Indonesia Rice Check Procedure: an Approach for Acceleration the Adoption of ICM

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ABSTRACT

Ricecheck is a procedure of extensionist-assisted farmer-group self learning. The most important feature of Ricecheck is to encourage farmers to monitor and check their crops to see how the crops compare to the 10 key checks. The 10 key checks are to (1) use locally appropriate cultivars, (2) use certified seeds with high vigor, (3) ensure effective levelling and tillage management, (4) synchronize seeding of the nursery, (5) establish sufficient plant population to ensure adequate grain-sink size for farmers' target yield, (6) achieve enough tillers at panicle initiation, (7) avoid excessive water or drought stress, (8) ensure no yield loss due to pests, (9) harvest at the right time, and (10) thresh at the right time. In a two-season 78-farmer Rice-Check assessment, grain yield and gross margin increased with number of achieved Checks. Farmers who achieved four key checks obtained 5.0 t ha^{-1} grain yield. Achievement of all nine checks resulted in a 59% increase in grain yield and a 91% increase in gross margin. Farmers strive to adopt the key checks in order to increase yields. The results confirm that adopting more checks results in higher yield. Sustainability - in Indonesia or elsewhere - shall depend on RiceCheck generating attractive on-farm gross margins. Monitoring indicates that for some ICM component technologies of the Year-2009 and 2010 diffusion/adoption were relatively low - notably for fertilizer application (SSNM) and for intermittent irrigation. Collaborative research between IAARD and IRRI had further developed a computer-based decision support tool, named Nutrient Manager for Rice or '*Pemupukan Hara Spesifik Lokasi*' (PHSL) in Bahasa Indonesia. PHSL was released for use on the Internet by the Minister of Agriculture in January 2011. In order to reach more small rice farmers faster, this collaborative research have now developed a mobile phone application of PHSL, referred to as PHSL HP.

Keywords: integrated crop management (ICM), rice check, irrigated rice, yield, gross margins, PHSL

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INTRODUCTION

Rice is the most important cereal and staple food consumed in Indonesia. As the fourth most populous country in the world, it had a population around 245 million in 2012. As the third-largest rice producer - with an average annual production during the last fifteen years of 1998-2012 it was of about 56.8 million tons (Mt) from a harvest area of almost 12.2 million hectares (Mha). However, during those fifteen years, the trend of production (within the usual year-to-year fluctuations) was of a period of non-increase (average 50.8 Mt/Ann.) during 1998-2002, then a progressive increase from 52.1 to 57.2 Mt/Ann during 2003-2007 and from 60.3 to 68.9 Mt/Ann during 2008-2012 (CBS, 2012). Efforts have been made to sustain rice self-sufficiency by improving and developing key factors. With an annual population increase of 1.4 percent, more food is needed every year.

Indonesia's stagnation in rice yields and in rice-farmers' gross margins is similar to that which afflicted Australia in the early 1980s (Lacy, 1997). The Australian remedy was the development, validation, and implementation (with extension-service support) of a successful procedure of farmer-group-participatory self-learning - RiceCheck (Jensen, 2012).

RiceCheck can be defined as a dynamic rice crop management system that presents key technology and management best practice as key checks; checks farmer practices with best practice to compare results; and learns through farmers' group discussion to sustain improvements in productivity, profitability, and environment safety. Simply, we can say that RiceCheck is learning by checking and sharing for best farming practice.

Essentially, these Australian *Check-Package* methodologies for agricultural-crop extension emphasize that because it is not possible to predict which yield constraints shall occur in any particular crop season, and because constraints interact, all components within a crop-production package must be rigorously adopted in every crop season. The *Check* aspect of the methodology is that within-season targets are established for key features of an integrated crop management that aims to achieve a realistic yield. The individual farmer observes, measures, and records his/her own crop and management to "check" whether he/she is or is not achieving the targets.

The Ricecheck approach tries to find the answer for high yields in high yielding fields of farmers rather than from research plots. The aim is to educate farmers to improve their learning and performance. Farmers are encouraged to monitor their crop, to compare it with the key check recommendations, and to record their findings. Extension agents give farmers individual feedback. This feedback shows how their performance compares with the key checks as well as with other farmers in the same sub-district.

