favourable and flood-prone areas, farmers from Maubin selected four varieties and those from Daik Oo selected five varieties. About 240 kg of Sin Thwe Latt seed were distributed to farmers in Maubin in April 2014. The resulting farmer-managed trial of Sin Thwe Latt in the 2014 WS provided a mean yield of 4.0 t/ha, compared with 3.4 t/ha for the farmer variety. In the 2014–15 DS, PVS trials of black gram, farmers preferred Yezin 2, 3 and 5 out of six varieties. Seven green gram varieties were tested and Yezin 11 and 14 were chosen. The PVS farmer-managed trials of black gram (Yezin 5) in Daik Oo provided a mean yield of 1.4 t/ha, compared with 1.3 t/ha for the farmer variety. Farmer-managed trials of Yezin 11 led to a mean yield of 1.09 t/ha compared with a mean yield of 0.93 t/ha for the farmer variety. Similar trials of green gram Yezin 14 led to a mean yield of 1.02 t/ha compared with a mean yield of 1.11 t/ha for the farmer variety. In November 2014, 1,370 kg of seeds of four DS rice varieties were distributed to farmers in Maubin and Daik Oo. In September 2014, 250 kg of seeds of two green gram varieties and 704 kg of seeds of two black gram varieties were distributed for the 2014–15 DS crop.

In the 2015 WS and 2015–16 DS, IV and IM practises were compared to farmer varieties and farmer management, both in replicated trials and in larger-scale field demonstrations (0.4 ha/farmer) both for rice–rice and rice–pulse systems. Results of the farmer diaries were made the basis for the design of the farmer varieties and farmer management components. Nutrient management trials also were implemented in both crop systems. Partial cost-benefit analyses indicated that IV+IM practises for monsoon rice in rice–rice systems increased yield by from 7 to 56% for three new varieties. Farmers who used Yemyoke Khan2 plus 1M increased their income by 81%, however, the other two varieties did not return increased profit because the total cost of production increased by more than 40% for the IM practises.

For summer rice in rice–rice systems, yields increased significantly by from 6 to 15% for three new varieties. Production costs for IM increased by approximately 7%. For pulses in rice–pulse systems, improve black gram varieties plus IM increased yield by from 30 to 55% for two new varieties. IM costs are considerably higher (>50%) and these need to be reduced before we roll out the IV and IM. For green gram, two IV + IM increased yield by 10%. More importantly the improved varieties realized considerably higher prices in the market resulting in increased profits for farmers of >130%. The use of the drum seeder compared with broadcast seeding led to a positive B/C ratio. This was more evident during the summer rice crop in rice–rice systems.

In the 2015 WS, 3,507 kg of seed of six monsoon rice varieties were distributed to 142 farmers (17 females) at 1 basket/farmer (= 21 kg) in Maubin and Daik-U townships. In the 2014–15 DS, 1,228.5 kg of four summer rice varieties were distributed to 32 male farmers and, in the 2015–16 DS, 1,858.5 kg of three monsoon rice varieties were distributed to 62 farmers (5 females). In the 2014–15 DS, 2,752 kg of seed of three green gram varieties and 1,024 kg of seed of two black gram varieties were distributed to 85 farmers (13 females). And, in the 2015–16 DS, 1,888 kg of seed of four green gram varieties and 544 kg of seed of one black gram variety were distributed to 73 farmers (9 females) (see Appendix Tables 4A–C).

B. Disease and pest monitoring

We have developed simple protocols for monitoring rice diseases and pests in the upper delta. In Maubin, the most common disease was bacterial blight in both favourable and stagnant areas. In favorable areas in Daik Oo, the most common pests were weeds and rodents. Stem borer occurred more often in flooded areas.

C. Reduction of postharvest losses

Grain and grain quality losses

Postharvest loss assessment (November 2013–September 2016)

Four postharvest loss assessments were conducted from 2013 to 2016. In 2013 and 2014, the assessments were done in rice–pulse villages during the monsoon season; while in 2015 and 2016, the assessments were conducted in rice–rice villages during the DS. In these assessments, physical losses along each activity in the value chain were measured and quantified and quality losses were analyzed at the end of the processing after milling. Also, losses from traditional FP were compared to the recommended BMPs postharvest.

For the rice–pulse villages, the focus of the assessments was on the effect of the farmers' practise of piling or stacking the harvested rice in the field and then threshing after 2–4 weeks. For the rice–rice villages, farmers do not pile the harvested rice and so the focus of the assessments was on the use of combine harvester compared to the traditional harvesting methods and other postharvest technologies.

In 2013, in the first assessment, it was found that physical losses of rice grain during piling, threshing, drying and storing from FP were from 10 to 13%. Using BMPs such as threshing immediately after harvesting, systematic drying using a flatbed dryer and hermetic storage, led to a 3–7% reduction in physical losses (Appendix Figure 4).

In 2014, the lightweight thresher was introduced as an additional BMP to the assessment. Physical losses decreased by 5–6% from using the lightweight thresher alone. Overall, physical losses can be reduced by 18–25% through the use of best postharvest management practises in rice–pulse villages (Appendix Figure 6).

In 2015, combine harvesters started to proliferate in Myanmar and rice farmers were taking notice. Because of this, the combine was added as a BMP together with flatbed drying and hermetic storage for the rice–rice villages' loss assessment. Through the use of the combine alone, physical losses from harvesting and threshing were reduced by 9% as a result. Using all the BMPs, total physical losses was reduced by 12% compared to that of the FPs (Appendix Figure 8).

In 2016, the loss assessment for the rice–rice village was replicated. It was noted that harvesting was done at the right time and the farmers' granary was well-maintained. Despite the seeming optimum conditions, physical losses were still reduced by 7% through the use of BMPs compared to that of FPs.

In terms of grain quality, the grains processed using the BMPs consistently had higher milling recovery and head rice recovery than the grains processed using traditional FPs in all loss assessments conducted. For the rice–pulse villages, grains using BMPs had 1–12% higher milling recovery and 2–11% higher head rice recovery. For the rice–rice villages, grains using BMPs had 1–4% higher milling recovery and 6–7% higher head rice recovery (Appendix Figures 10 and 11). Clearly, FPs such as field stacking or piling of unthreshed rice, delayed threshing, sun-drying and traditional storage all contributed to low milling recovery and low head rice recovery.

Higher milling recovery and higher head rice recovery through the use of BMPs mean farmers have more rice to sell at a higher price. This was confirmed during the assessments in the rice–rice villages wherein FP and BMP milled-rice samples were brought to the local market and rice traders were asked how much they were willing to pay. For the FP-milled rice sample, the traders were willing to pay Ks 18,000 for 50 kg while for the BMP sample; the traders were willing to pay Ks 23,000 for 50 kg. This means that the rice traders in the local market were willing to pay 28% more for BMP-milled rice ascribing to its higher quality.

Grain losses due to rodents

In 2014, the mean loss of grain in storage to rodents was 1.22%. Total grain loss in 6 months was about 34 kg (could feed two people for 1 month). Mean contamination with rodents' faeces was 5 faeces in one cup of 480 mm^3. The 2014 and 2015 trials generated the following findings: (a) mean cumulative losses from grain stores and in the field were 165.3 kg (enough to feed a family of five for 1.6 months) in Maubin and 34.9 kg (enough to feed a family of five for 18 days) in Daik-U; (b) a pilot study of community village-level rodent management in Maubin and Daik-U townships showed that farmers can benefit by USD 81/household. The rate of faecal contamination decreased from 0.1% (mean of 5 faeces in one cup of 480 mm^3) to 0.002%. This could reduce considerably the health risk of rural families from rodent-borne diseases.

Community village-level rodent management

A community rodent management system including trapping, sanitation around storage houses and installing rodent-proofing was used in one village in Maubin and in two villages in Daik-U (10 houses/village). Sanitation around storage houses and trapping were done every 2 weeks. Losses by rodents were assessed in five treatment houses and five control houses. The techniques for assessing losses were based on those developed in Bangladesh (Belmain et al 2007). The losses from treatment and control houses were compared. Rodent losses declined from 4 to 1% and farmers can benefit about USD 81 (Appendix Figure 12). Farmers are interested in rodent-proofing; however, they do not willingly set up traps regularly and do not pay attention to sanitation.

D. Identification and evaluation of effective dissemination strategies

Using communication as a means, rather than as a tool, was the driving framework to identify project-based dissemination strategies. Communication of project activities and research results targeting donor, scientific community and project stakeholders in research and development were disseminated through IRRI-based channels (*IRRI News* and *Rice Today* online and print), and other internationally-recognised semitechnical publications such as the ACIAR website and magazine. *RIPPLE*, a magazine featuring collection of milestones in natural resource management research and outreach, published 14 articles featuring MyRice project activities and milestones.

A video on Participatory Varietal Selection of Rice was produced in 2014 in English and Myanma versions to promote the method and inform stakeholders about how it is conducted. The video has been shown during important events with DOA and DAR staff, as well as selected farming villages. Currently, on YouTube, the video has nearly 2,200 views in English (https://youtu.be/ONLL37GgSfc) and close to 1,250 in Myanma (https://youtu.be/Z3yCArbQepw).

Individual and collective assessments of the BMP trials and technologies, initiated using the farmer-to-farmer knowledge sharing from the LA platform, were also used as a mechanism to effectively disseminate learning about using BMPs. A farmers' field day at the end of the trial season also provided a mechanism for farmer-cooperators to determine what technology worked and preferred technologies to try. The farmer-to-farmer knowledge sharing and cross-site visits initiated by the project also provided opportunities for the farmer cooperators to disseminate effective BMPs in rice production from the other rice granaries, such as the Shwe Bo farmers, who are producing the export-quality Shwe Bo Paw San variety.

Key stories of changes in practises were also documented. The stories tracked the practises that the key seven cooperators subscribed to before the project and the key changes they have observed after participating in the BMP trials (see Appendix 10.3). It also traced adoption—what practises and technologies (varieties, etc.) did the cooperators chose to use in the next season? And what innovations have been done in equipment or machinery they have tried (e.g., modifying threshers for pulses and using superbags for pulses)? Some selected stories were published in ACIAR Magazine and *Rice Today*. Printed copies of the published stories were distributed to LA members during meetings.

E. Capacity building of farmers and partners on NRM and PVS for rice-based cropping systems and high-level officials meetings

From January 2013 to December 2015, the MyRice project increased the capacity and awareness of partners by conducting 19 training events for farmers; 20 for DoA staff and other partners; 16 workshops, seminars, and fora; four high-level official meetings; 38 farmers' and government staff meetings; 45 farmers' field days and three postharvest demonstrations. These were attended by 2,889 farmers (17% women); 1,126 staff members (68% women) from the DoA, DAR, DoF, YAU; and 53 partners (38% women) from private groups (see Appendix Table 2). Twenty-nine significant training events were provided to the partners and project staff (Appendix Table 2B).

The MyRice project also provided research thesis support to 16 MSc and 1 PhD students (12 female, 5 male) from DoA and DAR. All are enrolled at YAU. Two MSc students graduated in October 2015 and nine MSc students graduated in October 2016. The rest are expected to graduate in October 2017 (see Appendix Table 5).

Dr. Nyo Me Htwe (DoA; seconded to IRRI as a postdoctoral fellow through June 2016) participated in the 2016 John Dillon Program. A report of her activities was forwarded to the ACIAR program manager.

Ms. Ohnmar Myint (DAR) began her PhD program at the University of Queensland in early 2016 with a grant from the John Allwright Fellowship.

Phase II: July 2016 to December 2017

A. Reduce high postharvest losses of the monsoon rice crop caused by delays in threshing, drying and processing

Continue postharvest demonstrations and verify business models

Business models of lightweight thresher, solar bubble dryer and GrainSafe 3 were piloted in Phase I. Farmer-cooperators from project villages formed committees to manage the equipment and come up with a plan on how to gain profit from them (service provision, etc.) to optimise their use. Alongside this topic, demonstrations and technical assistance were provided to any equipment that the managers need assistance with, e.g., solar bubble dryer. The LA platform was used to collectively assess equipment that the business model groups have chosen to manage. LA meetings have been conducted at the beginning and end of the harvest season to plan who will use the equipment, how it will be used, and then assess performance, whether the farmers gained profit or not and constraints encountered. LA members have formed committees that are in charge of managing the equipment and designing incentive mechanisms, such as priority of use for members. Members are asked to provide a membership fee to go into a revolving fund to maintain the equipment.

During the 12th LA meeting, members conducted a summative evaluation of the business model verification activity. They concluded that the equipment items they have chosen to manage are applicable in certain situations, but not all. The lightweight thresher, for instance, is useful during the DS when the combine harvesting schedule is late and as a back-up if it suddenly rains or the combine harvester breaks down. Also, the lightweight thresher is useful during the monsoon season when farmers usually prefer to use it over the combine. Members in Maubin also assessed that the solar bubble dryer needs technical assistance from IRRI and more trials in order for them to bring down the moisture content to a certain level.

Conduct sustainability assessment for different postharvest management practises

Sustainability analysis. A lifecycle-based comparative analysis among the different postharvest management practises. The sustainable factors including energy efficiency and GHGE were analysed based on the postharvest loss assessments conducted in Maubin township. Results showed that the improved practises by applying mechanised harvesting and drying and hermetic storage reduced postharvest losses by 2 to 3 times

the farmers' practises. It also reduced energy consumption and production cost significantly. Mechanised practises, though, use fossil fuel, but they do not generate higher GHGE than the farmers' practise due to the balancing of the total GHGE that can be accounted for losses. This analysis resulted in an illustration that the mechanized practise is more sustainable than farmers' practises in terms of reducing losses, cost and energy consumption while not increasing GHGE of rice production.

Figure 3 shows the comparative results of cost, labour, energy consumption, postharvest losses and GHGE of different postharvest management practises in the 2014 WS. It illustrates that improved practises that use the flatbed dryer and hermetic storage can reduce losses by 2 to 3 times (20 to 30% of rice produced), reduce 30% of the cost (USD 50), and slightly reduce GHGE during the postharvest operations.

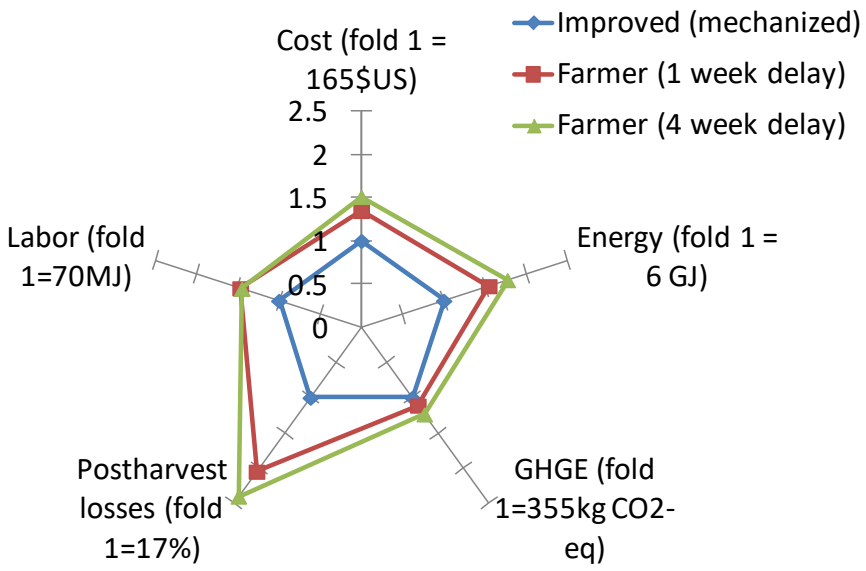


Fig. 3. Comparative analysis of different postharvest management practises in 2014 WS.

For the DS, we looked at two groups of practises: (1) FPs using manual harvesting, sun-drying and granary storage; and (2) IMPs using combine harvesting, the flatbed dryer and hermetic storage. Other operations, such as paddy transportation and milling, are assumed to be the same for both FPs and IMPs. Figure 4 shows the results. Similar to the WS, postharvest losses for the IMPs were lower by 5 times or equal to 25% of rice produced than those of the FPs. The IMPs also saved energy consumed and costs by 2 times compared with the FPs.

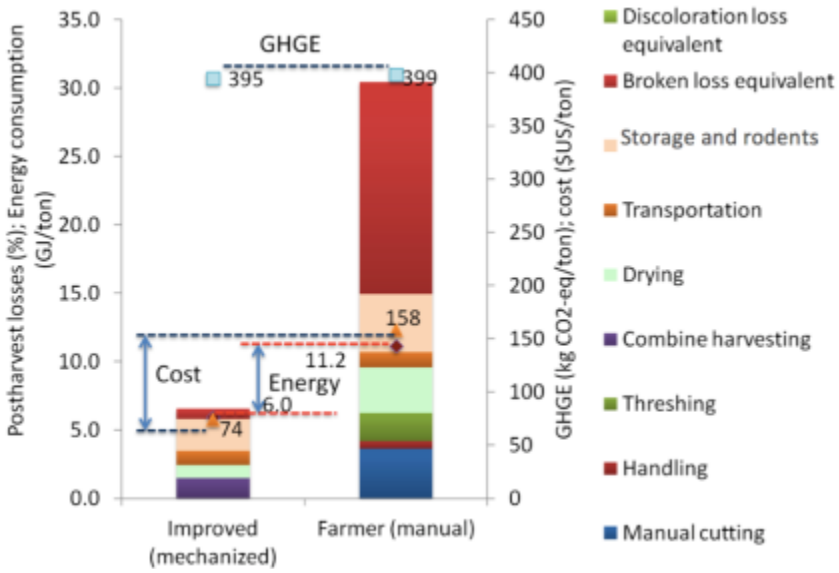


Fig. 4. Comparative analysis of different postharvest management practises in the 2015–2016 DS.

Findings of the comparative analysis resulted in useful implications for both of the corresponding endusers and policy and extension sectors. Endusers should have their best choices of the postharvest operations to increase their profits and reduce labour dependencies. The policy and extension sectors can refer to this illustration to plan for better postharvest management practises towards a sustainable value chain of rice production. A manuscript was prepared and will be submitted to *Field Crops Research Journal* in 2018.

Assist MyPulses and MyFish in evaluating the potential of the solar bubble dryer for pulses solar tunnel dryer for fish

In February 2016, the MyRice team met with Gareth Johnstone and Manjurul Karim of WorldFish to initiate a collaboration on using the solar bubble dryer (SBD) for drying fish and fish feed. The group discussed quality traits that need to be measured and agreed to do some straightforward trials to gather basic information and have an overall idea of the possibility of using the SBD for these drying operations. IRRI's Martin Gummert suggested that for fish drying, a solar tunnel dryer (STD) might be a better option since it is already a proven technology for fish drying. The group decided to focus first on fish feed drying using the SBD and to jointly look for funding for a STD prototype to be used in fish drying.

In June 2016, ACIAR approved the project, *Developing Rice Fish Business Models in Disadvantaged Flood-Prone Areas of the Ayeyarwady Delta*, proposed by the MyRice and MyFish teams. Two of the project's activities are the development of a STD using locally available resources and to conduct postharvest assessment of drying fish using it and using the SBD for drying rice.

The design of a downsized version of the Hohenheim STD was finalised in December 2016 with a prototype being fabricated in January 2017. Initial testing of the STD for fish has been accomplished and data analysis is ongoing. It is planned to add a vacuum packaging machine to demonstrate the potential of value adding by increasing the market value of the dried fish.

B. Increasing rice yields and reducing the rice yield gap

Benchmarking activities (2016 wet season)

For monsoon rice replicated trial in rice–rice system, a 35% increase in yield using improved variety 1 (Inpara 3) and improved management was obtained while there is a 34% increase in yield using improved variety 2 (Sin Thwe Latt) and improved

management compared to using farmer variety (Hmwabi 2) and farmer management. This also gave a 61% increase in income for IV1 +IM and 45% increase in income for IV2 + IM compared to FV+FM (Appendix Table 7A).

For the rice replicated trial in rice–pulse system, a 47% increase in yield using improved variety 1 (Pyi Taw Yin) and improved management was obtained while there is 34% increase in yield using improved variety 2 (Sin Thwe Latt) and improved management compared to using farmer variety (Sin Thu Kha) and farmer management. This also gave a 229% increase in income for IV1 +IM and 327% increase in income for IV2 + IM compared to FV+FM (Appendix Table 7B).

Scaling-up BMPs and farmer-selected varieties of rice and pulses in both systems

In consultation with the regional minister of the Ministry of Agriculture, Livestock, Irrigation and Natural Resources and with the regional directors of the DoA in the Ayeyarwady and Bago regions, the outscaling activities were discussed together with the IRRI team.

For 2016 WS and 2016–17 DS, the plans and priorities for Ayeyarwady Region and Bago Region were discussed and agreed to with respective DoA Regional Directors and officials on 31 Jan. –1 Feb. 2017 in the DoA Ayeyarwady regional office, Pathein City and on 26–27 Feb. 2017 in DoA Bago regional office, Bago City. Prior to the implementation of the 2016 WS trials, a briefing on the protocol and data collection for the expansion areas with the DoA District/Township officials and ag technicians was made on 7 June 2016 in Bago DoA regional office and on 22 June 2016 in DoA Maubin district office.

A representative number of farmers were selected to have complete data set and simple cost and return analysis. For monsoon rice in rice–rice system of outreach sites in Ayeyarwady region during 2016 WS, yields and income increased significantly with improved variety plus improved management (IV + IM) compared to farmer variety plus farmer management (FV + FM). Increased yield ranged from 5.4 to 27.3% while increased income ranged from 11.1 to 37% (Appendix Table 8A). For monsoon rice in rice–pulse system in the same season in the Ayeyarwady region, increased yield ranged from 1.5 to 13% while increased income ranged from 2.0 to 37% (Appendix Table 8B). For monsoon rice in rice–rice system during 2016 WS in the Bago region, IV + IM had increased yield of from 0.7 to 9.0% and increased income of from 17.2 to 40.2% compared to FV + FM while for monsoon rice in rice–pulse system IV + IM had increased yield of 4.8% and increased income of 5.7% (Appendix Tables 8C and 8D).

For summer rice in the rice–rice system during 2016–17 DS in the Ayeyarwady region, IV + IM had increased yield of from 5.7 to 11.5% and increased income of from -2.3 to 30.9% while for black gram (Yezin 2) in rice–pulse system had increased yield of from -0.7 to 9.1% and increased income of from -9.7 to 14.2% compared to FV + FM (Appendix Tables 9A and 9B).

For the 2017 WS, the respective regional directors presented the plans on 10 April 2017 at the DoA regional office, Bago City, and on 11 April 2017 at the DoA regional office, Pathein City.

In May–June 2017, 1,002 baskets (21,042 kg) of monsoon rice varieties for the Ayeyarwady region and 1,085 baskets (22,785 kg) for the Bago region were distributed to DoA offices intended for the 2017 WS cropping (see Appendix Table 4A). Large-scale BMP demonstrations of monsoon rice in the rice–rice system (at 1 acre/farmer) in the 2017 WS were set up in 297 farmers' fields in the Ayeyarwady region covering seven municipalities and in 195 farmers' fields in Bago region covering 10 municipalities and three districts. In the same season, large-scale demonstrations of monsoon rice for the rice–pulse system (at 1 acre/farmer) were set up in 526 farmers' fields in the Ayeyarwady region covering 17 townships and in 460 farmers' fields in the Bago region covering 13 municipalities (see Appendix Table 1). Maps showing the test sites in Maubin and Daik U townships plus the other municipalities in the two regions for the outreach sites are shown

in Appendix Figures 13 and 14. The implementation and monitoring of these field demonstrations are now being led by the DoA with technical support from IRRI project staff.

