The System of Rice Intensification in INDONESIA

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Initial "rice intensification" efforts in Indonesia started in 1959 when the government established a network of local rice centers (*Padi Sentra*), which organized farmers for rice production and provided them with credit. Rice intensification was undertaken because we needed to produce more rice to feed the ever-increasing population in Indonesia.

After the initial program was evaluated, a "mass guidance" program known as BIMAS was established in 1965, with the addition of more components, to cover almost all irrigated areas in the country.

Following BIMAS, there were other modifications in the program for rice intensification. Starting in 1986, it was extended to become SUPRA-INSUS, the supra-intensification system. The components of this program included use of certified seed of recommended varieties, integrated pest management, balanced fertilization, and credit availability. The program was implemented throughout the irrigated rice areas in Indonesia.

Starting about 1995, it was realized that the existing rice intensification program could no longer support the needs of the rice sector. New production technology was failing to keep pace with food demand. SUPRA-INSUS could not reach the expected production levels.

To make matters worse, the technologies (especially the use of chemical inputs) have been upsetting the ecological balance in irrigated rice systems. Rice production and productivity was seen to be leveling off, stagnant, and in some places even declining.

Thus, despite many years of experience with rice intensification efforts, the rice production system in Indonesia appears to be less and less sustainable. Intensification programs that once made Indonesia one of the leading rice-producing countries, with self-sufficiency achieved for a short period after 1984, had to be improved. The country's strategy to increase rice production and secure sufficient food for its population needed to be repositioned.

Encouraged by a presentation on the System of Rice Intensification (SRI) by Prof. Norman Uphoff in October 1997 in Bogor, his first presentation on SRI made outside of Madagascar, AARD started to evaluate this system and to revise its rice intensification efforts.

After a full assessment of our past programs (involving expertise from IRRI), it was concluded that there was indeed something to be learned from SRI methods. Starting in 1999, AARD undertook evaluations of SRI at its Research Institute for Rice (RIR) in Sukamandi and found that a higher level of production could be attained with this method.

Since 2000, we have been thinking through, developing, and evaluating a new combined strategy for rice intensification that includes SRI practices with integrated pest management (IPM) practices, as well as other local-specific means to increase rice production. It is called the *Integrated Crop and Resource Management* (ICM) system for irrigated rice areas and has been evaluated on farmers' fields in 8 provinces of Indonesia.

Before and during program implementation, ICM ideas were introduced and spread with local staff and farmers in a decentralized and participatory manner. During the development and evaluation of the program, a participatory, farmer-centered approach has been used. This is important as the process should upgrade our human resources in agriculture, which are the key to success.

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Evaluations

With millions of people depending on irrigated rice ecosystems for their food and income, any drop in rice production could have serious implications for food security. Therefore, the Rice Institute, in accordance with its national mandate, has to find the ways to provide farmers with the knowledge and skills needed to improve their rice production and productivity in a sustainable manner. The strategy depends heavily on farmers' empowerment and on maintaining and improving soil fertility.

These efforts aim at regaining rice self-sufficiency, increasing farmers' welfare, and sustaining the system of rice production. Much hopes are hanging on this ICM approach to irrigated rice. It is expected to bring back self-sufficiency in rice as well as to sustain the rice production system.

The ICM system has three main components: intermittent irrigation to save water and improve soil quality, transplanting single younger seedlings, and increasing soil organic matter. The three components go to the heart of rice crop production thinking, relative to the conventional flooded systems. For maximum production in a given area, these components should be applied together. Other components should be promoted as far as socio-economic and environmental concerns are supportive.

Evaluation and development of ICM were undertaken during 2001 in 5-ha irrigated rice areas at 16 selected villages. Superimposed and component technology trials were conducted as well. The concept of integration is a broad one, including many levels, i.e., institutions, crops and resources, scientific personnel, and farmers, all linked analytically and operationally. Through this ICM approach, aside from increasing production levels, we expect that the quality of resources in wetland rice production systems could be maintained or improved.

All 5-ha demonstration plots and super-imposed trials in each of 16 villages were monitored and supervised by facilitators from the Assessment Institutes for Agricultural Technology (AIATs) in the respective provinces, as well as by researchers from Research Institute for Rice (RIR).

Results

Demonstration trials at Sukamandi

Dry and wet seasons of 1999 and 1999/2000

The first trials with ICM (modified SRI) for irrigated rice ecosystems were carried out on the main RIR experiment station at Sukamandi. In this study no P or K fertilizers were applied. The rate of N fertilizer was 200 kg urea/ha (normally farmers apply as much as 250-300 kg urea), and the timing of applications was determined based on leaf-color chart readings.

On average, the rice yield obtained from plots practicing ICM principles in the dry season of 1999 was 6.2 t/ha, or 51% higher than on plots with farmers' standard management practices (4.1 t/ha). These practices included transplanting 21-day-old seedlings, 3 per hill, with no application of organic matter, continuous flooding, and application of N-P-K fertilizer.