Due to its great influence on national economic and political stability, rice is the agricultural commodity attended the most. President ordered to increase rice production by 5% every year since 2008 to secure domestic demand and rice surplus 10 million tons by 2014. Indonesian President declared the action program of National Rice Production Improvement (P2BN, *Peningkatan Produksi Beras Nasional*).

One way to increase of rice production is through adoption of integrated rice crop management. Obviously, this action program demands involvements of all stakeholders, such as agricultural researchers, extension workers, academicians, farmers' organizations, and local leaders.

The aims of the study were a workable set of rice-crop check items and their target (indicator) values for a realistic target yield within an existing Indonesian integrated-crop-management package and quantification of the relations between check-indicators actually achieved by individual farmers and monitoring the adoption of integrated rice crop management.

METHODOLOGY

The study was conducted at South Lampung Regency, Lampung Province, Indonesia from 2006-2007. A multidisciplinary team of agricultural and social scientists conducted a Participatory Rural Appraisal (PRA) to characterize the village targeted agricultural resources and to help the villagers diagnose and plan interventions to overcome rice-system-productivity constraints and to strengthen thereby existing opportunities for income growth.

Using the outcomes of the agro-ecosystems analysis and of the familiarization training, the Farmer Group reviewed a set of prospective "RiceCheck items" that derived from an Integrated Crop Rice Management package. Farmers were encouraged to try all twelve ICM components so that they could select the options that suited biophysical, social, and economic circumstances and the availability of resources and component technologies. The ICM technology options were thus location-specific and dynamic. They subsequently adapted that set to local conditions, and agreed a set of RiceCheck items within a twelve-component integrated-rice-crop-management package (Table 1). Principles of Integrated Pest Management (IPM) and Site Spesific Nutrient Management (SSNM) were included in RiceCheck for respective crop management areas.

Farmer-Group Meetings and Outcomes. A RiceCheck Farmer Group consisted of 20-30 rice farmers, met regularly to improve their rice farming productivity and profitability through learning to understand and use the RiceCheck system of crop management.

The Group would meet initially to Commence the Group and then the10 times before, during and after each rice crop season: (a) 1 time, before the nursery seeding to plan the RiceCheck cropping season and start the RiceCheck Cycle, (b) 7 times during the growing season to manage, monitor and Check the RiceCheck field, and (c) 2 times after harvest with firstly a meeting to finalise the crop monitoring data, including the yield data, and secondly a Final Review meeting to review, analyse and interpret results, and the relationships between Checks achieved and yield results and Gross margins before starting the RiceCheck Cycle again with a new crop season and a planning meeting.