In the 2017 WS in the Ayeyarwady Region, IV + IM for monsoon rice in the rice–rice system increased yields by from 6 to17% and increased income by from 22 to 108%, compared to FV+FM. The improved varieties included Yaenelo 7, Pyi Taw Yin and Sin Thwe Lattt (see Appendix Tables 10A and 10B). Some farmers compared the performance of the FVs Sin Thu Kha and Paw San Yin with the FM and IM. Results showed that, with IM, yield increased by 8% using Sin Thu Kha and 35% using Paw San Yin giving an increased income of 18 and 180%, respectively (see Appendix Table 10B). In the same year, monsoon rice crops in rice–pulse systems had increased yields of from 6 to 10% and increased income by from 22 to 108%. The IVs included Yaenelo 7, Sin Thwe Latt and Pyi Taw Yin (see Appendix Table 11). In the Bago region, IV + IM for monsoon rice in the rice–rice system had an increased yield of 9% and increased income of 7%. IVs included Yaenelo 7, Pyi Taw Yin and Sin Thwe Latt (see Appendix Table 12). For monsoon rice in rice–pulse system, IV + IM had an increased yield of 11% and increased income of 19 %. IVs included Yaenelo 7, Pyi Taw Yin and Sin Thwe Latt (see Appendix Table 12).

Pilot and demonstrate laser-assisted land levelling

We did not have a large capital budget so an old laser leveling set that IRRI had used in 2006 for one initial demonstration and left in Myanmar was repaired and re-activated. The drag bucket was manufactured by a mechanical workshop in Mandalay using the IRRI drawings; a farmer in Maubin provided the tractor. IRRI headquarter staff worked with the Myanmar team and the villagers during several trips to Myanmar to set up the system and train the operator.

About 70 participants consisting of farmers, private-sector groups, NGOs and DoA staff attended a field demonstration in Maubin. Dr. Romy Labios, from IRRI, encouraged the LA members to take advantage of the opportunity to discuss options with the private sector (Dr. Myo) to bring the technology to Myanmar. There were lectures about the benefits of a well-levelled field that includes savings in pumping costs and irrigation water, efficient use of inputs and uniformity in crop maturity that results in increased yields. During the demonstration, participants were asked to conduct all the necessary activities before doing the actual laser-controlled land leveling with a tractor and the bucket—this included conducting the field survey and calculating the elevation and soil volume. An indicative economic cost was also presented to the participants, which at an average elevation of 9.6 cm, the total cost of laser levelling would be approximately USD 198/ha inclusive of capital and operating costs. Participants discussed the logistics of using the equipment.

Following the demonstration, another laser leveling unit was donated by Trimble, Inc. (Sunnyvale, California) to enable beneficiaries to access the technology through MyRice and other related IRRI projects in Myanmar.

C. Establishing stronger linkages of farmer groups with the rice value chain

For Phases I and II, 12 LA meetings and activities were conducted. They covered different learning topics that enabled linking farmers to markets and trying out village-level business models (Table 1).

During Phase I, LA members learned through market visits that quality plays a big role in pricing. In Phase II, LA members established business models to optimise use of the lightweight thresher (LT), SBD and GrainSafe 3 (GS3); these pieces of equipment were introduced during the LA demonstrations while exploring ways how to reduce postharvest losses and improve grain quality of the PVS varieties being tried out. Optimising the use of equipment required forming groups to manage the equipment and explore possible ways of generating a profit from using it or providing contract services to nearby farming

villages. The LA also encouraged farmer-level innovation, such as in the case of Daik-Oo, where farmers modified the LT for rice to also be used to thresh pulses.

Table 1. LA activities conducted during 2013–17.

Timeline	Activity	Participants		Key learning experience(s)
		Males	Females	
2013 December	PIPA workshop	19	20	Established village-level LA and agreed to establish a learning group on seeds/varieties and postharvest technologies such as threshers and hermetic storage.
2014 March	Review of PVS varieties being tested and testing o postharvest technologies	25	8	Varieties need a good seed source; Millers provided insights where price incentives are present; harvest at the right time to get good-quality grains, resulting in a higher price.
2014 November	Thresher demonstration	40	13	Demonstrated lightweight threshers for easier transportation.
2015 February	Market visit	9	_	Interacted with Shwe Bo farmers, producers of high-quality Paw San variety to share good practises; farmers who plan to sell interacted with traders.
2015 May	Review of LA activities and postharvest loss assessment review	32	6	Lightweight thresher generated less brokens and better quality grains. It can also be transported easily. Combine harvesters are impressive as part of the loss assessment trial in farmers' fields; high moisture content and unfilled grains affect price of grain even if good varieties are used. Farmers chose what varieties to try during monsoon and summer season from the PVS trials. Farmers shared that they are very keen to experience more farmer-to-farmer learning and cross-site visits.
2015 November	Business models	14	5	LA members were oriented with the concept of business models to help farmers identify optimal use of postharvest technologies (thresher, solar bubble dyer, and grain safe); LA members in each village were asked to form groups and come up with a plan to manage the equipment.
2016 February	Crafting village-level business models for postharvest	17	5	Each farming village presented their plans in managing the equipment, composition of members, incentive mechanisms, and charging for services.
2016 March	Review of piloted technologies for business models and possible entry points in other villages;	15	47	Market incentives for the seeds being produced. Sensory evaluation can help potential buyers assess the quality of grains through their cooking properties

Timeline	Activity	Participants		Key learning experience(s)
		Males	Females	
	sensory evaluation			
2016 June	Visit to Shwebo and Thanetpin Township	2		Importance of quality seed production, and the institutions involved. LA members also exchanged learning experiences about flatbed dryer and how to install it.
2016 August	Business model and initial assessment of technologies	17	11	LA members from Maubin and Daik-Oo exchanged experiences on using the technologies, the challenges and constraints in managing the equipment and identified possible supporting role for the project.
2016 September	Review of postharvest equipment for business models	17	3	Farmers from Daik-Oo shared the modifications conducted in the lightweight thresher so it can be used for threshing pulses. They have shared observations from using it. Also shared about the visit to Shwebo and their thoughts about the flatbed dryer.
2017 March	Evaluation of LA activities and laser leveling demonstration	60	10	LA members assessed that, of the equipment used as an alternative option to other postharvest technologies, they prefer to use first. For instance, the thresher is seen to be used for farmers who are not able to arrange for combine harvesters.
	Total	267	128	

LA members identified postharvest technologies (LT, SBD and GS3) that they were willing to try out in the BMP trials they had experienced in the adaptive trials. One unit each of the LT, SBD and GS 3 were distributed in Maubin and Daik-Oo townships. The concept of the LA was introduced in Daik-Oo township through the DOA. This encouraged collective use of the technologies and building business models out of them where the members and other farming communities can optimise their use and provide additional income opportunities. Initial meetings were conducted to organise farmers into working groups that will manage the technologies they will use. Technical backstopping was provided by the project staff to optimise use of the equipment. During the evaluation of the activities, farmers expressed their preference to try flatbed dryers over the SBDs. They also found the LA platform to be useful for driving innovations through initiating farmer-to-farmer learning. LA members from other townships and rice-based projects interacted with one another so they could share best practises that work and identify technologies they would like to try.

The LA also facilitated the formation of networks that enhance innovation. The laser-leveling demonstration brought together different sectors to discuss how the equipment could be optimally used and provide service to farmers. This resulted in the donation of one unit of laser leveling equipment by the Trimble Company.

D. Household surveys in Daik-U

A baseline household survey was conducted in eight selected villages of Daik-U township in August 2012. The survey was stratified between rice–rice and rice–pulse cropping systems with 100 farmers per system. For each system, 50 farmers each were

interviewed from project (trials on new best management practises, pre- and postharvest, and testing locally adapted early-maturing and high-yielding rice and pulse varieties) or nonproject villages. The villages were identified with the help of the local DoA partner in the Daik-U. Villages included in the surveys were Ka Doke Phayar Gyi, Oat Shit Kone, Pha Aung Weh, Kyaik Sa Kaw, Myo Ma, Mau Tan and Shwe Inn Done.

An endline household survey was conducted in August 2017 and with the goal of interviewing the same farmers. However, this was not possible in a few instances because they had moved or died. The survey was implemented with the use of the household survey app built using the CommCare platform. The design enabled comparisons in yield and income before and after implementation of best practises and new varieties and with and without the new practises. Details of actual costs and yields are presented in Table 2.

Farmers were originally classified as project or nonproject respondents. However, due to widespread uptake of the BMPs and varieties not only in project villages but also in nonproject villages, farmers were then reclassified into adopters (those who have adopted the new IMPs and IVs for both rice and pulse crop) and nonadopters.

The adopters changed to planting improved varieties such as Yeanelo 7 for rice and Yezin 2, 4, 5, 11 and 14 for pulse. They also followed the IMPs associated with better nutrient, weed and pest management and land levelling, plus threshing immediately after harvest.

Effect on cost income and yield at the household level

Although production costs had increased between 2012 and 2017, the adopters incurred lower production costs relative to those of nonadopters. The costs incurred for monsoon rice production for rice–rice and rice–pulse cropping systems of adopters were lower by 13% (USD 47 per ha) and 5.5% (USD 20 per ha). The cost of production for summer rice was lower by 5% (USD 19 per ha).

The combined effect of lower production costs and higher yields resulted in a significant increase in net income for adopters relative to their nonadopter counterparts. The adopters from the rice–rice cropping system had a significant net increase in their monsoon income of 263% (USD 179 per ha) while adopters from the rice–pulse system had a net increase of 71% (USD 101 per ha). Adopters with a rice–rice cropping system had a net increase of 86% (USD 99 per ha) in their summer income.

There was a significant yield increase in rice for both the rice–rice and rice–pulse cropping systems for adopters in both seasons. Yield increased by 572 kg per ha (23%) for monsoon rice under a rice–rice cropping system. There was also an increase in the monsoon rice yield of rice–pulse adopters of 291 kg per ha (9%). Adopters with rice–rice crop system had a significant increase in yield for summer rice of 25% (661 kg per ha) while their pulse yield increased by 39% (258 kg per ha).

Table 2. Percent difference in rice yield and income by classification under rice–rice cropping system in Daik-U, Myanmar.

ITEM	Baseline		Endline		Percent difference	
	Non-Adopter	Adopter	Non-Adopter	Adopter	Non-Adopter	Adopter
Rice-rice						
Monsoon rice	N=50	N=50	N=31	N=39		
Area (ha)	4.00	5.72	3.99	6.12	-0.25	6.99
Yield (kg/ha)	2659	2449	2979	3021	12.03	23.38
Production cost/ha	384	363	417	369	8.59	1.74
Gross income/ha	497	431	601	616	20.91	43.01
Net income/ha	113	68	209	247	84.61	263.33
Summer rice						
Area (ha)	3.47	2.54	3.50	4.02	0.86	58.27
Yield (kg/ha)	2719	2634	3078	3295	13.19	25.07
Production cost/ha	350	364	391	371	11.70	1.68
Gross income/ha	485	480	564	585	16.31	21.94
Net income/ha	135	115	196	214	45.61	85.99
Rice–Pulse						
Monsoon rice	N=50	N=50	N=47	N=51		
Area (ha)	2.56	3.64	4.66	3.93	82.03	7.97
Yield (kg/ha)	3018	3163	3355	3454	11.16	9.19
Production cost/ha	298	369	387	368	29.88	-0.06
Gross income/ha	470	522	600	630	27.63	20.88
Net income/ha	172	153	201	261	16.74	70.63
Summer pulse						
Area (ha)	3.59	2.65	3.66	4.39	1.95	65.66
Yield (kg/ha)	546	668	791	926	44.83	38.63

Note: (a) Official exchange rates used: Baseline: USD 1=Ks 969 and Endline: USD 1=Ks 1,100, Value: 2010=100 and (b) N = sample size.

Source: Baseline and endline surveys in 2012 and 2017

E. Most significant change in increased income to household

In August and November 2017, short surveys on the most significant change (MSC) of increased income were conducted using the CommCare App in the townships of Daik-U and Maubin. A total of 101 farmers were interviewed through a stratified random sampling reached by the project. From these farmers, 30% were identified to have achieved a

significant positive net change in income. This was complemented with a semi-structured interview to assess the influence of adopting MyRice technologies on the income and spending power of smallholder families.

Farmers adopted a variety of new technologies, such as using new rice varieties (Yaenelo 7), fertiliser management, judicious use of post-emergence herbicide and combine harvesters resulting in an increase in disposable income. Farmers have been responsive in using these technologies from the time of introduction to implementation in their respective fields. An average uptake time of from 0.8 to 1.0 year for the mentioned technologies has been reported, meaning that they are keen to try new technologies one to two seasons after demonstration or as soon as applicable and available (Figure 5).

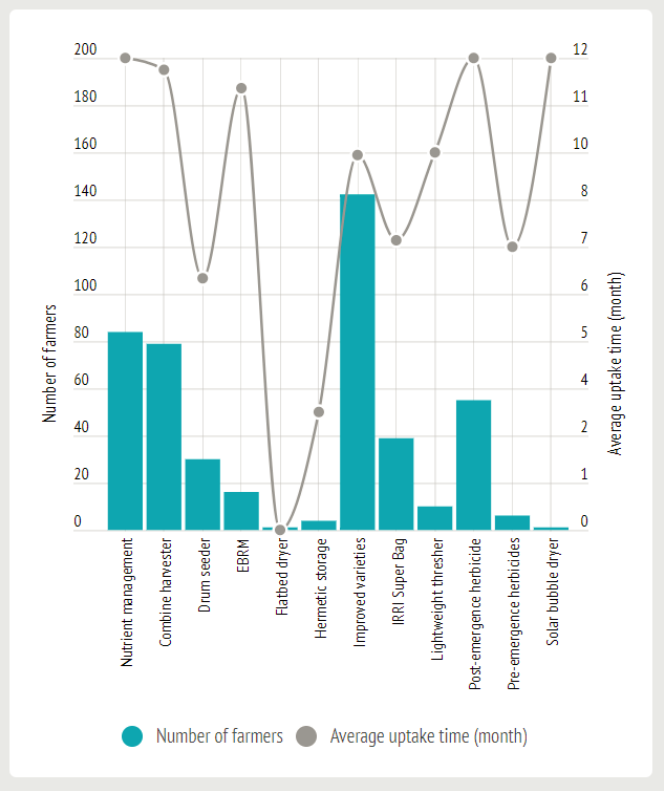


Fig. 5. Average uptake time of technologies from introduction to implementation, Myanmar, 2017.

Derived from partial budgets of farmers interviewed, 30% achieved a substantial net positive change in income per year; mean = USD 94.36 per ha. When asked how they allotted the additional amount, 100% of the farmers placed it into items that their household had priorities for: religious and sociocultural activities (90%), food (87%), health care (86%) and education (63%). In terms of spending the additional income, the farmers allocated 38% of the amount to their religious and sociocultural engagement in the village, 21% on food, 15% on education, 15% on health care and 10% on other expenses such as cellphone credits, transportation, electricity and apparel (Figure 6).

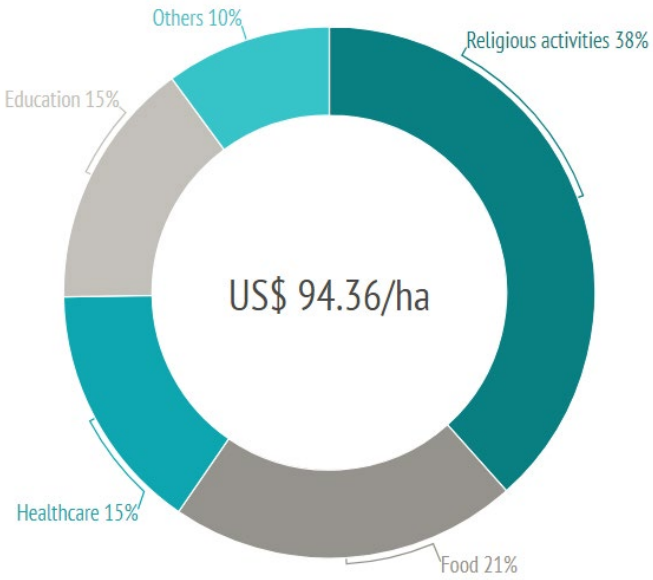


Fig. 6. Allocation of USD 94.36/ha additional household income of 30 MSC farmers, Myanmar, 2017.

As for the remaining 70% of the farmers interviewed who apparently did not achieve a significant positive change in income, factors such as slightly lower yield and little reduction in production costs were reported. Farmers who had a positive net change in income had a slightly higher yield difference of 230 kg per ha and had lower production costs of around USD 38.12 per ha, 65% higher than the savings of the other farmers.

There were marked livelihood changes for families who had adopted BMPs promoted by the MyRice project. These changes were not only on a personal level but also at a community level. People invested back into farming, more into their health through improved nutrition and into their children's education by enabling them to spend more time going to school rather than spending time on the farm. Furthermore, great amounts of time and finances were spent on community activities, which seem to strengthen the communities and enable communities to improve their infrastructure. Of note, a majority of parents wanted their children to become educated to work in high-profile positions, such as doctors or engineers, rather than pursue a career in agriculture.

F. Providing objective advice to high-ranking MoALI officials

The executive committee of the MyRice project was composed of representatives from the DoA, DAR and IRRI. Two meetings were set every year in May and October. In 2016, they were held on 13 May and 5 October and in 2017, on 13 May. The tasks and responsibilities of the executive committee were to: (1) oversee the implementation of field activities of the project and provide technical and administrative guidance; (2) serve as the focal team on matters of interest in the pursuit of adaptive research activities, degree and nondegree training; (3) maintain regular contacts with local and international institutions with similar thrusts, objectives and activities; (4) prepare recommendations and endorsement to the steering committee (DGs and DYDGs of DoA and DAR, project leaders from IRRI and ACIAR) that may have needed immediate action; (5) prepare annual highlights of accomplishments and plans for submission to the SC; and (6) meet regularly to plan, implement and assess related activities of the project.

Consultation meetings with the regional directors and other officials of the Ayeyarwady and Bago regions regarding the activities and plans for the 2016 WS and 2016–17 DS were held on 7 June and 9–10 September 2016 at the respective regional offices.

Activities of the MyRice project were also mentioned in the presentation of Dr. Jacqueline Hughes, IRRI's deputy director general for research, during the donors' meeting on 14

Sept. 2016 that was organized by MoALI and IRRI. The occasion was attended by Dr. Aung Thu, minister of MoALI; Dr. Tn Win, deputy minister; Dr Tin Htut, permanent secretary; and other directors general and directors of various departments and divisions of MoALI.

Presentation of the updates of the collaborative activities in the outreach sites and seed distribution of the 2016 WS and plans for the 2016–17 DS was held on 5 Nov. 2016 at the Pathein DoA regional office for the Ayeyarwady region. This was led by U Tun Aung Kyaw, regional director and attended by other DoA officials from the districts and townships involved in the project.

A consultation meeting regarding the 2017 WS activities in the outreach sites was held on 10–11 April 2017 in the DoA regional offices of the Ayeyarwady and Bago regions including the regional directors and other officials (see Appendix Table 3).

G. Build capacity of local partners (at least 40% women)

In 2016–17, six training events for DoA staff and partners were conducted and participated in by 223 staff members and private groups and 74 farmers of which 44% were women (see Appendix Table 2). In addition, nine workshops, seminars and fora were attended by 229 government staff members, 20 private groups and 87 farmers of which 40.5% were women.

In both years, two postharvest and laser-levelling demonstrations were conducted in which 21 government staff members, 8 private groups and 86 farmers of which 20.5% were women.

As part of the monitoring and evaluation of the project, CommCare was piloted for efficient and accurate collection, monitoring and reporting of the project's key performance indicators. CommCare is an open-source, web-based platform that allows creation, editing and deployment of mobile applications in mobile devices (https://wiki.commcarehq.org/display/commcarepublic/Home). Training on farmer data sheet application in CommCare was provided to 11 DoA/DAR staff members and 4 IRRI project staff members of which 47% were women.

Dr. Aye Min, DoA assistant director and project manager, was awarded a fellowship in the 2017 John Dillon Program.

8 Impact

8.1 Scientific impact – now and in 5 years

See Section 9.4 for listing of publications in peer-reviewed international journals listed in the Web of Science and a book chapter and Section 10.2 for a summary of news and other articles.

Ten master of science theses supported by the project are now archived at the Yezin Agricultural University Library.

The graduation of 10 staff members of DAR and DoA with a MAgSc because of support provided by the project is a major impact of the MyRice project. It would be very useful to map the progression of the career of these 10 people in 5 years after the completion of the project.

There were nine publications in international journals (see Section 9.4) and one book chapter.

There was also one publication in a national proceedings: Gummert M, Htwe NM, Cabardo C, Aung Y, Thant A, Maw PP, Kyaw MA, Quilloy R, Singleton GR. 2016. Loss assessment from harvesting to milling of rice in traditional and best-practice postharvest systems in Myanmar. Proceedings of Ninth Agricultural Research Conference. Edited by Myo Kywe, Kyaw Ngwe, and Aung Naing Oo. Yezin Agricultural University, Nay Pyi Taw, Myanmar. p. 59–62.

IRRI project scientists provided occasional lectures to YAU students. Dr. Nyo Me Htwe, a postdoctoral fellow for 18 months in the project, provided three 3–5 day courses on the mechanics of the adaptive research approach to extension specialists drawn from all the rice-growing regions of the country. Dr. Grant Singleton, project leader of MyRice, provided specialist input for half a day during one of these courses. The courses were held at the national facility for agricultural training in Hlegu.

8.2 Capacity impact – now and in 5 years

We have provided the following evidence of outputs that are heading positively along the impact pathway:

1. We have 16 MSc students and 1 PhD student from DoA and DAR enrolled at Yezin Agricultural University. Two students graduated in 2015, eight in 2016 and seven in 2017. Plus, the project is supporting two PhD students.
2. Five hundred twenty-five staff members (58.5% women) from DoA and DAR attended specialized training courses from 2013 to 2017. A highlight is our support of English-language courses for DoA staff at the township level. These were established following a request from the local staff (see Appendix Table 2B for details).
3. CARTC on Adaptive research: incorporated some of the output of the project into curricula that the DoA is using in the training of Ag Technicians.
4. Private partner-initiated training on postharvest management – Dr. Myo Aung Kyaw, managing director of Pioneer Agrobiz Co., Ltd. Myanmar and partner NGOs conducted training on post-harvest management.
    i. Community-Led Coastal Management in the Gulf of Mottama Project (CLCMGoMP) with Helvetas Myanmar in Bago on 26–27 August with 35 participants (9 female farmers, 4 female government staff and 2 female students) and in Kyikehto on 31 August–1 September 2017 with 28 participants (4 female farmers).

ii. Capacity Building Program (Value Chain Concept & Postharvest Management) with Good Neighbors International Myanmar in Bogale Township on 24–25 September 2017 with 37 participants (8 females from NGO and 2 female farmers).

8.3 Community impact – now and in 5 years

- **Influencing policy approaches at district, regional, and national levels**: We held high-level meetings with DoA, DAR, and Ministry officials in Nay Pyi Taw at least every 4 months. On the morning of 13 May 2016, we met with the new deputy minister of the new Ministry of Agriculture, Livestock, and Irrigation (MoALI); the DGs of DoA, DAR and Department of Planning; and the rector of YAU. In the afternoon, these officials, together with more than 100 MoALI staff, attended presentations at DAR from IRRI, DoA and DAR staff members on MyRice.

  We also held regular meetings with regional directors and district managers in both the Ayeyarwady and Bago regions and in project townships. Various project staff members met with high-level government officials on 42 occasions over 14 months, from May 2015 to June 2016 (see Appendix Table 3). Attendance by regional directors at our annual review and planning meeting in December 2015 led to a request for our adaptive research approach to be explained to their lead extension specialists from their respective districts. This led to presentations by the MyRice team at consultation meetings in the DoA Regional Office, Pathein, Ayeyarwady, on 31 Jan.–1 Feb. and in Bago City, Bago, on 26–27 Feb. 2016.