The grain yields in the wet season of 1999/2000, obtained from 6 demonstration plots (1,500 m^2 each) at Sukamandi, ranged from 7.2 to 9.3 t/ha, with *return-to-cost (R/C) ratios* of 1.63 to 2.08 (see Table 1). The average rice productivity using SRI methods under farmers' management was 6.5 t/ha (R/C value 1.61). Several rice samples, harvested from plots 10 x 10 m^2, had grain yield reaching 103 kg, which is the equivalent to 10.3 t/ha yield. This was the first time that rice yield in this area had reached 10 t/ha.

Dry and wet seasons of 2000 and 2000/01

ICM demonstration plots in the dry season at Sukamandi in this second year of trials, yielded 6.9 to 9.7 t/ha (R/C values = 1.83 to 2.39), averaging 8.3 t/ha. This was 30% higher than the 6.4 t/ha (R/C = 1.98) that farmers using conventional methods achieved. Moreover, in the wet season of 2000/01, the ICM plots yielded 7.7 to 9.1 t/ha (R/C values = 2.00 to 2.48), averaging 8.4 t/ha. This was a production increase of 29% more than on farmers' fields (6.5 t/ha, with R/C value = 1.97) (Table 2).

Dry and wet seasons of 2001 and 2001/02

In the dry season 2001, the response of three rice varieties was evaluated. Due to differing yield potentials of the three varieties, there were different yield responses to ICM methods: Ciherang yielded 7.3 to 7.7 t/ha, IR-64 gave 6.8 to 6.9 t/ha, and Way Apo Buru produced 7.4 to 7.6 t/ha. At the same time, farmers nearby using conventional methods achieved only 4.7, 4.9 and 5.7 t/ha with IR-64, Way Apo Buru and Ciherang, respectively. Irrespective of variety, ICM gave higher R/C values than those with conventional production methods (Table 3).

Table 1. Results of ICM demonstration plots using Way Apo Buru variety, Sukamandi, dry and wet seasons, 1999-2000

	Plot A	Plot B	Plot C	Plot D	Plot E	Plot F	Farmers Fields
Dry Season 1999							
Yield (t/ha)	6.2	–	–	–	–	–	4.1
R/C	2.40	–	–	–	–	–	67
Wet Season 1999-2000							
Yield (t/ha)	7.2	7.8	8.3	8.4	9.3	9.2	6.5
R/C	1.63	1.72	1.85	1.88	2.05	2.08	1.61

Table 2. Results of ICM demonstration plots using Way Apo Buru variety, Sukamandi, dry and wet seasons, 2000-2001

	Plot A	Plot B	Plot C	Plot D	Plot E	Plot F	Farmers Fields
Dry Season 1999							
Yield (t/ha)	8.0	8.2	8.0	6.9	9.7	9.0	6.4
R/C	2.11	2.07	1.98	1.83	2.39	2.16	1.98
Wet Season 2000-2001							
Yield (t/ha)	8.2	9.1	8.6	8.2	8.5	7.7	6.5
R/C	2.36	2.11	2.48	2.00	2.52	2.35	1.97

Table 3. Results of ICM demonstration plots using different varieties, Sukamandi, dry season, 2001

	Variety		
	Ciherang	IR-64	Way Apo Buru
ICM Methods			
Yield (t/ha)	7.3-7.7	6.8-6.9	7.4-7.6
R/C	2.35	2.46	2.48
Conventional Methods			
Yield (t/ha)	5.7	4.7	4.9
R/C	2.18	1.96	2.01

Table 4. Results of ICM demonstration plots using different varieties, Sukamandi, wet season, 2001-2002

	Variety		
	Way Apo Buro	IR58025A-IR53942 (Hybrid Variety)	BP364R-MR-33-3-MR5-4 (NPT)
ICM Methods			
Yield (t/ha)	7.0-8.3	5.9	5.8
R/C	2.04-2.27	1.76	1.74
Conventional Methods			
Yield (t/ha)	5.5	–	–
R/C	1.87	–	–

Starting in November 2001, the same fields were used with ICM methodology, and some farmers followed the ideas by themselves, for comparison. This season, one hybrid and one New Plant Type (NPT) cultivar were being tested, with Way Apo Buru as the standard variety for comparison (Table 4).

Way Apo Buru, an inbred variety, responded well to ICM in comparison to conventional methods, in terms of yield and R/C ratio. On the other hand, hybrid rice (IR58025A-IR53942) and the NPT variety (BP364R-MR-33-3-MR5-4) did not respond so well to ICM in comparison to Way Apo Buru. It seemed that the spacing of 25x25 cm was too wide for these two cultivars as they produced fewer tillers and panicles. In addition, the percentage of filled grains for the two cultivars was much lower than with Way Apo Buru.