Table 1. Summary of Indonesian RiceCheck recommendations

Management Area	Alternative ICM Components	Key Check	Criteria for achievement of Key Check
Pree seeding planning	1. Use appropriate high-yielding cultivar	(1) Used a locally appropriate high-yield cultivar as a recommended variety	The variety was selected from a list of varieties recommended for the local regency.
	2. Use high vigour seeds	(2) Used certified and high vigour seeds/seedlings through a flotation technique	▪ The seed purchased was certified, as indicated by a blue label attached to the bag, and ▪ High vigour seeds were selected by a flotation technique
Land Preparation		(3) Achieved a high bund	Bunds of a minimum height of 25cm could help retain intense rainfall within the field, and thereby prevented the loss of nutrients through to drains or to adjacent fields.
Crop Establishment	3. Used young seedling 4. Transplanting of 1-3 seedlings hill^{-1}	(4) Nursery seeded together	The nursery seeding date was not more than 4 days before NOR 4 days after the median date of seeding of all members of the farmer group
	5. Square (20 x 20 cm to 25 x 25 cm) or paired row (*legowo*) [1)] geometry for transplanting	(5) Achieved sufficient plant population to ensure adequate grain-sink size	Achieved an optimum hill population of healthy plants at 14 DAT: ▪ Legowo 4:1 (20x10 cm) x 40 cm = 40 hill m^{-2} or 4:1 (25x12.5 cm) x 50 cm =26 hill m^{-2} ▪ Legowo 2:1 (20x10 cm) x 40 cm = 33 hill m^{-2} or 2:1 (25x12.5 cm) x 50 cm = 21 hill m^{-2} ▪ Square 20x20 cm = 25 hill m^{-2} or 25x25 cm = 16 hill m^{-2}
Nutrient Management	6. Basal incorporation of organic fertilizer at 2 t ha^{-1} 7. Nitrogen fertilization guided by LCC 8. Soil test-based application of P and K fertilizers	(6) Achieved enough tillers at panicle initiation	Achieved enough tillers at heading initiation through adequate nutrients as follows: ▪ Legowo 4:1 (20x10cm) x 40 cm = 9 tillers/ hill or (25x12.5cm) x 50 cm = 14 tillers hill^{-1} ▪ Legowo 2:1 (20x20cm) x 40 cm = 11 tillers/ hill or (25x12.5cm) x 50 cm = 18 tillers hill^{-1} ▪ Square 20x20cm = 15 tillers/hill or 25x25cm = 23 tillers hill^{-1}
Water Management	9. Intermittent irrigation	(7) Avoided excessive water or drought stress	
Pest Disease Management	10. Mechanical weeding by rotary weeder 11. Integrated insect-pest management	(8) Ensured no yield loss due to weeds and pests	No significant yield loss due to insect pests, diseases, weeds, rats, snails, and birds.
Harvest Management	12. Threshing by a power thresher	(9) Reaped at the right time	Harvested the crop when 1/5 or 4-5 grains at the base of the panicle are in the hard dough stage
		(10) Threshed at the right time	Threshed the rice 1-2 days after reaping

[1)] Jajar legowo system where rice rows were alternately widely and closer spacing within rows.

Indonesia-RiceCheck included Farmer Field Laboratories (FFL) in which RiceCheck-farmers might make participatory investigations of rice-production procedures and in which RiceCheck technologies and RiceCheck methods of rice-crop observation, measurement, and recording could be demonstrated. These activities: (a) to support the discovery-learning procedures of RiceCheck, (b) to enable RiceCheck farmers to explore technological and procedural rice-production aspects with no risk to their food security and/or family income and welfare, and (c) to provide awareness of RiceCheck methodology to non-RiceCheck farmers in areas near to the current RiceCheck operations and to local government-sector and private-sector stakeholders in pre-harvest field-day.

Field monitoring in the area of FFL-ICM was conducted in 2009 and 2010 to evaluate the level of adoption of the various components of ICM technology. Monitoring conducted at 285 farmers in four provinces.

RESULTS AND DISCUSSIONS

Analysis of Participant Farmers' Rice Yields and Gross Margins

The Rice-chek system in support of ICM was based on the principle that yields increased as adoption of the 10 key checks increased. The 10 key checks were to (1) use locally appropriate cultivars, (2) use certified seeds with high vigor, (3) ensure effective leveling and tillage management, (4) synchronizw seeding of the nursery, (5) establish sufficient plant population to ensure adequate grain-sink size for farmers' target yield, (6) achieve enough tillers at panicle initiation, (7) avoid excessive water or drought stress, (8) ensure no yield loss due to pests, (9) harvest at the right time, and (10) thresh at the right time.

The Rice-check method was used to evaluate the success of ICM in farmers' fields. Figure 1 illustrated a strong relationship between the number of key checks achieved and increased in grain yield and gross margin. Farmers who achieved four key checks obtained 5.0 t ha^{-1} grain yield. Yields increased up to 8.0 t ha^{-1} as the number of key checks achieved increased from four to nine. Achievement of all nine checks resulted in a 59% increase in grain yield.

The beneficial effects of achieving more key checks for increasing gross margin could be more convincing than increasing grain yield (Fig. 1). Achievement of nine key checks resulted in a US$916 ha^{-1} gross margin compared with $483 ha^{-1} for farmers achieving only four checks. The achievement of nine key checks resulted in a 91% increase in gross margin. This 91% increase, compared to the59 % grain-yield increase, reflected that there was synergistic effect among ICM component technologies used by the most-strongly-adopting ICM farmers.