  During the annual project review on 10 Oct. 2016, the DoA regional directors of the Ayeyarwady and Bago regions presented the activities and accomplishments for 2015–16 and plans for 2017 activities in the DoA Bago regional office. The 2017 WS activities covered 2, 084 acres with 1,536 farmers in the two regions with DoA cost-sharing the expenses and taking the lead in their implementation and monitoring (see Appendix Table 4A).

- **Farmer participatory adaptive research:** Successful farmers involved in the project shared their experiences during planning meetings held at the end of each cropping season. In these meetings, we also discussed plans for field demonstrations for the next crop of the season. Seven cases of farmers' testimonies were documented (see Appendix 11. 3). Shorter-duration and stress-tolerant rice varieties chosen during PVS trials plus balanced nutrient management, drum seeding method, and use of a grain safe or hermetic bags for seed storage generated high interest among farmers in the community. In pulse-growing areas, line-sowing methods coupled with balanced nutrient management and use of hermetic seed storage was of high interest to the farming community.

- There have been a great variety of changes for the families since BMP have been rolled out in the community. These changes are not only on a personal level but also on a community level. People invest back into farming; they invest into their health through nutrition and in their children by enabling them to take part in education rather than spending time on the farm. Furthermore, a great amount of time and finances are spent on community activities, which seem to strengthen the communities and enable communities to improve their infrastructure. It seemed that people gained not only materialistic advances from BMP; they also broadened their own knowledge, which they are able to transfer into other areas of agriculture as well. However, it became clear that young people, in particular, leave the agricultural sector. Parents want their children to become educated to work in high profile positions, such as doctors or engineers.

- **Learning Alliance platform**: The LA is a multi-stakeholder platform that engages them in the rice value chain. We have active participation of farmers, traders and millers. The LA also served as a platform to communicate results of postharvest loss assessment trials, which compared BMPs for postharvest against FPs. It is also served as an avenue to collectively assess the profitability of business models on postharvest BMPs (threshing, drying and storage). The LA initiated farmer group assessment of the profitability of village-level postharvest business models on threshing and drying.

8.3.1 Economic impact

- **Partial cost-benefit analyses:** it indicated that IV+IM practises for monsoon rice in rice–rice systems increased yield by from 7 to 56% for three new varieties. Farmers who used Yemyoke Khan2 plus IM increased their income by 81%; however, the other two varieties did not return increased profits because the total cost of production increased by more than 40% for the IM practises. For summer rice in rice–rice systems, yields increased significantly by from 6 to 15% for three new varieties. Production costs for IM increased by approximately 7%.
- For pulses in rice–pulse systems, improve black gram varieties plus IM increased yield by from 30 to 55% for two new varieties. IM costs are considerably higher (>50%) and these need to be reduced before we roll-out the IV and IM. For green gram, two IV + IM increased yield by 10%. More importantly, the improved varieties realized considerably higher prices in the market resulting in increased profits to farmers of >130%.
- The use of drum seeders compared with broadcast seeding led to a positive B/C ratio. This was more evident during the summer rice crop in rice–rice systems.
- In the 2015 WS, 3,507 kg of seed of six monsoon rice varieties were distributed to 168 farmers (17 females) at 1 basket/farmer (= 21 kg) in Maubin and Daik-U townships. In the 2014–15 DS, 1,228.5 kg of four summer rice varieties were distributed to 32 male farmers and, in the 2015–16 DS, 1,858.5 kg of three monsoon rice varieties were distributed to 62 farmers (5 females) (see Appendix Tables 4A and 4B).
- In the 2014–15 DS, 2,752 kg of seed of three green gram varieties and 1,024 kg of seed of two black gram varieties were distributed to 85 farmers (13 females). In the 2015–16 DS, 1,888 kg of seed of four green gram varieties and 544 kg of seed of one black gram variety were distributed to 73 farmers (9 females). And in the 2016–17 DS, 352 kg of two green gram varieties and 4,800 kg of two black gram varieties were distributed to 161 farmers (see Appendix Table 4C).
- In May–June 2017, 1,002 baskets (21,042 kg) of monsoon rice varieties for Ayeyarwady region and 1,085 baskets (22,785 kg) for the Bago region were distributed to DoA offices intended for the 2017 WS cropping (see Appendix Table 4A).
- **Household surveys**: The adopters across eight villages were asked if they plan to continue adoption, 100% expressed their interest to carry on because of better yield, lower costs on labour and material inputs such as fertiliser. The number of household in the study villages was estimated to be between 100 and 150. Based on the survey, from 44 to 56% of the sample farmers in each study village have adopted best practises promoted by the MyRIce project. If we take a conservative estimate that 50% of the 1,250 households (across the eight villages) would continue adoption, then approximately 625 households (mean family size of six) from Daik-U would have better income of between USD 214 and 261 per ha in both rice–rice and rice–pulse systems, respectively. The yield increase would be on average about 17%.
- **Most significant change of increased income to household**. In August 2017, we surveyed a subset of farmer households in Daik-U and Maubin that had

adopted BMPs, to determine the “most significant changes” (MSC) in their livelihoods resulting from the outcomes of the study. Some 30% of households reported a significant net positive change in income. The mean increase for these households was USD 94.36 per ha per year, with a mean area of 6 ha of rice production per family per year (3.5 ha in the monsoon season and 2.5 ha in the dry season). The impact of the outcomes of the study on livelihoods of these smallholder families was an increase in expenditure on their religious and sociocultural engagement in the village (38%), on food (21%), education (15%), health care (15%) and other expenses such as cellphone credits, transportation, electricity and apparel (10%).

8.3.2 Social impact

Survey on women’s empowerment and impact of extension on gender equity

A survey of about 500 women was conducted in May and June 2015 in Maubin and Bogale townships to measure several indicators of women’s empowerment and to quantify the impact of training and extension on productivity, women’s empowerment, general livelihoods, and nutrition. Men have a lead role in land preparation and the application of pesticides and fertiliser, while women are primarily involved in crop establishment, weeding, harvesting, and postharvest activities. In terms of women’s work burden in rice farming systems, the results of our study show that women experience more difficulties with seasonal workloads, particularly during the crop establishment and harvesting seasons.

Periods in between are characterised by a lack of sufficient economic activities. Labour-saving technologies, such as combine harvesters, the drum seeder or mechanical transplanters have the potential to alleviate rural women’s drudgery and workload during peak periods and thus improve their well-being. However, these technologies do not solve the problem of inadequate income-generating opportunities for women. These findings suggest the need for a holistic view of rural development instead of focusing on farming in isolation. Meinzen-Dick et al (2014) focus on the need to expand the definition of agricultural research beyond field crop production to include homestead gardens, postharvest processing, and supply chains.

Men dominate community decisions in Myanmar. Women participate in neighbourhood or religious groups but these groups have no influence on community or farming decisions. Women’s lack of access to extension and information is common in Myanmar where men are mostly invited to meetings or training activities even though women are very interested in joining. A comparison of the households with and without training on rice production indicates a significantly higher yield of 7 baskets per acre (or 142 kg per ha), a yield increase of 18% for the households that received training. This highlights that the inclusion of women in extension training is important as they play an important role in rice production.

8.3.3 Environmental impact

Our recommendations for crop protection are based on ecologically-based approaches that are consistent with integrated pest management. In 2018, we will conduct an audit of the sustainability of practises by farmers in the project villages. We will mark the farmers against the 12 performance indicators for sustainable rice cultivation developed by the Sustainable Rice Platform, a joint initiative between the United Nations Environment Programme and IRRI.

The BMPs promoted by the MyRice project are consistent with the principles of climate-smart agriculture. We promoted increased nitrogen use efficiency, better water management with mid-season drainage that leads to reduced methane gas emissions, reduction in use of pesticides, and improved postharvest practises. The latter two practises reduce the use of fossil fuels by farmers

8.4 Communication and dissemination activities

Publication in international journals

See Section 9.4 (a to f)

Attendance at scientific meetings, workshops, and conferences

See Section 9.4 (g)

Project planning meetings with local partners

This meeting was conducted in Maubin, Ayeyarwady Region Agricultural Office, on 3 November 2014. We had participants from the DoA of Maubin Township, Daik Oo Township, Ayeyarwady Region, Bago District, Plant Protection Department, Department of Agricultural Research (DAR, Yezin), and Yezin Agricultural University. The key people were U Aye Tun (DyDG, DOA); U Myo Zaw (deputy regional director, Ayeyarwady Region, DoA); and Dr. Myo Aung Kyaw (the chairman and founder of the Pioneer Postharvest Development Group (PPHDG) and managing director of Pioneer Agrobiz Co., Ltd.). The project objectives and results of adaptive research trials were presented by Dr. Labios, Daw Ohnmar Myint (DAR), Dr. Nyo Me Htwe, Christopher Cabardo, Aung Myo Thant and Su Su San.

ACIAR program annual meetings. These meetings were hosted by ACIAR DFAT and AuSAid in Bagan in November 2014, in Inle Lake in 2015, and in Mandalay in 2016. The final meeting was held in Nay Pyi Taw in 2017. The IRRI-Myanmar team was composed of Singleton, Gummert, Labios, Htwe,Quilloy, Balingbing and Cabado (IRRI); U Than Aye and Dr. Myo Aung Kyaw (consultants, IRRI); U Tun Aung Kyaw (regional director, Ayeyarwady region); U Hla Myint (regional director, Bago region); U Theik Soe (district manager, Maubin district); U Lay Myint (district manager, Bago district), Dr. Aye Min (project manager, DoA); Daw TinTin Myint (DAR, in 2017 as IRRI consultant after her retirement); Daw Cho Cho Aung (DAR) and Daw Ohn Mar Myint (DAR).

Regular meetings with DGs, DyDGs and regional directors. Regular meetings (every 3 months) were held with regional and district directors in both regions and in project townships.

Extension material

a) One thousand copies of *Guidelines for Production, Postproduction, and Management of Rice in Rice–Rice Systems: A case in Myanmar* (http://aciar.gov.au/publication/cop30)
b) One thousand copies of *Guidelines for Production, Postproduction, and Management of Rice in Rice–Pulse Systems: A case in Myanmar* (http://aciar.gov.au/publication/cop28)
c) One thousand copies of *Guidelines for Production, Postproduction, and Management of Green Gram and Black Gram Grown in Rice Paddy: A case in Myanmar* (http://aciar.gov.au/publication/cop29)
d) Diversification and intensification of rice based systems in lower Myanmar (MyRice) FACTSHEET SMCN/2011/046 http://aciar.gov.au/files/smcn2011046_hr_final.pdf
e) One thousand copies of the handbook on *Rodent field methods and management of pest species*.
f) One thousand copies of 2-page leaflet*, Best Management Practices for Black Gram in Rice–Pulse Systems* (in Myanma version).
g) One thousand copies of 2-page leaflet, *Best Management Practices for Green Gram in Rice–Pulse Systems* (in Myanma version).
h) One thousand copies of 2-page leaflet, *Best Management Practices for Monsoon Rice in Rice–Rice Systems* (in Myanma version)
i) One thousand copies of 2-page leaflet, *Best Management Practices for Summer Rice in Rice–Rice Systems* (in Myanma version)

j) One thousand copies of 2-page leaflet, *Best Management Practices for Monsoon Rice in Rice–Pulse Systems* (in Myanma version)
k) One thousand copies of 2-page leaflet, *Postharvest management Practices in Rice-Based Systems* (in Myanma version)
l) Daw Aye Aye Mar from the Plant Protection Division developed and revised the *Management of Weeds* in Myanmar language. 1,000 copies printed.
m) Dr. Tin Ohn Mar Win from DoA developed the manual and pamphlets for postharvest technologies.
n) One thousand copies of the handbook on *Rice postharvest technologies*.
o) One thousand five hundred copies of Postharvest pamphlets
p) Five thousand copies each of pamphlets on *Rice harvesting do's and don'ts*, *Seed storage*, and *Systematic drying of rice seed*.
q) One article on Ecological management of pests on Department of Agriculture website.
r) Former communication specialist Trina Mendoza developed *Participatory Varietal Selection* video in English. IRRI, DoA, and DAR staff translated it into Myanma and distributed it to DoA, DAR, and YAU.

Farmers' field days, demonstrations, meetings and workshops with local partners

From 2013 to 2017, 55 farmers' field days with 2,271 participants (30.5% women), 5 postharvest demonstrations with 242 participants (25% women), 58 farmers and government staff meeting with 1,568 participants (25.3% women) and 25 workshops and others with 722 participants (37.8% women).

IRRI and ACIAR news/publications

Eighteen news/articles in IRRI News and ACIAR websites were documented (see Section 9.4 (c) for details.

Technical assistance and advice to relevant Myanmar government departments for policy strengthening

a) Drs. Labios and Htwe participated in developing the Myanmar Rice Strategy Policy, which was launched in May 2015. Three comprehensive workshops were conducted at MoAI in Nay Pyi Taw. Nyo Me Htwe participated in three workshops to contribute to the policy. Dr. Labios participated in the final meeting. In late May 2015, the Myanmar Rice Strategy was launched by Dr. Robert Zeigler, then IRRI director general, and U Hla Myint, then minister of MoAI.

b) Dr. Labios led the team in developing posters of BMPs for rice production in different agroecological zones in the lower delta and central dry zone in November 2014. A workshop was held at the DAR with partners from DoA, DAR, YAU, and other INGOs.

c) Dr. Labios led the team in the development and distribution of guidelines for production, postproduction, and management of (a) rice in rice–rice systems, (b) rice in rice–pulse systems, and (c) green gram and black gram grown in rice paddy. These are the now being followed in large-scale demonstrations of BMPs in different townships/districts of major rice-growing areas in Myanmar, an initiative led by the Rice Division of the Department of Agriculture.

Student seminars

a) Dr. Nyo Me Htwe gave seminars to undergraduate and postgraduate students at Yezin Agricultural University, Nay Pyi Taw, on 21 December 2015. Twenty-seven PhD students, 36 MSc students, and 243 undergraduate students attended.

b) Dr. Htwe gave a seminar to 90 final-year students at YAU, Hlegu campus, in February 2016.

c) Dr. Labios gave a seminar to 68 senior students of the Crop Science course in the College of Agriculture at UPLB in April 2017.

d) Dr. Labios gave a seminar to 90 senior students of Agriculture 199 course in the College of Agriculture at UPLB in September 2017

9 Conclusions and recommendations

9.1 Conclusions

1. The MyRice project reported the introduction of six new monsoon rice varieties, which provided yield advantages of from 0.6 to 1.0 t/ha over the current variety used by farmers and six new summer rice varieties with equal yield with yield advantages of from 0.2 to 1.0 t/ha over the main variety used by farmers.
2. Through partnership with DoA and DAR, varieties were released for commercial planting on a large scale in the country: (a) two varieties with tolerance for submergence and good for the WS in rice–rice systems (Yemyoke Khan 1 and 2), (b) six varieties with tolerance for drought good for the summer season in rice–rice systems (Yeanelo 2, 3, 4, 5, 6 and 7), (c) three varieties with tolerance for salinity good for rice–pulse systems (Saltol Sin Thwe Latt, Pyi Myanmar Sein and Swe ASEAN) and (d) one variety for freshwater, good for WS and summer season in rice–rice systems (Pyi Taw Yin). Four promising lines were identified for registration in 2017 that are high-yielding and with tolerance for submergence (Inpara 3, IR85309-Sub1-156-1-1-1, IR85309-Sub1-28-1-1-1-1 and IR79207-52-2-3-3), the last with tolerance for stagnancy.
3. A combination of improved variety and improved management (IV + IM), both for rice–rice and rice–pulse systems, increased the yield and income of farmers and produced quality rice for home consumption and the domestic market. Partial cost-benefit analyses indicated that IV+IM practises for monsoon rice in rice–rice systems increased yield by from 7 to 56% for three new varieties in the 2015 WS and by from 23 to 33% for two new varieties in the 2016 WS. For monsoon rice in rice–pulse systems, an increased yield of from 47 and 43 % for IV1 (Pyi Taw Yin) and IV2 (Sin Thwe Latt) resulting in increased income compared to using the farmer variety Sin Thu Ka (229 and 327%, respectively). For the 2015–16 DS summer rice in rice–rice systems, yields increased significantly by from 6 to 15% for three new varieties. Production costs for IM increased by approximately 7%.
4. In the 2015–16 DS for pulses in rice–pulse systems, improved black gram varieties plus IM increased yield by from 30 to 55% for two new varieties. IM costs are considerably higher (>50%) and these need to be reduced before we roll out the IV and IM. For green gram, two IV + IM increased yield by 10%. More importantly, the improved varieties resulted in considerably higher prices in the market resulting in increased profits for farmers by >130%.
5. The use of drum seeders compared to broadcast seeding led to a positive B/C ratio. This was more evident during the summer rice crop in rice–rice systems.
6. Pest monitoring in Maubin indicated that the most common pests were bacterial blight and stem borer, while in Daik-U the most common problems were weeds and rodents. A pilot study of community village-level rodent management in grain storage in Maubin and Daik-U townships showed that farmers can benefit by USD 81 per household.
7. Postharvest technologies reduced losses by from 13–16%. The grains processed using BMPs consistently had higher milling recovery (1–2%) and head rice recovery (2-11%) than the grains processed using traditional FPs. Through the LA, it was demonstrated that farmers can receive higher income by selling better quality grains.
8. A life cycle-based comparative analysis, including energy efficiency and GHGEs, showed that avoiding delay of threshing and drying harvested rice in the field, using the flatbed dryer and hermetic storage can reduce losses by 2 to 3 times (20–30% of rice produced), reduce cost by 30% (USD 50) and slightly reduce GHGE during the postharvest operations in the 2014 WS. In the 2015 DS,

postharvest losses of the improved practises were lower by 5 times (equal to 25% of rice produced) than that of the farmers' practises. The IM also saved energy and cost by 2 times in comparison with the FPs.

9. The household surveys provided quantitative data on increases in yield and income from a combination of IMPs and new variety. Yield increased by 23 and 9% for monsoon rice production in rice–rice and rice–pulse systems, respectively. Net income for farmers during the monsoon rice increased by 263% for adopters from a rice–rice cropping system and by 71% for a rice-pulse system, compared to farmer practice. These findings confirmed the potential yield and income increases reported in the field trials.
10. Derived from partial budgets of farmers interviewed, 30% have achieved a net positive change in income of around US$ 94.36 per ha where 38% of the amount will be spent to their religious and sociocultural engagements in the village, 21% on food, 15% on education, 15% on healthcare and 10% on other expenses such as cellphone credits, transportation, electricity and apparel.
11. Provision of degree (MSc and PhD) and nondegree specialised training to DoA and DAR partners by the MyRice project, as part of their capacity building, ensures a cadre of new rice scientists for the next generation in Myanmar.
12. Having an executive committee for the MyRice project with representatives from DoA, DAR and IRRI helps in facilitating and overseeing the implementation and monitoring of field activities and provision of quick technical and administrative guidance, as well as in providing future directions for the succeeding cropping seasons. It also facilitated early adoption of introduced innovations by farmers and the DoA regional offices for outscaling activities to other townships in the region over the last 2 years of the project.

9.2 Recommendations

1. The initiatives by the two regional directors of Ayeyarwady and Bago regions in outscaling the BMPs suitable to their local conditions indicate that the positive findings reported from MyRice are likely to be sustained and expanded to other regions with similar agroenvironments.
2. Capacity building of the DoA agricultural technicians, especially on new technologies in rice-based systems, should be continued and sustained to ensure that farmers will have ready access to these technologies and acquire new knowledge that they can use to increase income and improve their livelihoods.
3. With new improved and high-yielding varieties released for commercial planting by the DAR and other breeding institutions in Myanmar, improvement of seed systems implementation, regulation and infrastructure of the DoA and DAR may require significant support in the near future.
4. Improvement of crop production and post-production management, together with improved varieties, and with innovations in communication and extension delivery should be sustained in the regions to encourage wider adoption by farmers.
5. Given the success of the project, the adaptive agronomy approach has tremendous potential to be applied to reduce yield gaps and increase productivity of cropping systems in the central dry zone and in upland rainfed cropping systems in Myanmar.

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10 Appendices

10.1 Appendix 1: Tables and figures

Appendix Table 1. Number of farmer-cooperators in MyRice activities from WS 2016, DS 2016–17 and WS 2017.

Activity	WS 2016 (May/June-Nov/Dec)		DS 2016/ 2017 (Nov/Dec-March/April)		WS 2017 (May/June-Nov/Dec)		Total
	AYDY*	BAGO**	AYDY*	BAGO**	AYDY*	BAGO**	
1. Best management practice for rice in R-R system (replicated trials)		1					1
2. Large-scale BMP demonstration for rice in R-R system (1 acre/farmer)	23	68	47	53	297	195	683
3. Large-scale BMP demonstration for rice in R-P system (1 acre/farmer)	39	20			526	460	1045
4. Large-scale BMP demonstration for green gram in R-P system (1 acre/farmer)				14			14
5. Large-scale BMP demonstration for black gram in R-P system (1 acre/farmer)			123	75			198
6. Business model: Demonstration of hermetic storage, lightweight thresher, dryer, laser levelling)	37	2	46	6			91
7. Famer/Community Rice seed production	8	3	13	1			25
8. Mini Rice–Fish Replicated Trial			1		1		2
9. Learning Alliance and market visit	37	2	46	6			91
10. Farmer Diary	80	80	80	80			320
11. CommCare Application	31	36					67
Total	**255**	**212**	**356**	**235**	**824**	**655**	**2537**

*Ayeyarwady townships - Maubin, Ingapu, Myaungmya, Wakema, Pathein, Kangyidauk, Pyapon

**Bago townships - Daik U, Bago, Taungoo, Gyobingauk , Min Hla

Appendix Table 2. Summary of meeting, workshop, training, and other field activities from 2013–17.

			2013	2014	2015	2016	2017	Total
Activity	no. of demonstration		1	1	1	1	1	5
Post Harvest Demonstration	Government	Male	2	14	13	1	10	40
		Female	3	12	21	4	6	46
	Farmer	Male	4	39	15	37	37	132
		Female			3	9	3	15
	Private	Male		1		1	7	9
		Female						0
	Total participants		9	66	52	52	63	242
Farmers' Field Day	field day		8	25	12	6	4	55
	Government	Male	18	53	26	95	79	271
		Female	26	98	40	115	50	329
	Farmer	Male	186	558	347	77	125	1293
		Female	57	179	65	19	31	351
	Private	Male	0	1	0	1	12	14
		Female	0	0	0	2	11	13
	Total participants		287	889	478	309	308	2271
Farmers' and government staff meeting	meeting		8	16	14	13	11	62
	Government	Male	20	41	27	25	121	234
		Female	32	85	53	28	107	305
	Farmer	Male	145	298	363	203	23	1032
		Female	25	50	52	29	12	168
	Private	Male		1	0	0	36	37
		Female		2	0	0	14	16
	Total participants		222	477	495	285	313	1792
High Level Officials meeting	official' meeting		1	1	2	14	16	34
	Government	Male	8	3	19	166	186	382
		Female	6	4	34	130	155	329
	Farmer	Male				0		0
		Female				0		0
	Private	Male				5	7	12
		Female				4	6	10
	Total participants		14	7	53	305	354	733
Training of Farmers	training for farmers		3	6	10	1		20
	Government	Male	8	10	19	8		45
		Female	12	22	33	15		82
	Farmer	Male	8	98	148	18		272
		Female	0	18	13	4		35
	Private	Male	1	0	0	1		2
		Female	2	0	0			2
	Total participants		31	148	213	46	0	438

Training of DoA staff and other partners	training for DoA staff		4	6	10	5	2	27
	Government	Male	21	10	9	93	15	148
		Female	52	8	32	105	15	212
	Farmer	Male	8			59	0	67
		Female				15	0	15
	Private	Male	4			0	1	5
		Female	5			2	2	9
	Total participants		90	18	41	274	33	456
Workshop, Seminar and Forum	workshop, etc.		1	8	7	5	4	25
	Government	Male	2	25	14	61	43	145
		Female	11	72	16	86	39	224
	Farmer	Male	10	93	80	29	51	263
		Female	5	8	14	4	3	34
	Private	Male	3	22	0	9	7	41
		Female	1	10	0	4	0	15
	Total participants		32	230	124	193	143	722
TOTAL ACTIVITIES	**No. of total activities**		**26**	**63**	**56**	**45**	**36**	**226**
	Government	Male	79	156	127	449	454	1265
		Female	142	301	229	483	372	1527
	Farmer	Male	361	1086	953	423	236	3059
		Female	87	255	147	80	49	618
	Private	Male	8	25	0	17	70	120
		Female	8	12	0	12	33	65
	Grand Total participants	**Male**	**448**	**1267**	**1080**	**889**	**760**	**4444**
		Female	**237**	**568**	**376**	**575**	**454**	**2210**
		TOTAL	**685**	**1835**	**1456**	**1464**	**1214**	**6654**

Appendix Table 2B. Significant training activities from July 2013 to May 2017.

Unit	Topic	Date	Training location	Participants and institution								Total
				Government (DAR, DoA, YAU)		Farmers		INGO, NGO, private sector, others		IRRI		
				M	F	M	F	M	F	M	F	
1	Ecological Management of Pests	1-6 July 2013	(CARTC)	12	8				2	7		29
2	PVS Training (Maubin)	3-5 October 2013	Nga Gee Gayat	12	16	0		2		0		30
3	Preference analysis of PVS (rainfed)	22 Oct. 2013	Ywar Thit Su, Nga Gee Gayat (rainfed)	2	4	26	**7**	0		3	4	46
4	Ecological pest management	4-15 Nov. 2013	IRRI, Los Baños	1	1	0		0		1		3
5	Postproduction to market	28 Oct-8 Nov. 2013	IRRI, Los Baños	0		1		0		1		2
6	Rodent management	25-26 May 2014	Pathein, DoA Regnl office	2	5	12		20	10			49
7	Conducting research trials	13-Aug-14	Maubin, Township DoA office	6	11					2		19
8	Conducting research trials	20-Aug-14	Daik Oo, Township DoA office	4	6					2	2	14
9	Quality rice seed production	29 Sep-2 Oct 2014	DAR seed farm, Myaung Mya (in collaboration with LIFT)	7		6	3	28	2			46
10	Quality rice seed production for technicians	6-8 Oct 2014	DAR, Yezin, Nay Pyi Taw (in collaboration with USAID)	13	10			5	4	18	9	59
11	Basic English training course, DoA extension staff	18-23 Oct 2014	Maubin, Township DoA office	11	8							19

12	Weed management	9-Dec-14	Maubin, Township DoA office		5	40					1	46
13	Weed management	18-Dec-14	Daik Oo, Township DoA office	8	13	49	3					73
14	Plant Breeding Tools for Statistical Analysis	19-22 January 2015	IMO, Yangon							3	1	4
15	Laser Leveling	2-5 Feb 2015	IRRI, Philippines							1		1
16	Postharvest management	9-11 Feb 2015	CART Hlegu (in collaboration with LIFT)	22	10			2	1			35
17	Basic English training course for DoA extension staff	1 May-14 June 2015	Bago, Regnl. office	8	29							37
18	Aflatoxin quick test kit demonstration	1-Jul-15	IMO, Yangon	1	3					5	2	11
19	Nutrient management training and soil test kit demonstration	4 Aug-26 Aug 2015	Maubin, Daik-U	8	16	121	13	0	0	8	7	173
20	Seed production training	17-20 Aug 2015	Hmawbi Seed farm	11	17	27				4	2	61
21	Ecological Management of rodents, insects and weeds in rice agro-ecosystems course	2-13 Nov 2015	IRRI, Phils.		3					1		4
22	Transplanter hands on training and demonstration	12-Aug-16	Gyoe Pin Sakhan	8	15	18	4	1		4	1	51
23	CommCare Training at IMO	17-19 Aug 2016	IMO, Yangon	0	0				1	2	1	2
24	Focus Group Discussion (FGD) training and protocol workshop, Rice–Fish Project	4-5 Oct 2016	Maubin	5	7					4	1	17

25	Participatory Adaptive Research training at Pwe Pyae seed farm, Pyay	21-Oct-16	Pyay	37	33	19	5			4	1	99
26	Participatory Adaptive Research training at Oat Phyat seed farm, Pyu	23-Oct-16	Pyu	37	37	15	9			3	1	102
27	Participatory Adaptive Research training at TaKunTaing Seed Farm, Hinthada	29-Oct-16	Hinthada	8	23	25	1		1		1	59
28	CommCare Training	14-17 Nov 2016	IRRI, Phil.								1	1
29	Training on Farmer Data Sheet App in CommCare	19-22 Dec 2016	IMO, Yangon	6	5					2	2	15
30	Training of trainers on Rice–Fish system in Maubin	8-9 May 2017	TaLoak Hla fish hatchery, Maubin	8	3	5	7					23
	Total			**237**	**288**	**364**	**52**	**58**	**21**	**73**	**37**	**1130**

Appendix Table 3. Selected meeting with high level officials, June 2016 to April 2017.

No	Name of Staff	Date	Venue	Topic/Purpose	Person(s) met and Designation/Position	Highlights
1	R Labios Than Aye AyeMin CCAung SSSan AMThant YLAung	7 June 2016	Bago DoA Regional office	Workshop with DoA staff for the WS 2016 outscaling activities; seed distribution	U Hla Myint, Regional Director, DoA Bago Region; Daw Thu Zar Myint, Director, Rice Division, DoA; Other District and Township Managers	Presentation of the target and plans for WS 2016
2	R Labios TTMyint Than Aye AyeMin CCAung SSSan AMThant YLAung	9 Sept 2016	Pathein DoA Regional office	Meeting with DoA RD and other officials of Ayeyarwady Region regarding WS 2016 and DS2016/2017 activities	U Tun Aung Kyaw, Regional Director; U Htay Lwin, Deputy Regional Director; U Theik Soe, Assistant Director/District Manager, Maubin district; U Tin Maung Nyein, MyaungMya Township Manager	Discussion on activities and plans for WS 2016 and DS 2016/2017
3	R Labios TTMyint Than Aye AyeMin CCAung SSSan AMThant YLAung	10 Sept 2016	Bago DoA Regional office	Meeting with DoA RD and other officials of Bago Region regarding WS 2016 and DS2016/2017 activities	U Hla Myint, Regional Director; U Lay Myint, Assistant Director/District Manager, Bago District; Daw San San Oo, Staff Officer, Bago region; Daw San San Htay, Staff Officer, Bago district; Daw Ye Ye Win, Deputy Staff Officer, Daik U	Discussion on activities and plans for WS 2016 and DS 2016/2017
4	Matthew Morell JHughes CGuerta AYSteel RLabios JShin	14 Sept 2016	DAR, Yezin	Donors Forum	Dr Aung Thu, Minister, MoALI; Dr. Tun Win, Deputy Minister, MOALI; Dr. Tint Htut, Permanent Secretary, MOALI; Representatives from SDC, WB, FAO, ADB, UNHabitat, other Development partners	Presentation of a) MoALI's program and new directions b) IRRI's program
5	GSingleton R Labios TTMyint Than Aye AyeMin CCAung SSSan AMThant YLAung	10 Oct 2016	Bago DoA Regional office	MyRice project Annual Review & Planning Meeting	U Aung Zaw Naing, Regional Minister Agriculture, Livestock, Natural Resources and Environmental Conservation, Bago Region; U Hla Myint Aung, Deputy Director General, DoA; U Hla Myint, Regional Director, DoA Bago Region; U Tun Aung Kyaw, Regional Director, DoA Ayeyarwady Region; Daw Thu Zar Myint, Director, Rice Division, DoA	Presentation of 2015/2016 activities and plans for 2017 activities
6	GSingleton R Labios	12-13 Oct	Mandalay City	ACIAR DFAT Annual Meeting	Nicolas Coppel, Australian Ambassador to Myanmar; Dr Robert Edis; Dr. Peter Horne; Other	Presentation of MyFarm program highlights plus 5

No	Name of Staff	Date	Venue	Topic/Purpose	Person(s) met and Designation/Position	Highlights
	TTMyint AyeMin CCAung SSSan	2016			ACIAR officials; Dr. Aung Thu, Minister, MOALI; Dr Tin Htut, PS, MOALI; Dr. Ye Tint Tun, DG, DoA; Other DoA, DAR officials	projects (MyRice, MyFish, MyLife, Legumes/Pulses, Livestock)
7	R Labios UThan Aye TTMyint AyeMin CCAung SSSan AMThant YLAung	5 Nov 2016	Pathein DoA Regional office	Review and Planning of Collaborative Outreach Activities in Rice-based Systems in Ayeyarwady Region	U Tun Aung Kyaw, Regional Director, DoA Ayeyarwady Region; Other officials DoA Region, District/Township	Presentation of updates in the collaborative outreach activities and seed production of WS 2016 and plans for DS2016/2017
8	GSingleton DJohnson RLabios MCasimero	24 Jan 2017	MoALI, Nay Pyi Taw	ROD of CORIGAP, ACIAR Rice–Fish new project WB ADSP proposal	Dr. Tin Htut, PS, MoALI; Dr. Ye Tin Tun, DG, DoA Directors of DoA Divisions Dr. Karim Manjurul, WF	Signing of CORIGAP MOU with MoALI Presented plans for new ACIAR WF IRRI Rice–Fish project Consultation of WB ADSP implementation strategy
9	GSingleton RLabios TTMyint SSSan AMThant YLAung	27 Feb	Maubin	ACIAR commission visit to rice-fish project in Maubin township	Don Heatley (Commission Chairman), Catherine Marriot, Lucinda Corrigan, Tony Gregson, John Cook (Commission members), Eleanor Dean (General Manager - Outreach and Capacity Building), Peter Horne (General Manager - Country Programs), Suzanne Gaynor (Executive Officer – CEO), Maree Livermore (Executive Officer - Country Programs), Dulce Simmanivong (Regional Manager),Ohnmar Khaing and Myo Thura Dr. Michael Akester –WF Country Rep; Dr. Manjurul Karim - Program Manager, WF; Dr. Xavier Simon André Tezzo- Technical Support Officer, WF; Dr. Robyn Johnston -IWMI Representative in Myanmar; Dr. Nilar Shein -Deputy Director, Aquaculture Division, DoF; U Tun Aung Kyaw-Regional Director, DoA Ayeyarwady Region; U Myint Oo - Director Extension Div, DoA	Consultation with farmers from Maubin; Presentation of MyRice and MyFish Activities and Accomplishments
10	RLabios TTMyint AMThant SSSan YLAung	14 Mar 2017	Maubin	Australian Minister and Ambassador visit to Maubin rice–fish project site	Australian Minister Hon Concetta Anna Fierravanti-Wells (Ministry of International Development and the Pacific); Australian Ambassador to Myanmar Hon Nicolas Coppel; First Secretary to Myanmar Hon Esther Sainsbury; Ms. Michelle Pendrick -	Field visit and consultation with farmers

No	Name of Staff	Date	Venue	Topic/Purpose	Person(s) met and Designation/Position	Highlights
					Advisor to the Minister; Mr. Philip Green - First Assistant Secretary, Department of Foreign Affairs and Trade (DFAT), Canberra; Mr. Nick Cumpston - Counsellor, Australian Embassy Yangon; Ms. Jo Ronalds -Assistant Director, Myanmar Section, DFAT, Canberra U Khin Maung Maw, DG, DOF; U Hlwan Moe Zaw, DyDG DOF Yangon Region; U Tin Maung Oo, DyDG Maubin District; U Myint Oo Director Extension Div, DoA; U Tun Aung Kyaw, Regional Director, Ayeyarwady Region; U Theik Soe; Asst Director, Maubin District	
11	TAye TT Myint AMin CCAung AMThant	10 Apr 2017	Bago DoA Regional Office	Consultation meeting regarding the BMP outreach for 2017WS	U Hla Myint(Regional Director), U Lay Myint(District Manager, Bago), U San Lwin(District Manager, Taungoo), Daw Tin Mya Lwin(District Manager, Tharyarwaddy), Daw San San Oo(Officer, Regional office), Daw San San Htay(Officer, District office), Daw Lei Lei Win(Assistance Director, Bago regional office), Daw Khin Myint Myint(Assistance Director, Land use department, Bago regional office) U San Tun Win(Officer, Phyu)	Plan for BMP in 2017WS within the Bago region and seed requirement for BMP in 2017WS.
12	TAye TT Myint AMin CCAung AMThant	11 Apr 2017	Pathein DoA Regional office	Consultation meeting regarding the BMP outreach for 2017WS	U Tun Aung Kyaw(Regional Director), U Htay Lwin(Deputy Regional Director), U Theik Soe(Assistance Director, Maubin), U San Win(District Manager, Hinthada), Daw Maw Maw Tin(Officer, Pathein Regional office), U Sein Maung Myint(Assistance Director, Pathein District), Daw Thin Thin Han(Deputy officer, Myaung Mya)	Plan for BMP in 2017WS within the Ayeyarwady region and seed requirement for BMP in 2017 WS.
13	GRSingleton RLabios MGummert TAye TT Myint Amin CCAung CBalingbing RQuilloy AMThant SSSan YLAung	9-10 Oct 2017	IMO, Yangon and Bago DoA Regional Office	MyRice Project Final review and meeting	Dr. Robert Edis (ACIAR Research Program Manager), Miss Dulce Simmanivong (Regional Manager, East Asia), Dr. Rod Lefroy and U Aye Tun (External Reviewer), U Aung Zaw Naing (Regional Minister Agriculture, Livestock, Natural Resources and Environmental Conservation, Bago Region), U Hla Myint Aung(Deputy Director General, DoA), U Hla Myint (Regional Director, DoA Bago Region), U Htay Lwin Tun (Deputy Regional Director, DoA Ayeyarwady Region), Daw Thu Zar Myint (Director, Rice Division, DoA), Dr. Nyo Me Htwe (Dep Staff Officer, DoA),	Presentation of accomplishments of MyRice project for past 5 years and way forward

No	Name of Staff	Date	Venue	Topic/Purpose	Person(s) met and Designation/Position	Highlights
14	GRSingleton DJohnson RLabios MGummert TAye TT Myint Amin CCAung CBalingbing RQuilloy AMThant SSSan YLAung	12-14 Oct 2017	Nay Pyi Taw	ACIAR DFAT Final Meeting and Showcase	U Hla Kyaw (Deputy Minister for Agriculture, Livestock and Irrigation) ACIAR DFAT - HE Nicholas Coppel (Australian Ambassador),Vanessa Hegaty, Dr Peter Horne, Dr Jayne Curnow, Dr Robert Edis, Dr Werner Stur, Dulce Simmanivong, Dr Rod Lefroy, Sally Pryor, U Myo Thura, Dr Ohnmar Khaing, Anna Okello, Sein Sein Myint, Dr Tin Maung Aye, David Shearer, U Aye Tun MyPulses Team, MyFish Team, Dahat Pan Team, MyLife Team,	Highlight outcomes and achievements at Project and Program levels for past 5 years. Identified the highest priorities for future agricultural research in Myanmar. The Program Showcase featured interactive exhibits that reflect key findings and provide snapshots of the richness and diversity of each project.

NOTE: An additional list of high official meetings is available upon request.

Appendix Table 4A. Rice RS seed distribution summary from 2014 WS to 2017 WS in selected townships of Ayeyarwady and Bago regions.

Year	Season	Township	Village	Crop	No. of farmers	No of Varieties	Total Amount (bsk)
2014	WS	Maubin	NgaGyiGayat	Rice	13	1	12
Sub-Total					*13*	*1*	*12*
2015	WS	Maubin	Tar Pet(W)	Rice	21	2	22
2015	WS	Maubin	A. Lann	Rice	17	2	20
2015	WS	Maubin	NgaGyiGayat	Rice	34	2	41
2015	WS	Maubin	Pan Pin Su	Rice	25	2	29
2015	WS	Daik Oo	Kadote phyar Gyi	Rice	22	3	29
2015	WS	Daik Oo	Pyin Ma Lwin	Rice	3	3	3
2015	WS	Daik Oo	Phaung Wae	Rice	10	4	13
2015	WS	Daik Oo	Oak Shit Kone	Rice	10	3	10
Sub-Total					*142*	*21*	*167*
2016	WS	Maubin	Tar Pet(W)	Rice	5	3	7
2016	WS	Maubin	A. Lann	Rice	7	2	7
2016	WS	Maubin	NgaGyiGayat	Rice	19	4	19
2016	WS	Maubin	Pan Pin Su	Rice	10	3	10
2016	WS	Maubin	Thu Htay Kone	Rice	5	2	5
2016	WS	Daik Oo	Kadote phyar Gyi	Rice	19	1	19
2016	WS	Daik Oo	Pyin Ma Lwin	Rice	10	2	10
2016	WS	Daik Oo	Phaung Wae	Rice	12	2	12
2016	WS	Daik Oo	Oak Shit Kone	Rice	11	2	11
2016	WS	Daik Oo	Pahung Aung Su	Rice	7	1	7
Sub-Total					*105*	*19*	*107*
Year	Season	Region	District/ Township No.	Area planted (acre)	No. of farmers	No of Varieties	Total Amount (bsk)
2017	WS	Bago	Bago District/ 4	347	350	5	350
2017	WS	Bago	Taungoo District/ 5	360	136	5	360
2017	WS	Bago	Tharyarwaddy District/ 4	375	162	2	375
2017	WS	Ayeyarwady	Pathein District/ 6	150	181	1	150
2017	WS	Ayeyarwady	Hintada District/ 6	280	153	2	280
2017	WS	Ayeyarwady	Myaung Mya District/ 6	104	153	3	104
2017	WS	Ayeyarwady	Maubin District/ 4	335	367	6	335
2017	WS	Ayeyarwady	Pyapone District/4	133	120	2	133
Sub-Total				2084	1536	26	2087
TOTAL					**1796**		**2361**

Over all total is 2,361 basket (49,581 kg) from 10 varieties to 1,796 farmers.
Varieties : Varieties = Pyi Taw Yin, Yaenelo 7, Sin Thu Ka, Yadanar Toe, Shwe Phyi Tan, Manaw Thu Ka, Sin Thwe Latt, Thee Htat Yin, IR 85309 Sub 1 156-1-1-1, IR 79207-52-2-3-3.

Appendix Table 4B. Rice RS seed distribution summary for 2015 DS, 2016 DS in Maubin and Daik U and for 2017 DS to other townships.

Year	Season	Township	Village	Crop	No. of farmers	No of Varieties	Total Amount (bsk)
2015	DS	Maubin	A. Lann	Rice	12	4	25
2015	DS	Maubin	Tar Pet(W)	Rice	9	4	17
2015	DS	Daik Oo	Kadote phyar Gyi	Rice	5	1	7.5
2015	DS	Daik Oo	Kyaik Sa Kaw	Rice	6	1	9
Sub-Total					32	10	58.5
2016	DS	Maubin	Tar Pet(W)	Rice	14	2	22.5
2016	DS	Maubin	A. Lann	Rice	27	3	45
2016	DS	Daik Oo	Kadote phyar Gyi	Rice	18	1	18
2016	DS	Daik Oo	Pyin Ma Lwin	Rice	3	1	3
Sub-Total					62	7	88.5
2017	DS	Maubin	9 villages	Rice	35	1	35
2017	DS	Ingapu	1 village	Rice	2	1	2
2017	DS	Myaung Mya	5 villages	Rice	5	1	5
2017	DS	Wakema	2 villages	Rice	2	1	2
2017	DS	Pathein	4 villages	Rice	4	2	4
2017	DS	Kangyidaunk	3 villages	Rice	3	1	3
2017	DS	Pyapon	3 villages	Rice	3	2	3
2017	DS	Daik Oo	5 villages	Rice	11	2	23
2017	DS	Taungoo	4 villages	Rice	20	1	20
2017	DS	Gyobingauk	1 village	Rice	5	1	10
Sub-Total					90	13	107
TOTAL					**184**	**30**	**254**

Over all total is 254 basket (5,229 kg) from 7 varieties to 184 farmers

Varieties = Pyi Myanmar Sein, Pyi Taw Yin, Yaenelo 1,Yaenelo 4, Yaeneolo 7, Yn 3155-421-18-3-7-1

Appendix Table 4C. Pulse RS seed distribution summary for 2015 DS, 2016 DS in Maubin and Daik U and in 2017 DS to other townships.

Year	Season	Township	Village	Crop	No. of farmers	No of Varieties	Total Amount (bsk)
2015	DS	Maubin	NgaGyiGayat	Pulse	27	2	41
2015	DS	Maubin	Pan Pin Su	Pulse	28	5	43
2015	DS	Daik Oo	Phaung Wae	Pulse	13	2	17
2015	DS	Daik Oo	Oat Shit Kone	Pulse	17	4	17
Sub-Total					*85*	*13*	*118*
2016	DS	Maubin	Pan Pin Su	Pulse	16	2	17
2016	DS	Maubin	NgaGyiGayat	Pulse	31	3	32
2016	DS	Daik Oo	Oat Shit Kone	Pulse	10	2	10
2016	DS	Daik Oo	Phaung Wae	Pulse	16	2	17
Sub-Total					*73*	*9*	*76*
2017	DS	Maubin		Pulse	37	1	37
2017	DS	Pan Ta Naw		Pulse	5	2	5
2017	DS	Nyaungdon		Pulse	5	1	5
2017	DS	Da Nu Phyu		Pulse	5	1	5
2017	DS	Hinthada		Pulse	15	1	15
2017	DS	Zalun		Pulse	15	1	15
2017	DS	Einme		Pulse	5	1	5
2017	DS	Wakema		Pulse	3	1	3
2017	DS	Kangyidaut		Pulse	2	1	2
2017	DS	Daik Oo		Pulse	29	3	29
2017	DS	Taungoo		Pulse	10	1	10
2017	DS	Gyopingauk		Pulse	30	1	30
Sub-Total					*161*	*15*	*161*
TOTAL (12 tsp)					**319**	**37**	**355**

1bsk=16 pyi =32 kg ; 4 pyi=8kg

1 farmer received 4 pyi/variety or 8kg/variety good for 0.25 acre

Overall total is 355 basket (11,360 kg) from 6 varieties to 319 farmers.

Varieties = Black gram (Yezin 2, Yezin 3, Yezin 5); Green gram (Yezin 11, Yezin 14, Pale Tun).

Appendix Table 5.Research Theses Grantees from DoA and DAR by ACIAR project, 2012–17.