The overall adoption of key checks was good with the exception of achieving high bunds for avoiding excessive water or drought stress, especially during the dry season (Fig. 2). Key checks adopted that generally improved accross seasons were to (1) use certified seeds with high vigor, (2) synchronize seeding at the nursery, (3) achieve enough tillers at panicle initiation, and (4) thresh at the right time.

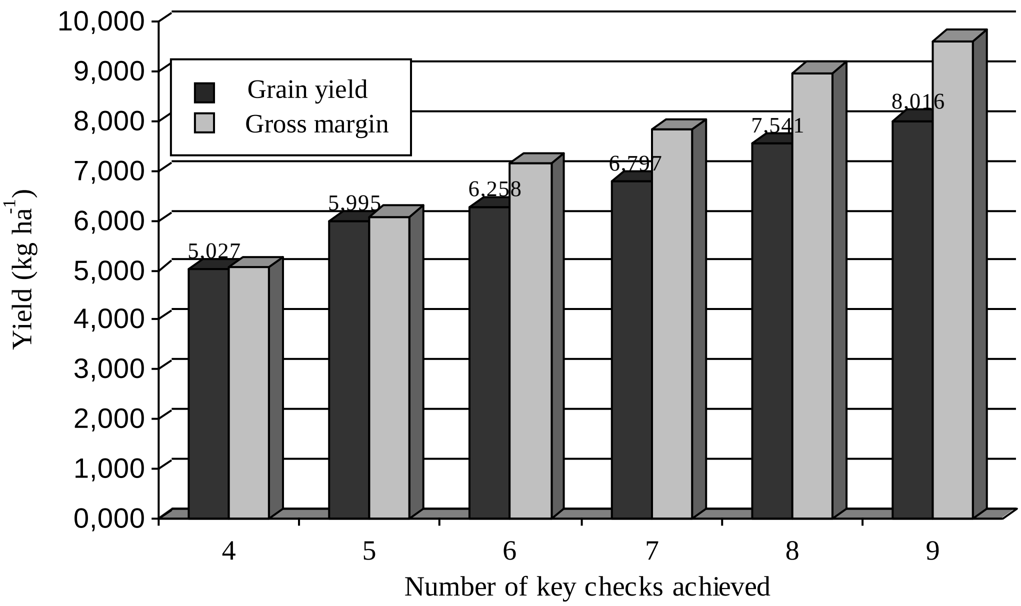

Fig. 1. Relationship between key checks achieved with grain yield and gross margin results in Rice-check farmer groups, Lampung Province, Indonesia, 2006-07 WS and 2007 DS (N = 78 and 60 males and 18 females).

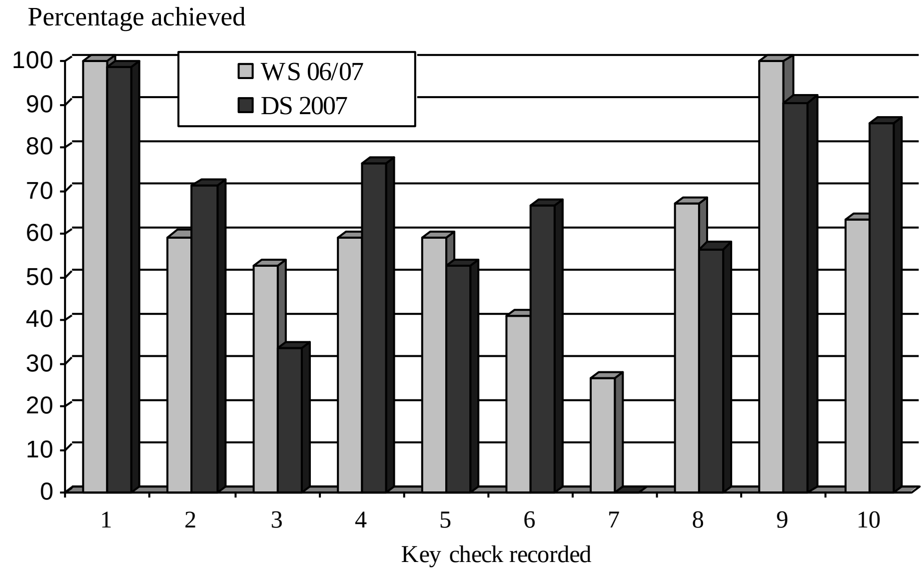

Fig. 2. Adoption of key checks in Rice-check farmer groups (N=78 and 60 males and 18 females), Lampung Province, Indonesia, 2006-07 WS and 2007 DS.