Name	Sex	Organization	Degree and Major Field	Start/End of Semester	Research Topic
1. Daw Lay Nge[2]	F	DoA	MSc (Soil Science)	Nov 2013/ Nov2016	Assessment of Nitrogen and Potassium Balanced Fertilization on Yield of Rice in Maubin Township
2.U Zar Ni Hlaing[2]	M	DoA	MSc (Socio-economic)	Nov 2013/ Nov2016	Analysis of Rice Supply Change and Farmer's Demand Estimation for Rice Quality Seed in Maubin Township
3. DawTheintTheint Soe Mon[2]	F	DoA	MSc (Agronomy)	Nov 2013/ Nov2016	Farmer's awareness and Behavior to Climate Change in Rice–Rice production in Maubin Township
4. U Kyaw Lin Thu[2]	M	DoA	MSc (Soil Science)	Nov 2013/ Nov2016	Effect of farm yard manure on rice production
5. Daw Kathy Khin[2]	F	DoA	MSc (Socio-economic)	Nov 2013/ Nov2016	Study on the comparative advantage in Rice Production of the selected Townships in Myanmar
6. DawHla Moe Khaing[3]	F	DoA	MSc (Soil Science)	Nov 2014/ Nov2017	Effect of improved and farmer fertilizers management practices for growth and yield of three rice varieties in Maubin and DaikOo Townships
7. Daw Aye Aye Min[3]	F	DoA	MSc (Soil Science)	Nov 2014/ Nov2017	Balanced fertiliser and residue management on green gram under rice-pulse cropping system in Maubin and DaikOo Townships
8. Daw Phone Thidar Aung[3]	F	DoA	MSc (Agronomy)	Nov 2014/ Nov2017	Comparison of water productivity of rice varieties under the farmer and improve practices in Maubin and DaikOo
9. Daw Cho Cho Aung [1]	F	DAR	MSc (Agronomy)	Nov 2012/ Nov2015	Evaluation of submergence tolerant rice (*Oryza sativa* L.)varieties in selected submerged areas of Ayeyarwady and Bago (East) regions
10. Daw Zarchi Phyo[2]	F	DAR	MSc (Plant Breeding)	Nov 2013/ Nov2016	Responses of drought tolerant rice varieties in rainfed lowland areas of Myanmar
11.U KyawMyint Htoo[1]	M	DAR	MSc (Plant Pathology)	Nov 2012/ Nov2015	Effect of potassium fertiliser application on bacterial leaf blight of rice

12.U Mya Win Aung[2]	M	DAR	Post-graduate research	Nov 2014/ Nov2016	Evaluation of effective control measure against BB of rice caused by Xanthomonasoryzaepv. oryzae
13. Daw Su HlaingPhyoe[2]	F	DAR	Post-graduate research	Nov 2014/ Nov2016	Response of rice cultivars affected by nitrogen and boron fertiliser application at flowering stage
14. U KyawThet[3]	M	DAR	MSc(Agronomy)	Nov 2014/ Nov2017	Evaluation of variety performance response to the best management practises
15. Daw Chan MyaeLwin[3]	F	DAR	MSc (Socio-economic)	Nov 2014/ Nov2017	Evaluation of farmer's practices, knowledge and attitude response to the best management practises
16.DawThanda Win[3]	F	DAR	MSc (Socio-economic)	Nov 2014/ Nov2017	Evaluation of farmer's practices, knowledge and attitude response to the best management practises
17.Daw Pa Pa Win[3]	F	DAR	P.hD (Plant Breeding)	Nov 2013/April 2017	Investigation of released and promising varieties for Distinctness, Uniformity and Stability (DUS) Test in Rice (*Oryza sativa* L.)

NOTE: [1] Graduated in November 2015 (2); [2] graduated in Nov 2016 (8); [3] graduated in Nov 2017 (7). Total of 5 male; 12 female

Appendix Table 6A. Farmers' and best management options for rice in rice-rice systems, Ka Dote Phayar Gyi village, Daik-U Township, WS 2016.

For transplanted rice (replicated trial)

	Based on Farmer Diary	Best management practice protocol
Variety/maturity	● Hmawbi 2	Inpara 3, Sin Thwe Lat
Seeding rate (kg/ha)	● 103.7kg/ha	● 39kg/ha
Seedbed nursery (include size of nursery)	● Farmer practice nursery (1000m^2)	● Seed bed nursery(604 m^2)
Fertiliser application in nursery	● Urea-242kg/ha (two times)	● 10g $ZnSO_4$/20m^2 Cover with ash after seeding ● 0.54 kg of 15-1-5-15/20 m^2 ● 0.05 kg of urea (46-0-0)/20 m^2
Land preparation	● 1 times ploughing ● 3 times harrowing ● 1 times leveling	● 1 times ploughing ● 3 times harrowing ● 1 times leveling
Seedling age	● 35 Days	● 35 Days
Planting/transplanting	● Hand transplanting	Hand transplanting
Fertiliser application (kg/ha NPK) in field after transplanting	● Urea-89kg/ha(one time) ● Compound(10:10:5)-79kg/ha(mix with urea)	● 10 DAT- Compound(15:15:15)-100kg/ha ● 25 DAT-Compound(15:15:15)-100kg/ha and Urea-25kg/ha ● 40-45DAT-Urea-50kg/ha
Insect pest and disease management	● No	● No
Weed and other pest management	● No	● No
Water management	● Depending on rainfall condition	● Depending on rainfall condition
Harvesting	● 85% maturity	● 85% maturity
Postharvest management	● Immediately sell	● Immediately sell

Appendix Table 6B. Farmers' and best management options for rice in rice–pulse systems, Pa Aung Wei village, Daik-U Township, WS 2016.

For transplanted rice (replicated trial)

	Based on Farmer Diary	Best management practice protocol
Variety/maturity	● Sin ThuKa	Pyi Taw Yin, Sin Thwe Latt
Seeding rate (kg/ha)	● 103.7kg/ha	● 39kg/ha
Seedbed nursery (include size of nursery)	● Farmer practice nursery (1000m^2)	● Seed bed nursery(604 m^2)
Fertiliser application in nursery	● Urea-123 kg/ha(2 times)	● 10g $ZnSO_4$/20m^2 Cover with ash after seeding ● 0.54 kg of 15-1-5-15/20 m^2 ● 0.05 kg of urea (46-0-0)/20 m^2
Land preparation	● 2 time ploughing ● 3 time harrowing ● 1 time leveling	● 2 time ploughing ● 3 time harrowing ● 1 time leveling
Seedling age	● 35 Days	● 35 Days
Planting/transplanting	● Hand transplanting	Hand transplanting
Fertiliser application (kg/ha NPK) in field after transplanting	● Urea-92.6kg/ha(one times)(10-15 DAT)	● 10 DAT- Compound(15:15:15)-100kg/ha ● 25 DAT-Compound(15:15:15)-100kg/ha and Urea-25kg/ha ● 40-45DAT-Urea-50kg/ha
Insect pest and disease management	● No	● No
Weed and other pest management	● Herbicide apply	● Herbicide apply
Water management	● Depending on rainfall condition	● Depending on rainfall condition
Harvesting	● 85% maturity	● 85% maturity
Postharvest management	● Immediately sell	● Immediately sell

Appendix Table 7A. Improved varieties and improved management for monsoon rice in rice–rice systems in Kadote Phayar Gyi, Daik U (with three replicates), WS 2016.

	Farmer Name - U Myo Myint Aung					
	FV + FM	FV+IM	IV1+FM	IV2+FM	IV1+IM	IV2+IM
Variety	Hmawbi 2	Hmawbi 2	Inpara 3	Sin Htwe Latt	Inpara 3	Sin Htwe Latt
Yield (t/ha)	3.0	3.6	3.9	3.9	4.6	4.5
Gross Return (MMK/ha)	702,785	828,623	779,054	784,346	925,954	905,842
Total Cost (MMK/ha)	559,401	644,125	559,401	644,125	559,401	644,125
Gross Margin (MMK/ha)	143,383	184,498	219,653	140,221	366,553	261,717
B/C Ratio	1.26	1.29	1.39	1.22	1.66	1.41

Appendix Table 7B. Improved varieties and improved management for monsoon rice in rice–pulse systems in Pa Aung Wei, Daik U (with three replicates), WS 2016.

	Farmer Name: U San Pwint					
	FV + FM	FV+IM	IV1+FM	IV2+FM	IV1+IM	IV2+IM
Variety	Sin Thu Kha	Sin Thu Kha	Pyi Taw Yin	Sin Thwe Latt	Pyi Taw Yin	Sin Thwe Latt
Yield (t/ha)	2.6	3.4	4.3	4.2	4.8	4.6
Gross Return (MMK/ha)	487,680	647,071	810,254	806,444	913,124	868,051
Total Cost (MMK/ha)	623,305	808,380	623,305	623,305	808,380	808,380
Gross Margin (MMK/ha)	(135,625)	(161,309)	186,949	183,139	104,744	59,671
B/C Ratio	0.78	0.80	1.30	1.29	1.13	1.07

Appendix Table 8A. Average grain yield (t/ha) and gross margin (MMK/ha) of monsoon rice in rice–rice systems of outreach sites, Ayeyarwady region, 2016 WS.

	Tar Pat W, Maubin (n= 4)		AhLan, Maubin (n= 5)		Pathein & Kan Gyi Daung (n= 6)	
Management	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM
Yield (t/ha)	3.1	4.3	3.6	4.3	3.8	4.0
Gross Margin (MMK/ha)	392,008	622,595	468,035	599,487	220,620	248,060
% increase in yield		27.3		15.9		5.4
%increase in income		37.0		21.9		11.1
Variety	Hnan Kar, Bay Gar	Manaw ThuKa2	Sin ThuKa, Ayeyar Min,	Sin Thwe Latt	Thee Htat Yin	Pyi Taw Yin

Appendix Table 8B. Average grain yield (t/ha) and gross margin (MMK/ha) of monsoon rice in rice–pulse systems of outreach sites, Ayeyarwady region, 2016 WS.

	PaPinSu, Maubin (n-= 5)		NgaGyiGayat, Maubin (n= 6)		ThuKayTone, Maubin (n= 5)		Nyaungdon (n=6)		Pantanaw (n=5)		Danupyu (n= 5)		Hintada (n=2)	
Management	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM
Yield (t/ha)	3.9	3.9	4.5	5.2	4.3	4.5	3.9	3.9	4.9	4.6	4.7	3.9	4.4	4.5
Gross Margin (MMK/ha)	426,527	578,326	563,027	740,369	268,122	289,545	426,527	578,326	859,186	797,618	367,629	301,158	816,660	834,935
% increase in yield		12.9		12.9		5.3		1.5		-4.9		-22.1		3.7
%increase in income		36.5		24.0		7.4		26.2		-7.7		-22.1		2.2
Variety	Sin ThuKa	Sin Thwe Latt, Manaw Thuka 2	Sin Thuka	Sin Thwe Latt, Pyi Taw Yin	Sin ThuKa	Pyi Taw Yin, Manaw ThuKa2	Sin Thuka, HteeHtat Yin	Pyi Taw Yin	Sin Thuka	Pyi Taw Yin	Sin Thuka	Pyi Taw Yin	Sin Thuka	Pyi Taw Yin

Appendix Table 8C. Average grain yield (t/ha) and gross margin (MMK/ha) of monsoon rice in rice–rice systems of outreach sites, Bago region, 2016 WS.

	Taungoo (n=24)		Gyobin Gauk (n=22)	
Management	FV + FM	IV+IM	FV + FM	IV+IM
Yield (t/ha)	4.2	4.6	5.9	6.0
Gross Margin (MMK/ha)	281,715	340,034	874,227	1,460,909
% increase in yield		9.0		0.7
%increase in income		17.2		40.2
Variety	Sin ThuKa, Thai 90, Aye Yar Min	Pyi Taw Yin, Shwe Pyi Tan	Yadanar Toe,Shwe Myanmar, Yet 90	Shwe Pyi Tan, Pyi Taw Yin

Appendix Table 8D. Average grain yield (t/ha) and gross margin (MMK/ha) of monsoon rice in rice–pulse systems of outreach sites, Bago region, 2016 WS.

	Daik U (n=10)	
Management	FV + FM	IV+IM
Yield (t/ha)	4.5	4.7
Gross Margin (MMK/ha)	281,715	340,034
% increase in yield		4.8
%increase in income		5.7
Variety	Byawt Tun, Sin Thu Kha, Hmawbi	Pyi Taw Yin, Sin Thwe Latt

Appendix Table 9A. Average grain yield (t/ha) and gross margin (MMK/ha) of summer rice in Rice–Rice Systems of outreach sites, Ayeyarwady region, 2016/2017 DS.

	Maubin (n-= 25)		Myaungmya (n-= 7)		Pathein & Kan Gyi Daung (n= 6)	
Management	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM
Yield (t/ha)	5.0	5.4	4.3	4.8	3.8	4.0
Gross Margin (MMK/ha)	465,081	608,623	326,275	318,887	220,620	248,060
% increase in yield		7.6		11.5		5.7
%increase in income		30.9		-2.3		12.4
Variety	Thee Htat Yin	Yaenelo 7	Thee Htat Yin	Yaenelo 7	Thee Htat Yin	Pyi Taw Yin

Appendix Table 9B. Average grain yield (t/ha) and gross margin (MMK/ha) of green gram in rice–pulse Systems of outreach sites, Ayeyarwady region, 2016/2017 DS.

	Maubin (n-= 20)		Myaungmya (n-= 8)		PNW,DYU,NDN*(n=25)	
Management	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM
Yield (t/ha)	0.7	0.7	1.3	1.4	1.0	1.0
Gross Margin (MMK/ha)	245,488	280,242	581,426	624,748	702,795	634,626
% increase in yield		3.7		9.1		-0.7
%increase in income		14.2		7.5		-9.7
Variety	local variety	Yezin 2	Pearl Tun	Yezin 2	local variety	Yezin 2

*PNW = Pan Ta Naw; DYU=Danubyu; NDN = Nyaungdon

Appendix Table 9C. Average grain yield (t/ha) and gross margin (MMK/ha) of summer rice in Rice–Rice Systems of outreach sites, Bago region, 2016–17 DS.

	Daik U (n-= 4)		Daik U (n-= 4)		Taungoo (n= 10)		Taungoo (n= 10)	
Management	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+IM
Yield (t/ha)	3.9	4.3	4.8	5.1	4.9	5.0	4.5	4.6
Gross Margin (MMK/ha)	413,388	497,977	572,007	729,845	594,831	669,069	556,830	574,729
% increase in yield		9.7		5.3		2.1		1.4
%increase in income		17.0		21.6		11.1		3.1
Variety	Yadanar Toe, Yet 90	Yaenelo 7	SinThuka	Yaenelo 7	Yet 90	Yaenelo 7	Dagone 2	Yaenelo 7

Appendix Table 9D. Average grain yield (t/ha) and gross margin (MMK/ha) of black/green gram in rice–pulse systems of outreach sites, Bago region, 2016–17 DS.

	Daik U (n= 5)		Daik U (n= 1)		Daik U (n= 18)		Zalun (n=4)		Gobinauk (n= 3)		Gobinauk (n= 24)		Gobinauk (n= 3)		Taungoo (n= 10)	
Management	FV + FM	IV+IM	IV1 + FM	IV2+IM	FV + FM	IV+IM	FV + FM	IV+IM	FV + FM	IV+ IM	FV + FM	IV+ IM	FV + FM	IV+ IM	IV1 + FM	IV2+ IM
Yield (t/ha)	1.1	1.2	1.1	1.5	0.9	1.1	1.6	1.7	1.2	1.2	1.3	1.2	1.1	1.0	1.2	1.2
Gross Margin (MMK/ha)	903,065	1,052,578	797,492	689,748	628,580	696,170	1,253,243	1,371,150								
% increase in yield		13.4		35.4		9.4		11.9		-4.1		-8.6		-10.8		0
%increase in income		16.6		-13.5		10.7		9.4								
Variety	Site Phyo	Yezin 14	Yezin 14	Yezin 14	Pearl Tun, Pin Yaung New Yaung ,Ywet Chun	Yezin 3	local variety	Yezin 2	Yezin 2	Yezin 3	Pe Kan Zun	Yezin 2	Yezin 2	Yezin 5	Yezin 2	Yezin 2

Appendix Table 10A. Average grain yield (t/ha) and gross margin (MMK/ha) of monsoon rice in Rice-Rice systems of outreach sites, Ayeyarwady region, 2017 WS.

	Maubin District/ 10 Townships (n=37)		Hintada District/ 3 Townships (n=15)		Maubin District/ Pantanaw Township (n=26)		Maubin District/Danuphyu Tsp. (n=26)	
Management	FV + FM	IV + IM	FV + FM	IV + IM	FV + FM	IV + IM	FV + FM	IV + IM
Yield (t/ha)	3.9	4.2	4.1	4.3	4.3	4.7	4.0	4.3
Gross Margin (kyts/ha)	497,774	887,970	424,703	884,025	418,539	661,324	543,355	662,754
% increase in yield		8		6		10		7
%increase in income		78		108		58		22
Variety	Sin Thu Kha, Thee Htat Yin	Yaenelo 7, Sin Thwe Latt, IR79207	Shwe War Tun, Aye Yar Min, Sin Thu Kha	Yaenelo 7, Pyi Taw Yin	Sin Thu Kha, Pa Khan Shwe War	Yaenelo 7, Sin Thwe Latt, Pyi Taw Yin	Sin Thu Kha, Pa Khan Shwe War	Yaenelo 7

Appendix Table 10B. Average grain yield (t/ha) and gross margin (MMK/ha) of monsoon rice in Rice-Rice systems of outreach sites, Ayeyarwady region, 2017 WS.

	MyaungMya District/ War Kae Ma Tsp.(n=3)		MyaungMya District/ 2 Tsp. (n=13)		MyaungMya District/ War Khae Ma Tsp. and Pathein District/ Nga Pu Taw Tsp. (n=10)		Pathein District/ 3 Townships (n=46)	
Management	FV + FM	FV + IM	FV + FM	FV + IM	FV + FM	FV + IM	FV + FM	FV + IM
Yield (t/ha)	4.24	5.00	4.2	4.6	2.65	3.58	4.53	4.86
Gross Margin (kyts/ha)	450,413	817,405	604,683	714,942	266,513	747,546	789,110	983,586
% increase in yield		18		8		35		7
%increase in income		81		18		180		25
Variety	Thee Htat Yin	Yaenelo 7	Sin Thu Kha	Sin Thu Kha	Paw San Yin	Paw San Yin	Sin Thu Kha	Pyi Taw Yin

Appendix Table 11. Average grain yield (t/ha) and gross margin (MMK/ha) of monsoon rice in Rice-Pulse systems of outreach sites, Ayeyarwady region, 2017 WS.

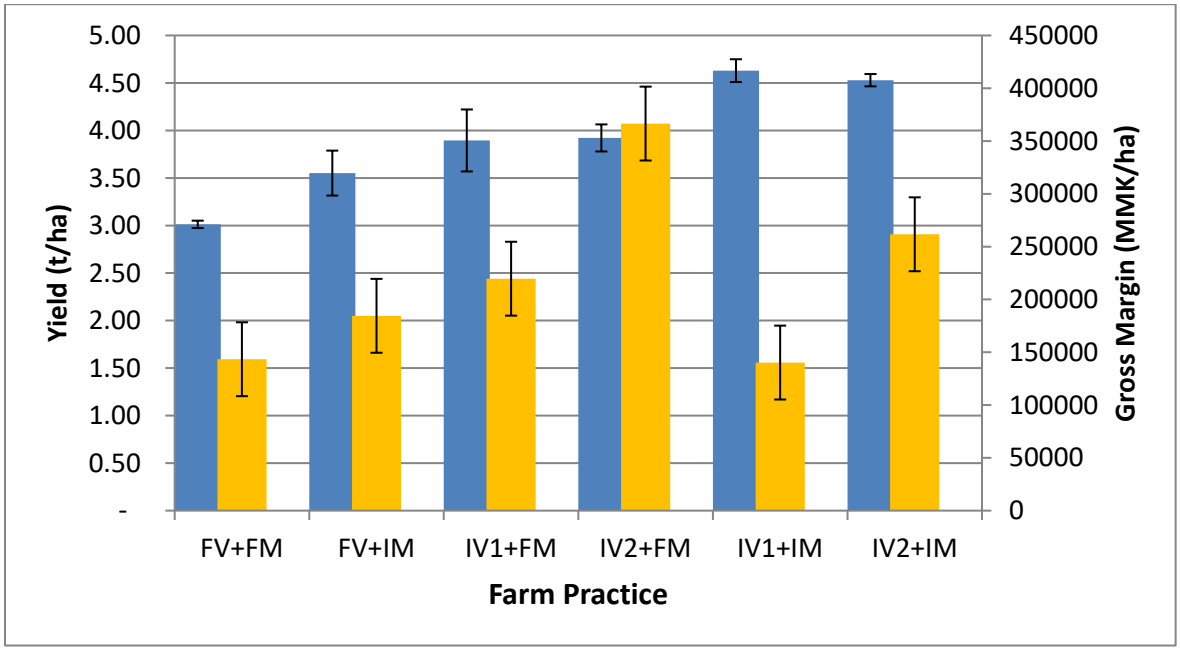
	Hintada District/ 3 Townships (n=15)		Maubin District/ Pantanaw Township (n=26)		Maubin District/Danuphyu Tsp. (n=26)	
Management	FV + FM	IV + IM	FV + FM	IV + IM	FV + FM	IV + IM
Yield (t/ha)	4.1	4.3	4.3	4.7	4.0	4.3
Gross Margin (kyts/ha)	424,703	884,025	418,539	661,324	543,355	662,754
% increase in yield		6		10		7
%increase in income		108		58		22
Variety	Shwe War Tun, Aye Yar Min, Sin Thu Kha	Yaenelo 7, Pyi Taw Yin	Sin Thu Kha, Pa Khan Shwe War	Yaenelo 7, Sin Thwe Latt, Pyi Taw Yin	Sin Thu Kha, Pa Khan Shwe War	Yaenelo 7

Appendix Table 12. Average grain yield (t/ha) and gross margin (MMK/ha) of monsoon rice in Rice-Rice and Rice-Pulse systems of outreach sites, Bago region, 2017 WS.

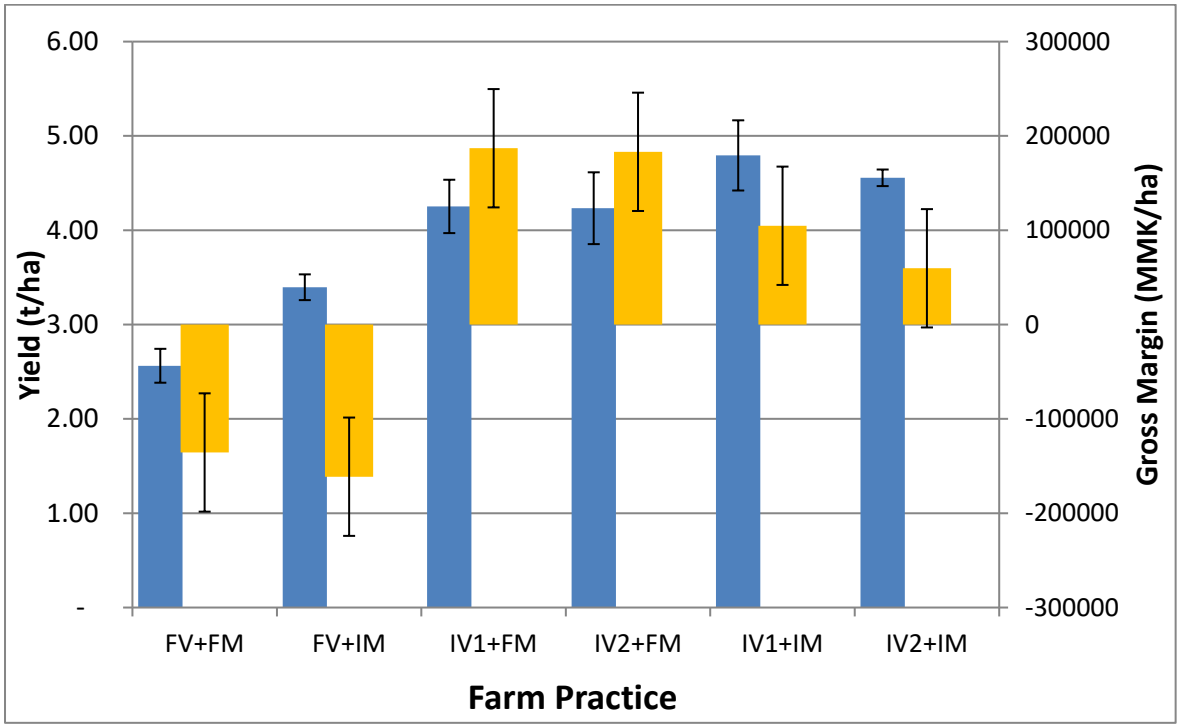
	Bago District/Daik U Township (n=12) Rice-Rice system		Bago District/Daik U Township (n=12) Rice-Pulse system	
Management	FV + FM	IV+IM	FV + FM	IV+IM
Yield (t/ha)	4.9	5.3	4.2	4.7
Gross Margin (kyts/ha)	918,235	980,824	617,082	737,329
% increase in yield		9		11
%increase in income		7		19
Variety	Sin ThuKa, Hmawbi2	Sin Thwe Latt, Yaenelo7, Pyi Taw Yin	Hmawbi2, Byaw Tun, Yadanar Toe, Sin Thu Kha	Sin Thwe Latt, Yaenelo7, Pyi Taw Yin

Appendix Table 13. PVS contribution to Myanmar's' variety registration and release system.

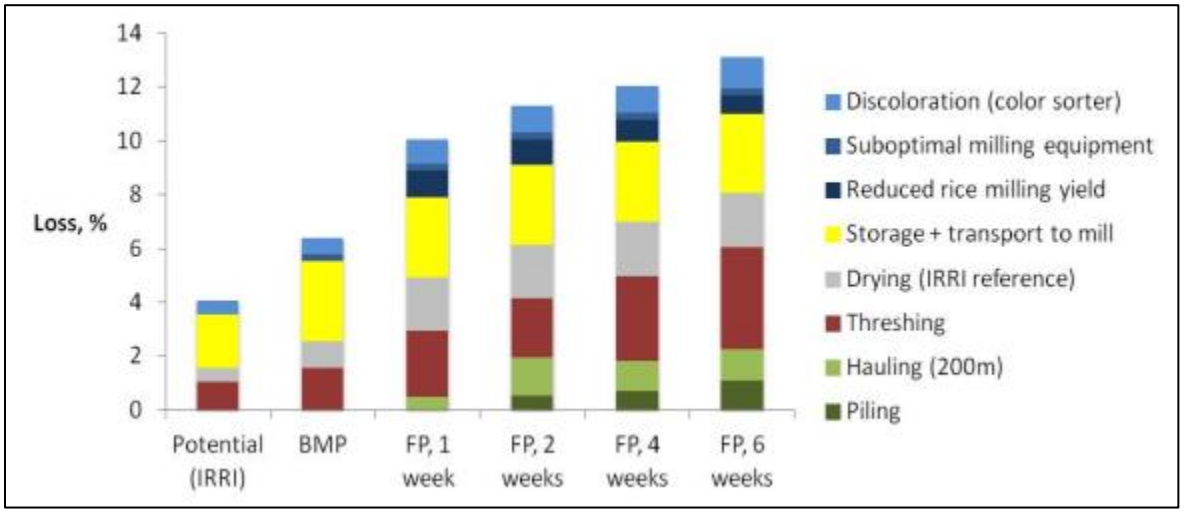
Name	Local Name	Maturity (days)	Plant Height (cm)	Potential Yield (t/ha	Amylose content (%)	Prominent Traits	Year Released
1. Swarna-Sub1	Yemyoke Khan 1	140	99	4.5-5.0	23.7	Submergence Tolerant	2012
2. Salt Tol Sin Thwe Latt	Sangakhan SinThwe Latt	140	108	4.5-5.0	20.4	Salinity Tolerant	2013
3. BR11-Sub1	Yemyoke Khan 2	135	110	5.0-6.5	24.0	Submergence tolerant	2015
4. CSR 36	Shwe ASEAN	115	110	4.0-4.5	23.6	Salinity Tolerant	2015
5. IR 10T 107	Pyi Myanmar Sein	115	122	5.0-5.5	21.6	Salinity Tolerant	2015
6. IR 87707-446-B-B-B	Yaenelo 4	114	134	5.0-5.5	24.2	Drought tolerant; Early	2015
7. IR77542-90-111-5	Pyi Taw Yin	126	116	4.0-5.0	24.1	Early, HYV, fresh water favorable	2015
8. Tephana-170-DB	Sin Thiri May	120	111	4.5-5.0	25.5	Lodging tolerance, BB resistance	2015
9. IR87705-44-4-B	Yaenelo 5	110	110	4.5-5.0	18.9	Drought tolerant, early, blast resistance	2016
10. IR87707-182-B-B-B	Yaenelo 6	110	120	5.0-6.0	24.2	Drought tolerant, early, blast resistance	2016
11. IR87705-83-12B	Yaenelo 7	115	108	4.0-4.5	23.7	Drought tolerant, early, blast resistance	2016



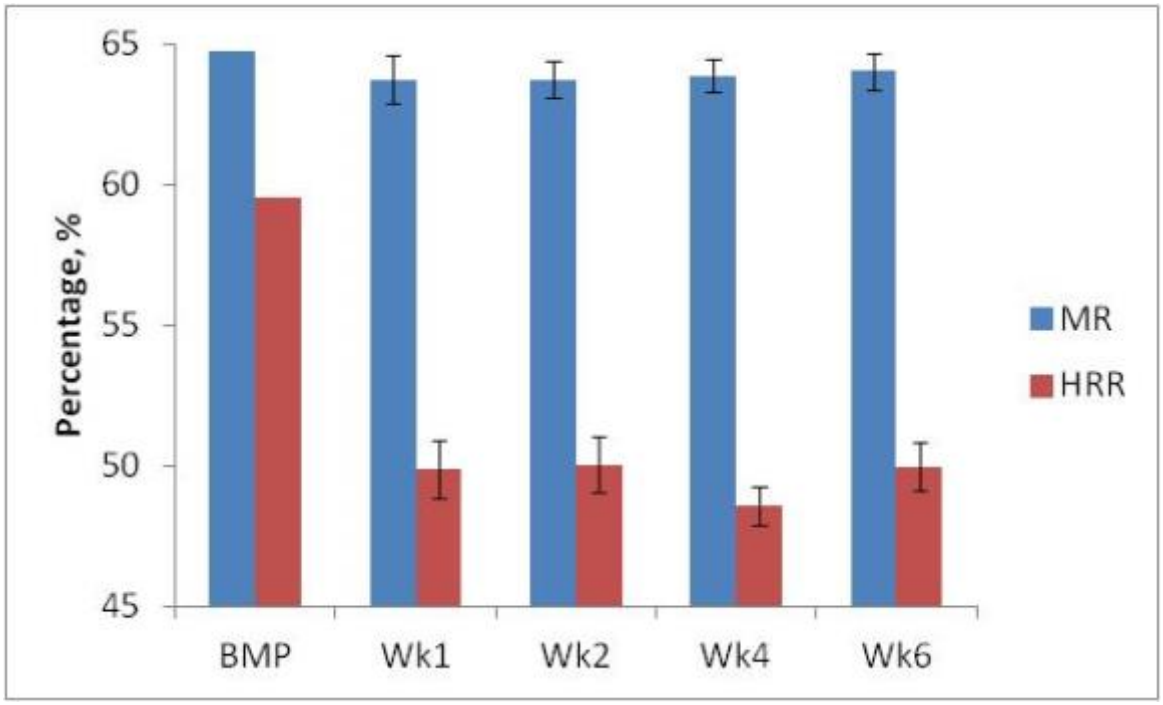
Appendix Fig.1. BMP replication of Improve Variety (Inpara 3 and Sin Thwe Latt) + Improve Management for monsoon rice in rice–rice system, Kadote phayarGyi, Daik U, WS 2016.



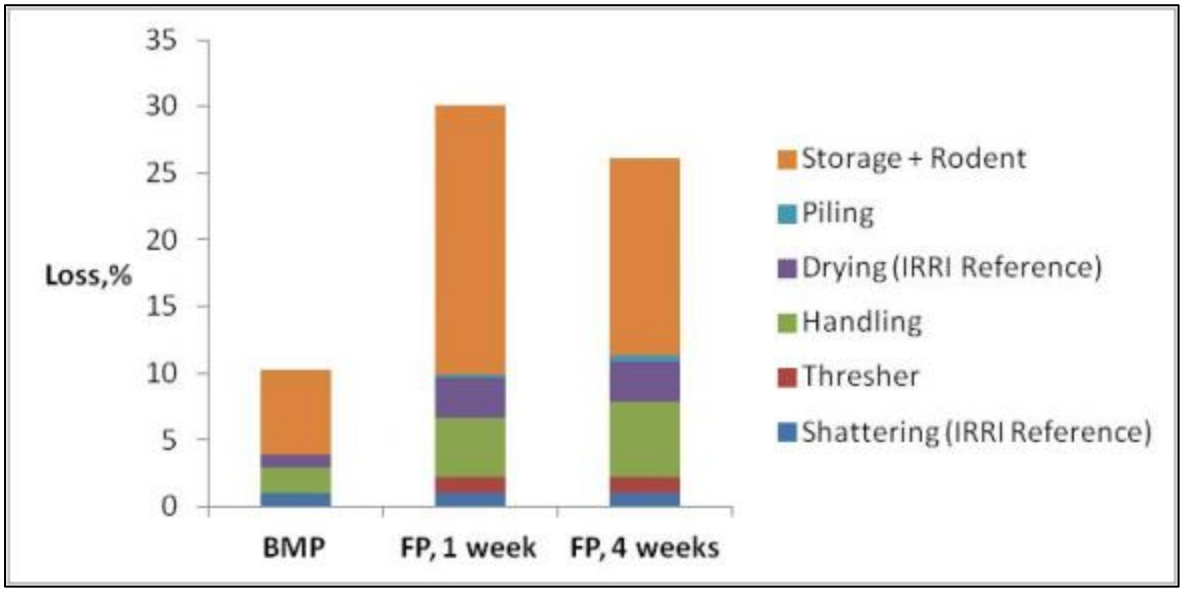
Appendix Fig. 2. BMP replication of Improve Variety (Pyi Taw Yin and Sin Thwe Latt) + Improve Management for monsoon rice in rice–pulse system, Pa Aung Wei, Daik U, WS 2016.



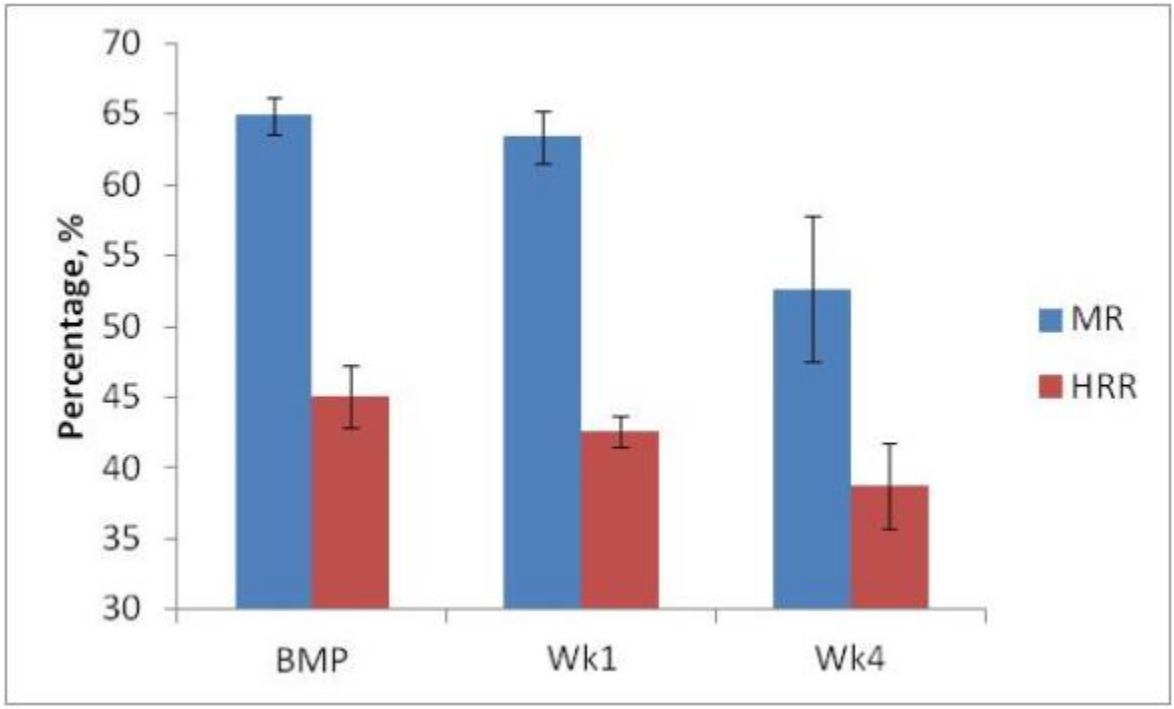
Appendix Fig. 3. Total physical losses of BMP and FP piled from 1 to 6 weeks before threshing for rice–pulse village (WS 2013).



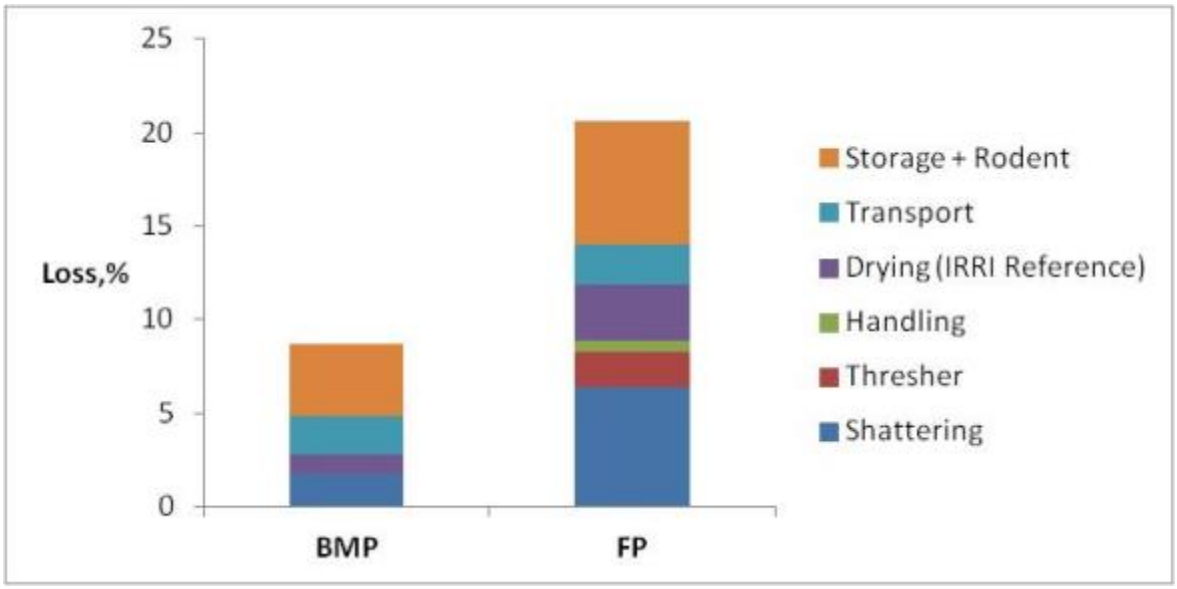
Appendix Fig. 4. Milling recovery and head rice recovery of BMP and FP piled from 1 to 6 weeks before threshing for rice–pulse village (WS 2013).



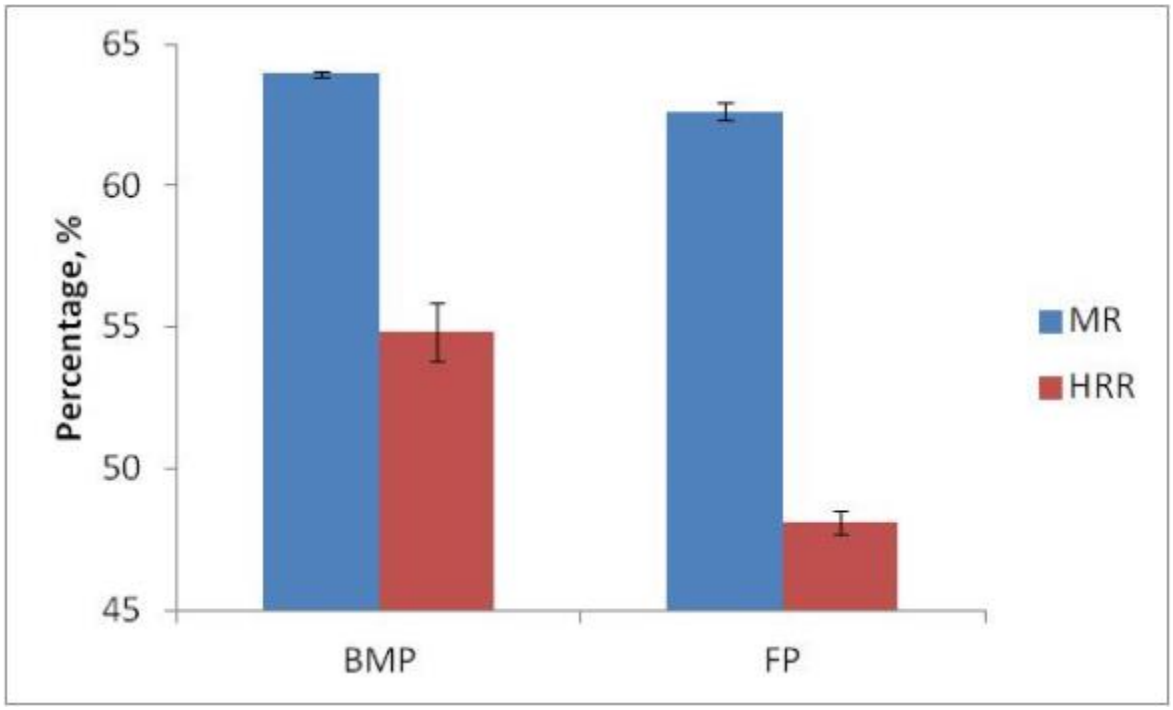
Appendix Fig. 5. Total physical losses of BMP and FP piled for 1 week and 4 weeks before threshing for rice–pulse village (WS 2014).



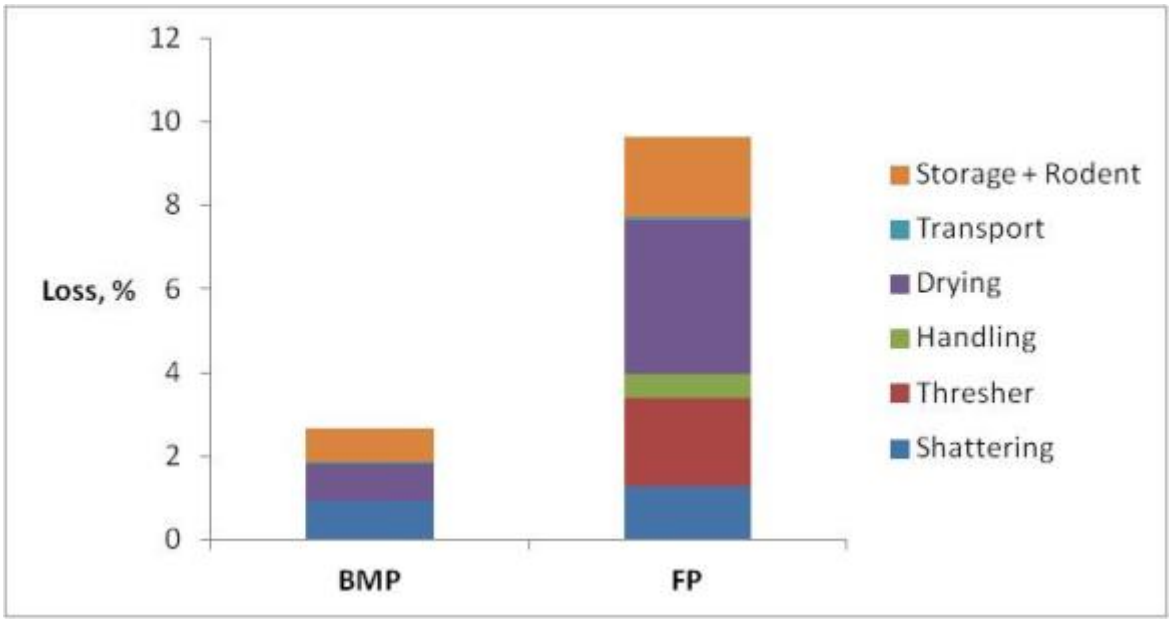
Appendix Fig. 6. Milling recovery and head rice recovery of BMP and FP piled for 1 week and 4 weeks before threshing for rice–pulse village (WS 2014).



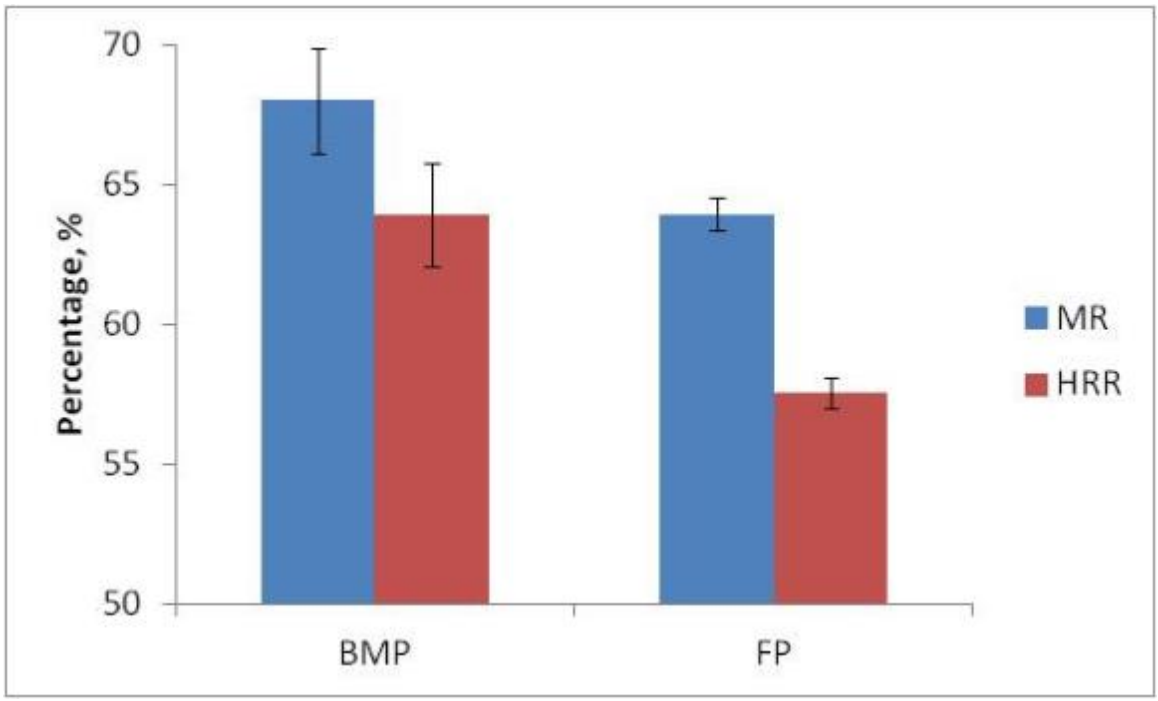
Appendix Fig. 7. Total physical losses of BMP and FP for rice–rice village (DS 2015).