One of the aims of Ricecheck was to improve the adoption of the Key Checks since the higher the adoption was the higher the yields. These results supported those results from Australia and the Philippines, that the more of the key checks achieved (i.e. the more of the best management practices adopted by farmers) then the higher of the yields (Singh, *et. al.*, 2005; Lacy, *et. al.*, 2005; Jensen, 2012).

Interpretations of Yield Gaps and of Gross-Margins Gaps

The individual-farmer data for checks achieved, grain yields, and gross margins had permitted additional analyses that gave insight into the relative influences among the ten check items - for average of 78 ricecheck' farmers and two season - in terms both of yield and of gross margins. The analysis for grain yield permitted interpretation in terms of yield-gap components among these ten check items. Analyses for gross margins and for gross margins in association with grain yields, permitted interpretation in terms of relative cost-effectiveness among those ten checks here investigated in a real cropping situation.

Table 2 summarized the benefits (in t ha^{-1} grain yield and in thousand Rp ha^{-1} gross margins) from achieving each individual check and from achieving all of them. It also presented those individual benefits as a percentage fraction of their respective totals: (3,093 ± 0.24) t ha^{-1}, or (4,382 ± 346) thousand Rp ha^{-1}.

Table 2. Benefits of grain yield and of gross margins from achieving RiceCheck targets, average of WS 2006/07 and DS 2007, Lampung Province.

Check code number	Check item	Yield benefit from achieving the Check		Financial benefit from achieving the Check	
		(t / ha)	(%)	(thousand Rp / ha)	(%)
1.	Used a locally appropriate high-yield cultivar as a recommended variety	0,275±0.02	8.9	0.228±18	5.2
2.	Used certified and high vigour seeds/seedlings through a flotation technique	0,192±0.01	6.2	0.324±26	7.4
3.	Achieved a high bund	0,096±0.01	3.1	0.070±5	1.6
4.	Nursery seeded together	0,232±0.02	7.5	0.337±27	7.7
5.	Achieved sufficient plant population to ensure adequate grain-sink size	0,578±0.04	18.7	0.859±68	19.6
6.	Appliedfertilizer at the right time and the right amount based on SSNM	0,765±0.06	24.7	1.117±88	25.5
7.	Avoided excessive water or drought stress	0,451±0.03	14.6	0.688±54	15.7
8.	Ensured no yield loss due to weeds and pests	0,346±0.03	11.2	0.587±46	13.4
9.	Reaped at the right time	-	-	-	-
10.	Threshed at the right time	0,158±0.01	5.1	0.171±13	3.9
	All	3,093±0.24	100	4,382±346	100

Development of ICM in Indonesia.

Indonesia has a long and successful experience in assembling and disseminating rice-technology packages - with technical and economic components. Building on that experience, there is now the opportunity to assist farmer groups to combine the best features of the existing rice-production expertise with that of the ten component ICM approach to raising rice yield and production.

During 2009 to 2010, adoption of ICM/Farmer-Field-School (FFS) methodology expanded to two million hectares of irrigated lowland rice. Each of the 800,000 ICM / FFS units comprised 25 ha of farmers' fields and a one-hectare farmer managed Field Laboratory. Monitoring indicated (Table 3) that for some ICM component technologies the Year-2009 and 2010 diffusion/adoption were relatively low - notably for fertilizer application (SSNM) and for intermittent irrigation. Because of incomplete adoption of the packages, some farmers' benefits were impacted by unnecessarily high applications and hence cost of inputs - particularly of nitrogen fertilizer, with consequent increase in diseases and their costs of control.