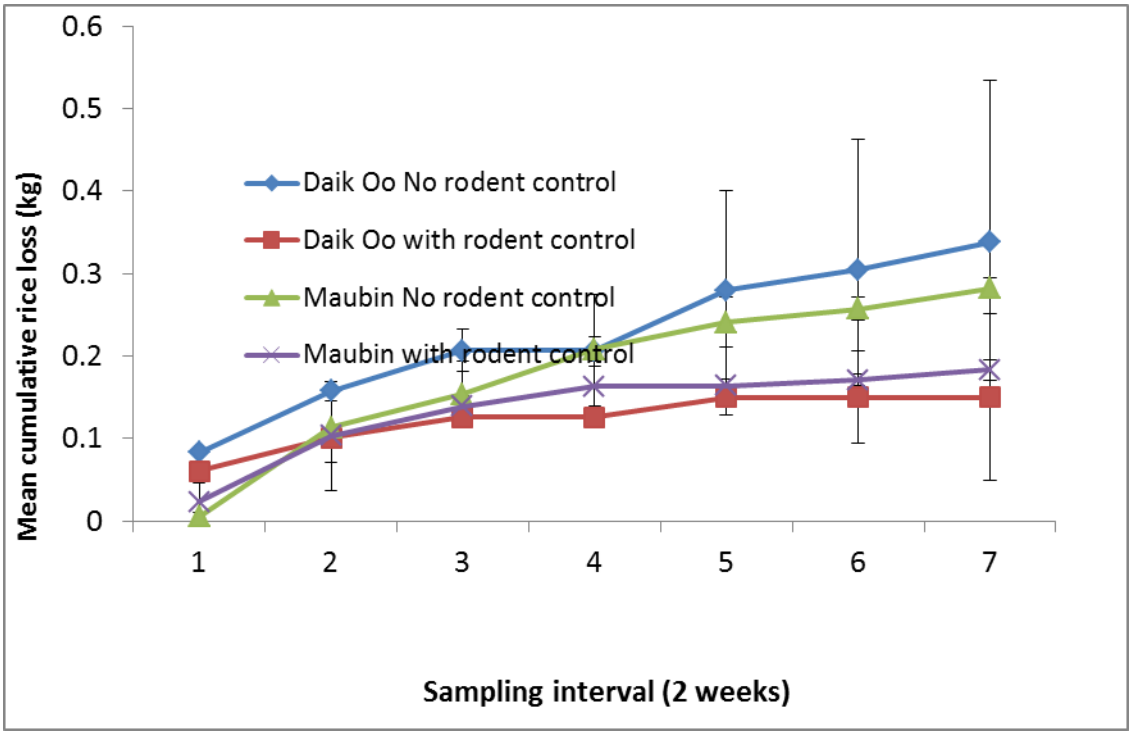
Appendix Fig. 8. Milling recovery and head rice recovery of BMP and FP for rice–rice village (DS 2015.)



Appendix Fig. 9. Total physical losses of BMP and FP for rice–rice village (DS 2016).



Appendix Fig. 10. Milling recovery and head rice recovery of BMP and FP for rice–rice village (DS 2016)



Appendix Fig. 11. Comparative losses caused by rodents in 2015 (10 grain stores per village).

Appendix Fig. 12. Location of townships (test site and outreach sites) in Ayeyarwady region.

Appendix Fig. 13. Location of townships (test site and outreach sites) in Bago region.

10.2 Appendix 2: News and articles

RICE—THE PULSE OF LIFE IN MYANMAR

PHOTO: GRANT SINGLETON

Smallholder farmers and researchers in lower Myanmar are partners in improving the country's agricultural profitability and productivity through adaptive research trials on rice-rice and rice-pulse cropping systems.

Smallholder farmers in lower Myanmar have struggled with low yield and income from rice farming. ACIAR's MYRice program has brought these farmers together to become partners in agricultural development.

BY **RONA NIÑA MAE ROJAS-AZUCENA AND DR GRANT SINGLETON**
International Rice Research Institute

Myanmar was once considered the 'pearl of the orient'. In the 1960s, the nation was a leading rice exporter in the global rice market. Events in the country, however, closed off the nation from neighbouring trade and international activities and dampened its once-illustrious rice sector.

In recent years Myanmar has slowly reopened its doors to global trade and re-established connections with other countries. New plant varieties and agricultural expertise are now available to Myanmar farmers.

The country's economic growth hinges on the development of its agricultural sector, particularly the rice sector. The Ministry of Agriculture, Livestock and Irrigation (MOALI) is keen to regain the country's status as a major rice exporter and to increase the income of its rice farmers. So it is essential to increase the efficiency of production and rice quality.

ACIAR's MYRice project is aiming to do just that, working in partnership with MOALI and others. The project is looking at best practice management, new varieties and rodent management.

Rice is very important in Myanmar and is cultivated on 64% of the country's arable land—more than eight million hectares. Rice farming involves more than five million rural households.

Myanmar has rich natural resources of land and water, yet rice farmers are well behind their Asian neighbours, with yields along the country's fertile Ayeyarwady Delta only reaching half of those along Vietnam's Mekong Delta.

People living in rural Myanmar have a large per capita consumption of rice—up to 154 kilograms per year. Rice provided 70% of their daily calorie intake in 2016. At the moment, most of the rice produced in Myanmar is used to feed the local people. In 2014 the population reached more than 52 million.

Increasing production will help Myanmar to be more competitive in the regional and global rice markets. As well as rice, MOALI is also looking at the production of pulses and other high-value crops, which are often grown immediately after the harvest of the monsoon rice.

The International Rice Research Institute (IRRI) is working closely with local partners to improve farm productivity and the profitability of smallholder farmers. The Department of Agriculture (DOA), the Department of Agricultural Research (DAR) and Yezin Agricultural University (YAU)—all under MOALI—are the main partners on the ACIAR MYRice project.

The MYRice project aims to diversify and intensify rice-based systems in lower Myanmar and to assist smallholder farmers in the mid and upper Ayeyarwady Delta. These farmers grow rice in the monsoon season; in the dry season about one-third grow rice and two-thirds grow pulses.

SOLUTIONS THROUGH FARMER PARTICIPATION

With partners from DAR and DOA, the MYRice project identified two target townships: Maubin in the Ayeyarwady Region and Daik Oo in the Bago Region. (Regions in Myanmar are equivalent to states.) Forty-four trials were undertaken from the 2012–13 dry season to the 2016 wet season. These were on-farm participatory adaptive research trials, implemented with 2,990 farmer-partners.

This research with farmers focused on:

- short-duration and new high-yielding varieties of rice and pulses
- new best management practices
- community rodent management
- improved postharvest management.

A participatory varietal selection (PVS) approach was used to obtain immediate feedback from farmers—their reasons for their preferences and constraints to adoption. This close collaboration among farmers and national partners resulted in the release of two flood-tolerant varieties for wet season rice/rice systems, drought-tolerant varieties

LEFT: Learning Alliance members collectively assess technologies that will help improve their current postharvest systems.

PHOTO: CHRISTOPHER CABARDO; IRRI

for dry season rice/rice systems and one variety suited for both wet and dry seasons.

Deputy Director-General of DAR and MYRice collaborating scientist, Daw Tin Tin Myint says the PVS approach "helped Myanmar's agricultural technicians and farmers to obtain a variety that suits their tastes and preferences. It's a leading technique for all participants to be involved in making decisions."

U Maung Maung Aye, a 52-year-old farmer from Phaung Wae Village, Daik Oo township, joined the trials on varietal selection for new green gram varieties. In the 2015 monsoon season he also participated in the trial for best-management practices in rice.

"We were taught new ways of planting pulses, such as line sowing," U Maung Maung Aye says. "I preferred it over our traditional practice of broadcasting seeds, because seed rates are lower using line sowing." He used 8 kg/ha with broadcast seeding, compared with 3.2 kg with line sowing.

In the 2015 monsoon season, husband and wife U San Pwint and Daw Aye Maw participated in the best management practice trials for rice, using new rice varieties Pyi Taw Yin and Sin Thwe Lat.

"We were planting traditional varieties such as Sin Thu Kha that yielded 80 baskets per acre (4 tons per hectare) and sold for 4,500 kyats (A$4.40) per basket as grain. We also incurred more losses in the field compared to when we tried growing Pyi Taw Yin, which yielded 95 baskets per acre (4.75 t/ha) and sold for 7,500 kyats (A$7.35) per basket as seed," U San Pwint says.

DOA assistant director and MYRice collaborating scientist Dr Aye Min says that new and improved crop varieties enable farmers to obtain a higher yield and income, and to cope with the effects of climate change. "Farmers feel more secure and are able to save on input costs."

Trials on drum seeding and integrated weed management in the rice/pulse system in Maubin township indicated a benefit of US$15/ha (A$20/ha) for the monsoon crop compared with the farmers' practice of transplanting. Row seeding using a drum seeder provided farmers with an extra US$100/ha (A$132/ha) for the summer crop.

During the 2014, 2015 and 2016 wet seasons, 8,148 kg of seed for monsoon rice varieties was distributed to 352 farmers in the Ayeyarwady and Bago regions. For the 2015, 2016 and 2017 dry seasons, 5,124 kg of summer rice varieties was distributed to 204 farmers.

For the first time in 20 years, pulse farmers in Myanmar have had access to new pulse varieties and more than 340 pulse farmers have adopted them. The combined benefit from new varieties and new best practice management (pre and postharvest) indicate that productivity benefits will be greater than 40%.

POSTHARVEST GAINS

An assessment conducted by IRRI in 2013 revealed that farmers in rice/pulse areas practice manual harvesting, and then pile up the harvested crops for as long as three weeks while they prepare their land for pulses. Farmers rely on outdated local threshers that are unable to thresh wet rice and are not mobile. This means that quality deteriorates and the harvest sells for a low price.

The MYRice team measured the losses from the traditional post-production process and compared these with the best management practices introduced by IRRI. Rice grain losses from traditional practices—piling, use of heavy threshers, sun drying and storing—can reach up to 13%. Rodents also cause significant damage and farmers lose about 100 kilograms of rice every six months. This is enough to feed a family for more than a month.

The farmers who adopted best management practices reduced their losses to 3–7%. The grains processed using best practice also had higher milling recovery than the grains processed through traditional farmers' methods.

Best practice techniques include:

- threshing crops immediately after harvest using a lightweight thresher or a combine harvester
- systematic drying using a flatbed dryer
- storing the paddy and pulses in hermetic (air-tight) bags.

"I am mostly impressed with the combine harvester, which I used to harvest rice last summer," says U Shwe Toe, one of the cooperators. Women involved in farming activities reported that they had more social and community activities when they began renting combine harvesters.

Since 2013 the use of combine harvesters has significantly increased in the village. Farmers have also tried using hermetic bags and 1 or 5-tonne GrainSafes to store their pulses.

Daw Tin Yee, a rice farmer for 25 years, stored her pulse seeds for nine months in a hermetic IRRI Super Bag. "After storage in the Super Bag, I noticed that the colour of the seed is better, the germination rate is higher and there was no insect infestation," she recalls. ➜

PHOTO: ACIAR

Daw Tin Yee, a farmer from Maubin, joined the MYRice on-farm research activities and benefited from her learning.

The following season, Daw Tin Yee planted the stored Yezin 2 seeds and harvested 12 baskets per acre. "The trader also preferred Yezin 2 so I was able to sell it at 48,000 kyat (A$47) per basket. I used the profit to renovate my house," she says.

The MYRice group also introduced community-level rodent management and reduced rodent losses by 25%. Farmers benefited by up to US$81 (A$107) per household. Another benefit was reduced contamination by faeces, improving human health.

BUILDING NETWORKS FOR CHANGE

The MYRice team established a multiple stakeholder platform called Learning Alliance (LA) to engage with different groups across the rice value chain. Farmers, traders, millers, DOA staff, and IRRI shared their knowledge and experience of technologies to optimise rice and pulse production.

The LA became an avenue for these groups to collectively assess their experiences from the best management practice trials and to identify opportunities to maximise the benefits. They visited the main wholesale market for rice, and the seed farms, where they learned about quality, different varieties and the process of selling in markets.

Alliance members also participated in a lightweight thresher demonstration on U Shwe Toe's farm to show how immediate threshing can reduce postharvest losses.

At the LA meetings, farmers from the best management practice trials also shared their experiences in using Sin Thwe Latt (rice) and Yezin (pulse) varieties with improved crop production management.

Recently, members organised farmer groups to develop postharvest services for the community in threshing, drying and storage. From the best management practice technologies used during the postharvest loss assessment trials, members chose the technologies they preferred to rent out and generate profit.

EQUAL OPPORTUNITY AND INCREASED CAPACITY

Collecting data on gender is part of the MYRice project. Gender equality outcomes are measured via large household surveys at the beginning and end of a project, and seasonal farmer diaries.

Gender equity was examined at one of the project's townships using the framework of the Women's Empowerment in Agriculture Index (WEAI).

Participatory varietal selection trials recorded the preferences of male and female farmers based on agronomic characteristics, and cooking and eating qualities of rice varieties tested on-farm. Feedback identified the most preferred rice varieties and their seed multiplication and distribution in the community.

Female farmers such as Daw Aye Nyein not only became active cooperators, but also successful seed growers. "I was able to pay off my loans because of the profit I earned," she says.

The MYRice project raised awareness among the project partners of the benefits of research and development on gender equality for agricultural smallholder communities.

MYRice is supporting two PhD students and Master of Science thesis grants for 17 DOA and DAR staff. The DOA partners who were mentored on farmer participatory research have gained project implementation skills and are now taking the lead during farmer meetings and field days.

SUSTAINABLE ADOPTION PATHWAYS

The MYRice team is ramping up plans to further scale-out best management practices and high-yielding varieties of rice and pulses. The project is also collaborating with other ACIAR initiatives in the country, such as MYPulse (legumes), MYFish (fisheries), and MYLife (livelihoods).

"The support for, and appreciation of, the project's benefits to smallholder farmers from the Government of Myanmar has strengthened due to the impressive results of field demonstrations and the process of participatory engagement with farmer groups," says Dr Grant Singleton, IRRI scientist and MYRice program manager.

"We are very pleased with the results of our collaborative research in Daik Oo. It is now time to expand the project in 2017," says U Hla Myint, DOA regional director of Bago. He and his counterpart

"FOR THE FIRST TIME IN 20 YEARS, PULSE FARMERS IN MYANMAR HAVE HAD ACCESS TO NEW PULSE VARIETIES AND MORE THAN 340 PULSE FARMERS HAVE ADOPTED THEM. THE COMBINED BENEFIT FROM NEW VARIETIES AND NEW BEST PRACTICE MANAGEMENT (PRE AND POSTHARVEST) INDICATE THAT PRODUCTIVITY BENEFITS WILL BE GREATER THAN 40%."

in the Ayeyarwady Region, U Tun Aung Kyaw, met with their staff to identify outreach priorities for the next year.

During the MYRice project meeting in October 2016, U Hla Myint said: "In 2017, we will expand MYRice to 63 new villages from four districts. This will require a large investment of resources—my extension staff's time and operating funds. The regional government is willing to provide the main investment in this outreach."

A similar commitment was made by U Tun Aung Kyaw. Initiatives from the MYRice project are a great contribution to Myanmar's goal to regain its position as a significant contributor to regional and global food security through rice. Strong collaboration and engagement among MOALI, IRRI, non-government organisations and private-sector partners are also highly important.

Boosting competitiveness in the domestic and international rice markets is critical. Methods learned in the MYRice project and access to new rice varieties will assist and will help pave the way towards the sustainable development of the Myanmar agricultural sector. ■

ACIAR PROJECT: SMCN/2011/046 'Diversification and intensification of rice-based systems in Lower Myanmar'

MORE INFORMATION: Dr Grant Singleton, IRRI, g.singleton@irri.org

PHOTO: ACIAR

The MYRice project team captures consent of a farmer using the signature function in CommCare.

MAD IN MYANMAR

The age-old method of collecting paper-based data in the field is all too familiar to researchers around the world. There are many inefficiencies with paper-based methods, including the time it takes to get the data into a usable form and the increased chances of introducing errors during transcription from paper to digital format. One of the greatest deficiencies in a paper survey system is the inability to provide real-time feedback to the farmers who give up their time to complete the questionnaires.

Since June 2015, ACIAR has funded the mobile acquired data (MAD) evaluation, which seeks to understand how digital data-collection apps affect ACIAR projects.

The first piece of MAD research, led by the R&D support company AgImpact, was a desktop review of the vast array of 'off-the-shelf' mobile data-collection apps. The most suitable apps were short-listed and trialled in a field pilot in Indonesia. The pilot not only identified the most suitable app for ACIAR-type projects (CommCare) but also demonstrated that apps have the ability to improve the relationships between stakeholders in the data-collection process. The use of apps had a positive influence on how farmers, field researchers and project leaders shared data. The ability to share research findings with farmers in near-real time was a very positive experience for farmers.

Following the field pilot, the MAD research team partnered with nine ACIAR projects to better understand the issues of adopting apps at scale. AgImpact provided CommCare adoption support and, in return for the support provided, the projects agreed to share information on the time and resources necessary to adopt apps and whether they believe the adoption of apps adds value to research projects. These findings will be important for future ACIAR projects looking to adopt apps.

The MYRice project in Myanmar is participating in the MAD series. The project is looking at sustainable methods to diversify and intensify rice production in the Ayeyarwady Delta. The MyRice team, led by the International Rice Research Institute, has adopted the open-source mobile application CommCare to monitor changes in farm productivity and share findings with farmers in near-real time. Some of the app features the MyRice team are using include GPS capture, auto-calculations and the freehand drawing function. ■

MORE INFORMATION: Information and videos on the ACIAR MAD evaluation series can be found at www.agimpact.org/resources or by contacting project leader Stuart Higgins, AgImpact, stuart@agimpact.org

IRRI News Wednesday, May 24, 2017

http://news.irri.org/2017/05/trimble-donates-laser-leveling.html

Trimble donates laser leveling equipment for IRRI projects in Myanmar

A partnership with Trimble, a company that supplies farming solutions, has been helping the International Rice Research Institute (IRRI) sustain the work to help farmers through promotion and adoption of the laser-assisted land-leveling technology.

Trimble has been a partner in the distribution of high-quality equipment as well as provision of equipment for demonstration and capacity building, and offers a reliable support service.

Just recently, Trimble donated brand-new laser equipment for use in IRRI projects in Myanmar. The donation was facilitated by IRRI's Postharvest and Mechanization Unit as a result of discussions held during *AGRITECHNICA Asia* in Bangkok in March 2017. The equipment will be used for adaptive research in laser leveling and for field demonstrations under the Closing Rice Yield Gaps in Asia (CORIGAP) and MyRice projects.

CORIGAP and MyRice in Myanmar are funded by the Swiss Agency for Development and Cooperation (SDC) and the Australian Center for International Agricultural Research (ACIAR), respectively. Both aim to increase farmers' income, field productivity, and ensure sustainable rice farming.

Martin Gummert, IRRI senior scientist for postharvest and mechanization, emphasizes the importance to IRRI of the cooperation. "The partnership with Trimble offers a win-win situation for both parties: IRRI benefits from (A) equipment donations for use in its training programs, (B) verification of laser leveling under IRRI projects, and (C) technical support when needed from Trimble. Trimble, on the other hand, benefits from development of markets for laser leveling through in-country demonstrations, training activities, and linking up with equipment dealership."

"Trimble is keen on spreading laser-assisted land-leveling wider to farmers and other end-users and meeting potential local distribution partners to bring the technology closer to them and establish an accessible and reliable after-sales service," said Scot Craig, Trimble regional sales manager for Southeast Asia and Japan.

During the seminar on rice mechanization at *AGRITECHNICA Asia*, Justin Van Viersen, Trimble regional director for Asia-Pacific, lauded IRRI's efforts in strengthening the partnership by highlighting Trimble's role in the development and scaling out of laser-assisted land-leveling technology in South and Southeast Asia.

Laser land-leveling technology is now in use by its first adopters in Cambodia, India, Indonesia, Myanmar, the Philippines, Sri Lanka, Thailand, and Vietnam, within IRRI's ongoing projects in these countries. It has brought tremendous benefits in irrigated rice production system in many parts of South and Southeast Asia. Its impact involves savings in irrigation water; efficiency in input usage; optimized field operations; and uniformity in crop growth, resulting in increase in milling yield and better head rice yield—thereby increasing farmers' income from rice production.

IRRI News Thursday, March 30, 2017

http://news.irri.org/2017/03/myanmar-farmers-extension-agents-join.html

Myanmar farmers, extension agents join workshop on mechanized land leveling to boost agricultural development

Farmers from four townships covered by MyRice and CORIGAP projects attended the workshop on laser land leveling. They also shared the current best management practices they are trying out in their farms during a Learning Alliance meeting.

MAUBIN, Myanmar—The Ayeyarwady Delta, the rice bowl of Myanmar, is endowed with vast land and water resources. However, traditional practices prevent smallholder farmers from achieving optimal rice yields. Increasing farmers' incomes and productivity require technological innovations such as laser land leveling.

"The precision land leveling using laser-guided system is a technology option that provides a more even land surface resulting in improved crop productivity through reduced irrigation water, chemical input, and more uniform crop growth," said Engr. Caling Balingbing, an agricultural engineer from the Postharvest and Mechanization Unit at the International Rice Research Institute (IRRI).

Balingbing was one of the experts tapped for a laser land leveling demonstration in Maubin on 23 March. About 60 farmers, extension agents, and private sector and non-government organization personnel from Daik-U, Hlegu, Maubin, and Letpadan Townships participated in the demonstration as an option for better crop management. The activity is part of the Learning Alliance, which brings varied stakeholders with similar interests to assess and develop ways to optimize the use of rice–based technologies and practices.

"This event is a great opportunity to interact with NGOs, the private sector, Department of Agriculture, and farmers from other townships," said Romeo Labios, IRRI scientist and agronomist in Myanmar. "Taking advantage of the Learning Alliance platform, stakeholders can discuss how these technologies from IRRI can provide efficient use of land and water resources and other farm inputs to increase productivity and get a better income. They can learn from each other's experiences and interact with our private sector guests how you can use this and other technologies."

"Just by observing the field, I can immediately see the difference and the benefit of laser-guided land leveling it will bring to my farm," said U Shwe Toe, a rice and pulse farmer leader from Maubin. "I want to use this immediately; I hope that we can come up with ways to own these technologies."

“This is a good initiative that helped farmers understand the benefit of the technology,” said Dr. Myo Aung Kyaw from Pioneer Agrobiz, Inc. “From the discussions, they are really convinced that this technology would really work well on their farms.”

Other IRRI experts at the laser land leveling demonstration were Yan Lin Aung, agricultural engineer, and Su Su San and Hlwan-Oo, assistant scientist and researcher, respectively at the IRRI Myanmar office.

The event was organized by Closing Rice Yield Gaps in Asia with Reduced Environmental Footprints (CORIGAP-PRO) and MyRice project. CORIGAP-PRO is funded by the Swiss Agency for Development and Cooperation, while MyRice is funded by the Australian Center for International Agricultural Research.

IRRI News Tuesday, March 21, 2017 (http://news.irri.org/2017/03/rice-fish-farming-could-help-boost.html)

Rice–fish farming could help boost farmers' income in Myanmar's "rice bowl"

H.E. Senator Concetta Anna Fierravanti-Wells and party consult farmer beneficiaries, DoA and DoF partners. (Photo by Hnin Thiri Naing).

MAUBIN Township, Myanmar— Aquaculture production in rice-based cropping systems could potentially boost farmers' productivity, income, and nutrition in the Ayeyarwady Region, the country's main rice-producing area.

Funded by Australian Centre for International Agricultural Research (ACIAR) and the Department of Foreign Affairs and Trade (DFAT), the 12-month mini rice–fish project aims to assess the potential of integrated rice–fish business models to increase the income of farmers in the disadvantaged flood-prone areas of the Ayeyarwady Delta.

"I am happy to see that farmers are benefiting from the investment provided by the Australian government in improving food security in Myanmar," said H.E. Concetta Anna Fierravanti-Wells, Minister of International Development and the Pacific. The Minister, along with Mr. Nicholas Coppel Australian, ambassador to Myanmar, and other Australian officials visited the site in Tar Pat West Village on 14 March.

H.E. Senator Concetta Anna Fierravanti-Wells and other Australian officials visit the rice–fish trial project site in Tar Pet West Village. (photo by Hnin Thiri Naing).

The mini rice–fish project is led by the International Rice Research Institute (IRRI) in collaboration with WorldFish, the Department of Agriculture (DoA) and Department of Fisheries (DoF).