Often, adoption was not simply a yes/no decision (Noltze *et al*., 2012). For instance, farmers might decide to adopt a certain innovation but only applied it on a part of their land, or, when several components were involved, they might decide to use only certain components but not others. The adoption decision was a process that extended over a certain period of time, from hearing about the technology for the first time to actual uptake. This held true in particular for knowledge-intensive system technologies such as ICM.

Table 3. Percent status of adoption ICM component in the FL of FFS-IRCM in Indonesia.

Check code number	Technology component	Adoption of ICM component technology					
		2009 (n=163)			2010 (n=122)		
		Central Java	Riau	Aver.	West NT	East NT	Aver.
1.	Used appropriate high-yielding cultivar	100.0	98.3	99.2	100.0	86.3	93.1
2.	Used certified with high vigour seeds	88.8	81.7	85.0	81.7	77.1	79.4
3.	Used young seedling (<21 days-old)	91.7	71.7	81.7	66.7	55.5	61.2
4.	Transplanting of 1-3 seedling hill^{-1}	93.3	68.3	80.8	61.7	46.2	53.9
5.	Squared (20 x 20 cm to 25 x 25 cm) or paired row (*legowo*) geometry for transplanting	58.3	48.3	53.3	36.7	3.7	20.2
6.	Fertilizer application guided by LCC/soil test kit	23.8	16.7	20.0	6.7	2.7	4.7
7.	Intermittent irrigation	10.0	13.3	11.7	10.0	3.5	6.7
8.	Integrated insect-pest management	41.7	35.0	38.3	20.0	9.8	14.9
9.	Reaped at the right time	93.3	85.0	89.2	81.7	89.4	85.5
10.	Threshed at the right time	94.7	91.3	93.0	85.7	88.2	87.4

Due to financial constraints, the Indonesian Government needed at 01 April 2010 to reduce its fertilizer subsidies. In consequence, prices paid by farmers for fertilizers increased at 01 April 2010 by between 25 and 40 %. These price increases, together with the fore-mentioned increases in population and in rice demand, required that farmers (and the country) had to use their fertilizers more efficiently. Use of fertilizer was essential for profitable rice farming and achieving rice self-sufficiency in Indonesia; but fertilizer represented a substantial input cost in rice farming for both farmers and the Government of Indonesia.

Collaborative research between the Indonesian Agency for Agricultural Research and Development (IAARD) and the International Rice Research Institute (IRRI) had fortunately led to the development of site-specific nutrient management (SSNM), which provided science-based principles for best-bet fertilizer practices (Buresh *et al*., 2010). IRRI and IAARD had further collaborated to develop a computer-based decision support tool, named Nutrient Manager for Rice or '*Pemupukan Hara Spesifik Lokasi*' (PHSL) in Bahasa Indonesia, which transformed the science of SSNM into a field-specific fertilizer recommendation for rice farmers (Buresh *et al*., 2012).

PHSL was released for use on the Internet by the Minister of Agriculture in January 2011. It contained about 14 questions, which could be easily answered by farmers usually with the assistance of an extension worker. Based on the farmer's answers, a fertilizer recommendation matching the farmer's rice-growing conditions was provided to the farmer.

In order to reach more small rice farmers faster, IRRI and IAARD have now developed a mobile phone application of PHSL, referred to as PHSL HP. With PHSL HP, a farmer dials 135 for free using a mobile phone and follows the instructions of a voice recording. The farmer first selects one of five languages (Bahasa Indonesia, Java, Sunda, Bali, and Bugis) by pushing an appropriate number on the keypad of the phone. The farmer then answers five simple questions with the keypad and afterwards receives a fertilizer recommendation by SMS on his phone. PHSL HP is being initially launched for use with mobile phones of Telkomsel subscribers. It is expected soon across the country with additional mobile carriers.

CONCLUSIONS

1. The prototype procedures of farmer-group formation and familiarization were effective. The evaluating agency for ricecheck-Indonesia operated at the interface between research and extension; it was effective in assisting the regular farmer-group discussions. Efforts are now needed to develop national-scale training for local-government ricecheck extensionists.

2. The development and testing of PHSL highlighted the potential for recent advances in information and communication technologies (ICT) to provide tools for reaching more farmers faster with appropriate information and services.

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