“It promotes the use of new high-yielding stress-tolerant rice varieties, new techniques in rice farming, and best management practices while raising fish in the same area,” said Dr. Romeo Labios, an IRRI scientist and agronomist in Myanmar.

“The rice field may be deliberately stocked with fish as in our study or enter the fields from the surrounding water ways when flooding occurs or both,” explained Dr. Manjurul Karim, the program manager of WorldFish.

Fish yields can range widely from 350-1000 kg/ha/season depending on the type of rice–fish systems, species present, and the management, according to Karim. The fish provides a source of protein and farm income.

During the visit, the Minister had the opportunity to interact with some of the target beneficiaries of the project, many of them were women farmers. She found that, while most male farmers’ are mainly interested in growing rice, all the women farmers showed great interest in the rice–fish system for the nutritional value of the fish as a dietary component, as well as the extra income from selling their fish harvest.

“I hope that the fish harvest from the project could help the nutrition requirement of the family,” H.E. Fierravanti-Wells said. She is also looking forward to outcomes from a larger rice–fish study funded by ACIAR that planned to begin in July.

U Aung Kyaw, a participating farmer in the rice–fish project, informed the Minister that he will invite other farmers to visit his farm before and during harvest and explain the benefits of the rice–fish systems. He plans to expand the system in his 6-hectare farm next season.

“The DoF also plans to apply the new techniques of rice–fish systems on a larger scale in areas where it is applicable,” said U Tin Mg Oo, DoF Maubin District Manager.

In addition to the rice–fish production, the Australian officials were also briefed about the Solar Tunnel Dryer for fish and the Solar Bubble Dryer for rice, two postharvest technologies developed by IRRI and the University of Hohenheim in Germany that prevent smallholder farmers from losing large portions of their harvests.

Ms. Su Su San explains the advantages of drying the harvested fish using the Solar Tunnel Dryer. (Photo by Hnin Thiri Naing)

Unlike traditional sun-drying, the Solar Tunnel Dryer protects the fish from dust, flies and other insects," said Ms. Su Su San, an IRRI assistant scientist in Myanmar. "Farmers do not need pesticides to control insects. It can use battery and solar panel as its power source and can be used to dry other product like chili and fruits."

Mr. Yan Linn Aung, a postharvest development specialist, explained the benefits and advantages of Solar Bubble Dryer for rice. The dryer minimizes the effects of unpredictable weather during the drying of the grains. It also traps solar radiation to heat the paddy while ventilators push the moisture out.

"This field visit provided me additional knowledge on the technologies IRRI and World Fish have developed on-farm," said Ambassador Coppel.

The IRRI Team is led by Dr. Labios with Dr. Jongsoo Shin, Mr. Aung Myo Thant, Mr. Aung, Ms. San, and Ms.Tin Tin Myint. The WorldFish team is led by Dr. Karim with Dr. Nilar Shein.

IRRI News Thursday, March 9, 2017

(http://news.irri.org/2017/03/australian-funded-projects-are-helping.html)

Australian-funded projects are helping Myanmar rice farmers improve their livelihood and income

Farmers and DoA and DoF partners hold a consultation meeting to talk about the impact of the ACIAR-funded projects. (Photo by Aung Myo Thant)

MAUBIN TOWNSHIP, Myanmar—Rice farmers in Ayeyarwady and Bago Regions are reaping the benefits from the adoption of new improved rice varieties, best crop management practices and post-harvest management introduced through two collaborative projects funded by the Australian Centre for International Agricultural Research (ACIAR). The projects focus on improving farmers' profitability and the productivity of rice–rice and rice–pulse cropping systems and promotes a system where fish are grown concurrently with rice.

On 27 February, Mr. Andrew Campbell, the chief executive officer of ACIAR, members of ACIAR's Commission for International Agricultural Research, and Ms. Esther Sainsbury, first secretary of Australian Embassy in Myanmar visited the project sites in Maubin Township and met with some of the beneficiaries of the projects.

In Tar Pet West Village, Maubin Township, the officials visited the mini rice–fish project, a 12-month project led by the International Rice Research Institute (IRRI) in collaboration with World Fish, the Department of Agriculture (DoA) and Department of Fisheries. The Commissioners also met with farmers and DoA partners involved in the Diversification and intensification of rice-based systems in lower Myanmar (MyRice) project. The project showcased the lightweight rice thresher, hermetic seed storage systems, a seeder for pulses, the Solar Bubble Drier for rice, and the Solar Tunnel Drier for fish.

ACIAR officials visit the rice-fish trial project site In Tar Pet West Village. (Photo by Su Su San)

“I am pleased to see the work of IRRI and WorldFish on-the-ground as well as the positive responses and benefits garnered by farmers in the community,” said Sainsbury.

Farmers from several villages in Maubin shared their experiences with the best management practices (BMPs) for rice–rice, rice–pulse, rice–fish systems; the Learning Alliance; and the business models of MyRice, and the impact of the project on their livelihoods.

“The project enhanced the knowledge and experience of our technicians while farmers benefited significantly from the improved technologies and best management practices (BMP) for rice–rice and rice–pulse production and post-production,” said U Theik Soe, DoA District Manager.

The team also visited the farmers’ 2-hectare seed production area for Yaenelo 7, a drought-tolerant rice variety suited for the summer cropping season, and the 5-hectare BMP showcase for summer rice. The BMPs include improved varieties (Yaenelo 4 and Yaenelo 7), drum seeder for row planting, and improved nutrient, pest, and weed management.

“I could make more money by selling seeds since the price is higher than grain,” said U Kyaw Thu, a farmer and seed producer.

“Because of higher yields and lower input costs (in BMPs), I am able to earn more money,” said U Thaung Win. “I was able to buy television and solar panels from extra money from 2016 monsoon harvest. I was also able to send my children to school for longer than I had planned.”

“I am happy to see that IRRI and WorldFish works together and produce effective achievements on-the-ground in Myanmar,” said Campbell.

The ACIAR Commissioners included Don Heatley (Commission Chairman), Catherine Marriot, Lucinda Corrigan, Tony Gregson, John Cook. Other accompanying delegates were Eleanor Dean (general manager, Outreach and Capacity Building), Peter Horne (general manager, Country Programs), Suzanne Gaynor (executive officer), Maree Livermore (executive officer, Country Programs), Dulce Simmanivong (regional manager), Ohnmar Khaing and Myo Thura (ACIAR Myanmar program manager and program coordinator, respectively).

The IRRI Team for MyRice is led by Dr. Grant Singleton with Dr. Romeo Labios, U Aung Myo Thant, U Yan Linn Aung, Daw Su Su San, and Daw Tin Tin Myint.

The World Fish Team is led by Dr. Michael Akester with Drs. Manjurul Karim and Xavier Simon André Tezzo.

The International Water Management Institute was represented by Dr. Robyn Johnston.

10.3 Appendix 3: Stories of change

A. STORIES OF CHANGE – U Hla Myint, Regional Director DoA, Bago Region

U Hla Myint is a Regional Director from Bago Region, who believes that the mission of DoA is to aid farmers in order to improve their livelihoods and enabling them to improve their income. He described that in the past, farmers would experience low rice productivity and yield. In 2012, an opportunity to changes things around came about, by collaborating with IRRI through the MyRice project.

"The MyRice project brought in best management practices (BMPs) that would help farmers improve their yield, therefore, increased incomes. It was challenging, at first, because we had to convince the farmers to follow the best management practices and they would rather see the results first before believing," he said. In 2017 wet season(WS), we set-up large scale BMP demonstration of monsoon rice in rice-rice system (at 1 acre/farmer) in 208 farmers' fields covering 10 Townships and three Districts and of monsoon rice for rice-pulse system in 874 farmer's fields covering 13 Townships and three Districts.

U Hla Myint and his team from the Department of Agriculture worked together with IRRI to work with the farmers and show them how they could benefit by following IRRI's best management practices in rice production. "Farmers were able to double up their yield and have more income, enabling them to have better life conditions. Some farmer-cooperators were able to send their children to school full time," U Hla Myint shared.

IRRI's role in fostering collaboration among various rice farming sectors bolstered opportunities to ensure the sustainability of use of the practices. U Hla Myint described that after participating in capacity building activities like seed production training, farmers have managed to produce good quality seeds, but would need a mechanism to distribute seeds to other interested farmers. So we have found an association of local seed producers in the Region, which is comprised of about 870 farmer-members. The members of the association and private sector will work together to help produce seeds. The seeds produced will be directly distributed to their fellow farmers to enable access to better quality seeds.

"Slowly, but surely, we are improving. What is important is that, this cooperation among IRRI, farmers, and DoA staff can vividly see the results of the trials they have tried altogether," he said.

(Interview by Rona Mae Rojas-Azucena, June 2017)

B. STORIES OF CHANGE – SELECTED FARMERS' TESTIMONIES

Story #1: U San Pwint and Daw Aye Maw (rice–pulse)
Phaung Wae Village, Daik-U Township

U San and Daw Auntie, husband and wife, have been farming rice and pulses for 20 years, and have always wanted to try new things. When the couple heard about the best management practice (BMP) trials of the ACIAR project team and Department of Agriculture, they quickly signified interest in becoming a cooperator.

"We tried growing recommended green gram varieties Yezin 9, 11, and 14 on an

acre of land, so we can see the difference from the traditional variety we have been using." For these recommended varieties, they attempted to apply fertiliser at the prescribed time. From previously using solely foliar fertiliser, they now also use basal fertiliser, which boosted yield from 10 to 17 baskets/acre. Among the three varieties tested, they found Yezin 11 to be the highest-yielding.

They also started participating in the monsoon 2015 BMP trial for rice, using IRRI-recommended varieties Pyi Taw Yin and Sin Thwe Lat. "We were planting traditional varieties such as Sin Thu Kha that yielded 80 baskets/acre (4.0 t/ha), which sold at 4,500 kyat/basket as grain. We also incurred more losses in the field than when we tried growing Pyi Taw Yin, which yielded 95 baskets/acre (4.75 t/ha) and sold for 7,500 kyat/basket as seed," said U San.

But it was not just about the yield. U San and Daw Auntie also found the new management practices very useful. "We were taught how to establish a seedbed and apply (A) triple superphosphate fertilizers as basal, (B) muriate of potash at 7 days after transplanting (DAT) and at maximum tillering stage, and (C) urea at 7 DAT and maximum tillering and panicle initiation stages to boost our yield," said Daw Auntie. "We have learned a lot. Seeing how yield has differed from that of the rest of our field where we used traditional practices, I have seen how the BMPs work."

"We used to do broadcast seeding, with 2–2.5 baskets of seeds per acre. Using the seedbed method, our seed rate went down to 1 basket per acre," Daw Auntie continued. "Among the varieties tested, I prefer Pyi Taw Yin the most because of the grain quality.

"We were also taught that, if the grains are 80% mature, it is the right time to harvest," she added. "However, harvesting properly is still a challenge for us because of the lack of combine harvesters and laborers. Most of the time, we end up harvesting overripe paddy."

The couple expressed great appreciation for having been part of the BMP trials and for the chance to try out technologies themselves. "We are happy to learn about these new ways that could help us maximize rice production and profit from doing so," they said. "We hope to learn more rice production management techniques from IRRI and DOA."
(Interview by Reianne Quilloy, May 2016)

Story #2: U Maung Maung Aye (rice–pulse)
Phaung Wae Village, Daik-U Township

U Maung Maung Aye, a 52-year-old farmer, has been growing rice for 36 years and is not afraid of change. Alongside rice, he planted other crops such as sesame for a decade, and then switched to pulses for the next 25 years.

In the monsoon season of 2014, U Maung Maung Aye joined a planning meeting of farmers organized by IRRI and DoA. “They were looking for farmer-cooperators for best management practices (BMPs) for rice and pulses, so I signed up,” he recalled.

He became involved in the participatory varietal selection for green gram pulses (Yezin series 1, 9, 11, 14, YM-03-2-5, YM-03-4-21, and Site Pyo Yay-1 [traditional variety]), and, in the 2015 monsoon season, for BMPs, rice (Pyi Taw Yin, Sin Thwe Lat, and Manaw Thukha 2).

“We were taught new ways of planting pulses, such as line sowing,” U Maung Maung Aye recalled. “I preferred it over our traditional practice of broadcasting seeds, as seed rates are lower using line sowing.” He used 10 pyi of seeds per acre (20 kg/acre) with broadcast seeding compared with 8 pyi per acre (16 kg/acre) with line sowing.

“Among the rice varieties tested, I liked Pyi Taw Yin the most and will grow it on the remaining 9 acres of my field this coming (2016) monsoon season,” U Maung Maung Aye said. “With Pyi Taw Yin, I harvested 70 baskets/acre (3.61 t/ha) in the 2015 monsoon season. I sold this to other villages, such as in Shwe Kyin Township. Farmers from other villages are also demanding this variety, but I had to keep some for myself.”

U Maung Maung Aye was grateful for his involvement in the BMP activities: “Aside from the chance to try out new varieties, I learned about new options for managing my pulse and rice crops. I found the recommended seedbed preparation easy to follow and very convenient. The practice has also made it easier for me to irrigate the field and drain it after transplanting. The fields are now easier to manage. I can do roguing easily and walk inside the line. After using the drum seeder, I observed that my field had more tillers as the spaces between rows were even. There is also less rodent damage. I also learned about new fertilizers, such as triple superphosphate, that, when applied as basal, will help boost my rice yield.”

“I plan to adopt the technologies and practices I have learned in managing the remainder of my fields for the next season,” he said. “I am happy to have joined these trials and realise that there are many options out there, which I now know about and have given me new opportunities to earn more.”

Not only he learned new and useful ways to manage his rice farm, he was also able to try better equipment that helps address their needs to make rice farming more efficient. “IRRI introduced the lightweight thresher to us; when we used the light weight thresher, we can bring it with less people particularly during times where labour is not available. This light weight thresher can be brought by four people from field to field from one farmer to another farmer,” he shared.

It can be also used not only for paddy but also for pulse by replacing the different size of sieve being able to use for dual purpose. We also allow the others to use light weight thresher with low charges.”

“The Learning Alliance provided a way for us to unite the farmers and talk how we can provide access to other farmers, produce better quality seeds, share knowledge and practices. By working together, we become like siblings who look after each other,” he shared.

U Maung Maung Aye also shared that working together as a group also provided an advantage for them. “When we collect seed altogether in one place, we get a pile of paddy and the trader buy our paddy for a higher price for both grain and seed. While the price is 40,000 MMK in the market, the price of 50,000 MMK is worth in the group,” U Maung Maung Aye said.

(Interview by Reianne Quilloy, May 2016; Updated by Rona Mae Rojas-Azucena, June 2017)

Story #3: U Myo Myint Aung (rice–rice)
Ka Thoat Phayar Gyi Village, Daik-U Township

U Myo Myint Aung has been tending his 25-acre rice farm for 24 years. He became a BMP cooperator for the ACIAR MyRice project in 2012 when he attended a meeting organized by IRRI, Department of Agricultural Research (DAR), and Department of Agriculture (DoA). Since then, he had been involved in testing IRRI-recommended technologies in the field.

He valued learning hand-in-hand with IRRI, DAR, and DoA, such as on the proper use of herbicides and fertilizers. (Previously, he merely followed what was on the label.)

Of all the technologies tested, U Myo Myint Aung found the most benefit in the use of the drum seeder during the summer. “When using the drum seeder, I observed that my seed rate went down by up to 1.5 baskets/acre. I thus earned up to 15,000 kyat more. I now use the drum seeder for my entire field and have observed, in addition, that there is less disease and rodent infestation. Yield also increased by 10 baskets/acre.

“I also used the improved varieties Yaenelo 4 and 7 for the summer rice crop,” he reported. “I found the quality of these varieties to be very good—almost the same as that of the traditional varieties—but with more yield. I was able to sell seeds of these varieties to other farmers at a higher price.”

“Upon collaborating with IRRI, we were trained on best management practices like fertiliser application to improve the rice productivity and on seed production which enabled us to produce our own seed. I observed that I got better yield with the varieties and practices introduced,” he said. U Myo Myint Aung also shared that he was able to get a higher price for seed than grain price and the yield also increased. “Now I could sell more and I earned more. My daughter can now study full time in the university,” he said. “Now, we can buy more than our basic needs. Also, my family can now eat high quality rice, the Paw San variety, instead of ordinary rice which we used to eat,” he shared.

In the past, we also experienced having seed storage problems. Whenever we store grains in our round baskets, the sparrows and rodents eat on the grains. IRRI provided training on proper storage using IRRI Superbags. Upon using it, I noticed that the germination of my stored grains increased to 90% without having significant damage to my stored seeds,” he shared.

(Interview by Reianne Quilloy, May 2016; Updated by Rona Mae Rojas-Azucena, June 2017)

Story #4: U Aung Than (rice–pulse)
Nga Gyi Gayat Village, Maubin Township

U Aung Than is a rice–pulse best management practices (BMPs) cooperator who owns 15 acres of farmland and has been farming for three years.

He helped identify BMPs such as manual leveling with support from the ACIAR MyRice project team. He attested that leveling his field made it easier to control the weeds than when he did not.

The 57-year-old farmer also tried using the drum seeder, another introduced technology. He described his old practice, which was to hire farm labour to do the transplanting, herbicide application to control weeds, and filling in missing hills. “Using the drum seeder, however, I saved 33,000 kyat/acre because I needed to hire only one person, who only had to fill in missing hills,” he said. “Because of the savings I made, I was able to buy more inputs for my next crop.”

He reported that the area on which he used the drum seeder remained more level than when he hired manual labour to do the seeding, when the number of people entering the field disturbed the soil surface. He also observed that well-leveled land was good for growing pulses such as black gram.

To compare with the traditional variety that he uses (Sin Thu Kha), U Aung Than also tried growing IRRI- and DAR (Department of Agricultural Research)-recommended varieties Pyi Taw Yin and Sin Thwe Lat, which he tested on a small portion of his farm. “I observed stark differences among these varieties,” he said. “Pyi Taw Yin and Sin Thwe Lat grew taller, but were prone to lodging and so caused problems during harvesting. But these varieties yielded far better than Sin Thu Kha.” He plans to use the new varieties in the next cropping season.

“I intend to share my BMP experience with other farmers, tell them how useful the drum seeder is,” he said, adding that he had stopped piling harvested paddy in the fields and can thus better prepare for the pulse crop. “I use a combine harvester, which cut harvesting time short and gave me time to process the rice harvest, so there was no longer any need to pile it on the field.”

As a result of his participation in the BMP component of the ACIAR MyRice project, U Aung Than imparts a suggestion for the next step: “My fellow farmers need to learn about nutrient management, how important it is that the soil receive complete nutrients. Most of them do not know how to apply fertiliser in the right amount and at the right time.”

For his pulse crop, U Aung Than tried growing black gram varieties Yezin 2 and 3 on an acre of his field, during the summer of 2015. “I saw that Yezin 2 and 3 bore more pods than the varieties I used to grow,” he said. “I then decided to plant both Yezin 2 and 3 on 14.5 acres, and a local variety on half an acre. The difference became even more obvious.

“I have not yet sold my harvest, but instead asked the trader to keep my seeds,” he shared. “We farmers cannot dictate the price of pulses, but we can decide when to sell them.”
(Interview by Reianne Quilloy, May 2016)

Story #5. Daw Aye Nyein (rice–pulse)
Nga Gyi Gayat Village, Maubin Township

Daw Aye Nyein, 62 years old, is a rice–pulse baby trial cooperator. She farms a total of 4 acres.

To store her seeds of the Yezin 2 black gram variety for eight months, Daw Aye Nyein used the IRRI Superbag, a farmer-friendly storage bag that allows cereal grains and other crops (e.g., rice, maize, pulses) to be safely stored for extended periods. The Superbag fits as a liner inside existing storage bags (e.g., woven polypropylene or jute bags). The ACIAR MyRice project introduced the postharvest management technologies to farmers in rice–pulse systems to reduce postharvest losses. This technology keeps stored seeds for an extended period while maintaining viability, which was given to her as part of a best management practices trial package. After storage, she noticed that seeds kept in the Superbag had a higher germination rate and less infestation from insects.

“I had doubts at first if the Superbag would be good material for storage because it is merely made of plastic,” she shared. “But, after eight months in storage, my black gram seeds had better appearance. I planted these seeds on 2 acres of my farm and harvested 22 baskets/acre (1.14 t/ha) of Yezin 2. The traditional variety I used to grow had a yield of 16 baskets/acre.”

Daw Aye Nyein sold the seeds at 50,000 kyat/basket to three farmers from Si Pin Kone, Phayar Kone, and Yala villages. “I did not even have to look for customers; the farmers sought me because they had heard that Yezin 2 is a good variety,” she said.

“I was able to pay off my loans because of the profit I earned,” Daw Aye Nyein said. “I am interested in buying the IRRI Superbag for future use, but I don’t know where to buy it.”

She also said she prefers using IRRI Superbags for pulses rather than for rice.
(Interview by Reianne Quilloy, May 2016)

Story #6: Daw Tin Yee (rice–pulse)
Nga Gyi Gayat Village, Maubin Township

Daw Tin Yee is another woman farmer who gave the IRRI Superbag a try. She has been a rice–pulse farmer for 25 years on her 3 acres. She signed up as a best management practices (BMPs) cooperator because her husband was not very interested in attending the meetings and training activities. As a cooperator, she planted the black gram variety Yezin 2 and observed how it performed better than the traditional variety she used to grow.

To keep the seeds for use in the next season, she stored the Yezin 2 seeds in an IRRI Superbag for eight months. “After storage in the Superbag, I noticed that the color of the seeds is better, germination rate is higher, and no insect infestation,” she recalled.

That season, Daw Tin Yee planted the stored seeds on 2.5 acres and the traditional variety on half an acre. “From the Yezin 2 plots, I harvested 12 baskets/acre,” she said. “With the traditional variety, I harvested 4 baskets from the half-acre. The trader also preferred Yezin 2 so I was able to sell it at 48,000 kyat/basket. I used the profit as added funds to renovate my house. “
(Interview by Reianne Quilloy, May 2016)

Story #7: U Nay Lin Oo (rice–rice)
Tar Pat Village, Maubin Township

U Nay Lin Oo is a village head and has been growing rice for 17 years. He joined as participatory varietal selection (PVS) cooperator in the 2014-15 summer season and in the 2015 wet season. He tested rice varieties promoted by IRRI.

In the summer of 2015, he tested the new improved varieties Pyi Myanmar Sein and Yaenelo 1, 4, and 7 on 2.0 acres, and compared these with farmers’ variety Thee Htat Yin on half an acre in PVS baby trials. His observations were that the varieties tested were drought-resistant and taller than Thee Htat Yin. He also reported using less chemicals with these five new improved varieties he tested.

U Nay Lin Oo was also a cooperator in the nutrient management trial in the 2015 wet season using variety Sin Htwe Latt and in the 2015-16 dry season using Htee Htat Yin. He learned the importance of adding muriate of potash (MOP) fertiliser in addition to triple superphosphate (TSP) and urea, following the protocol. Before the trials, he used only TSP and urea. Although the use of MOP entails added cost, this is offset by higher yields. Some farmers in the village are thus now following the steps for the proper amount and timing of fertiliser application.

“Among the varieties tested, I liked Yaenelo 7 the most. I planted it for my summer rice,” U Nay Lin Oo said. “After harvesting this season, I plan to use the solar bubble dryer. I have also used the IRRI Superbag to store my rice seeds—five baskets of Yaenelo 7 and seven baskets of Thee Htat Yin. I found that grain quality was maintained. I used to buy seeds for my next cropping as I found

it difficult to store seeds for the season. Now, there is no need to buy because I have the Superbags.

“Since I am part of the business model farmer group, I and my fellow farmers agreed to use GrainSafe to store our seeds this coming April,” he added.

(*Interview by Reianne Quilloy, May 2016).*