Farmer evaluations

IPM Program in 2001

SRI has also been evaluated by the Farmers' Science Group in Ciamis district, West Java, that is associated with Indonesia's Integrated Pest Management (IPM) program. The group was supported and facilitated by Mr. Enceng Asikin and Mr. Koeswara, IPM program alumni. Farmers got the idea of testing SRI from the FAO Community IPM Program.

This study was conducted on farmers' fields at Sindang Kasih village, Cikoneng sub-district, between February and early May 2001. Grain yields on the SRI fields were 6.7 and 7 t/ha compared to 4.5 t/ha on an adjacent field using regular methods, an increase of 49-56% over farmer practice. The yield improvement was associated with increased numbers of tillers and productive tillers. Also, the incidence of stem borer seemed to be lower with SRI (3%) compared with conventional methods (8%).

Evaluation of ICM in 8 provinces during 2001

Starting in the dry season 2001, two villages in each of 8 provinces in Indonesia were chosen for ICM development and evaluation. More than 4 ha irrigated lowland rice area were used as a test location in each village, having 10-20 farmers as cooperators. The program was planned for three years. According to different growing seasons among villages, the harvest time differed among villages and test locations.

Average rice yields in all of the ICM plots as part of this 8-province evaluation were found to be higher than the yields obtained by farmers in each of the participating villages. The subsequent results have been quite impressive, with rice yields with ICM methods being 7.1 to 33.3% higher (average = 16.4%) than those with farmers' usual practices.

Lower yield responses to ICM in some places were associated with the incomplete practice of its main components, especially not doing intermittent irrigation but rather keeping fields continuously flooded. In Bojongjaya, West Java, lower yields were due to flooding; ICM with its younger seedling gave a 3.3% yield reduction (Table 5). There is often not the willingness or the means to change age-old irrigation practices.

In the second season of evaluations at village level, the yield response to ICM was higher than in the first. Table 6 shows that ICM methodology produced 2.7 to 51.4% (average 28.4%) more grain in comparison with conventional methods. Lower yield responses to ICM methods at Kliwonan and Gunungrejo were due to reduced water availability toward the end of the dry season.

Farmers using ICM saved 15-40 kg seed and 140-200 kg of urea per hectare, lowering substantially their costs of production. As a result, the R/C values for ICM methodology were higher in most ICM trials (2.06 to 3.28, average 2.77) than with conventional methods (1.71 to 3.42, average 2.36).

Farmer evaluation under ADRA project in 2002

The most recent data on SRI evaluation in Indonesia has come from the ADRA Mother and Child Health and Agriculture (ADRA MCHA) project. Following a visit from Mr. Roland Bunch of COSECHA in November 2001, ADRA tried SRI methodology with farmers on their own fields in Kupang, West Timor. This NGO worked through farmer groups, involving more than 100 local farmers. In the trials, farmers practice transplanting single and younger (8 to 10-day-old) seedlings, 25x25 cm spacing, improved drainage during the vegetative growth stage, and 1-2 cm flood water during the reproductive stage. They gave small amounts of urea in addition to organic compost. The trials were conducted from January to May 2002.

SRI methods gave remarkably higher yields, from 8.6 to 13.8 t/ha, with an average of 11.6 t/ha, compared to yields with farmers' usual methods averaging 4.4 t/ha. Most farmers used IR-64 variety. Even a traditional variety, Si Putih, yielded 11.6 t/ha. More numerous tillers and panicles produced with SRI methods accounted for the higher yields in these trials.

Learning

Some possible constraints for the spread of ICM have been encountered since the first demonstration plots at Sukamandi in 1999 and during the implementation of the project in eight provinces. In general, the constraints were specific for certain areas. For example, in areas where the golden snail is endemic, farmers were afraid to use ICM because they feared that once the pest comes, the tiny seedling will disappear. In such areas we recommended using 2 to 3 seedlings per hill, although we found in our first tests in 1999 that intermittent flooding actually reduced the populations of golden snail.

Difficulties that have been faced in disseminating SRI methods so far are:

- Irrigation management and water control are not easy to maintain. As a result the optimal effects from increased soil aeration were often not realized.
- Labor requirement was higher than with the traditional practice, at least to begin.
- Many constraints limit the use of younger, single seedlings.
- Some pests and diseases attacked younger seedlings more after transplanting.
- It is not easy to handle and cultivate a tiny single seedling, at least until farmers gain skill and confidence in this method.
- Farmers are afraid of running greater risks with younger and single seedlings.
- Improvement of soil organic matter is often difficult in situations like on Java where often farmers do not own the land that they cultivate. So they hesitate to invest in improving the soil, even when they know that there will be benefits from this, even in the short run.
- Because not all farmers understand the ICM methodology equally well, and there are always some variations in bio-physical conditions, there were many differences among villages in how completely and how well they applied these methods. Not all farmers/villages utilized the main components completely. This means that there is still scope for further improvement of yields.

Prospects

Analyzing the trends and development of rice intensification in the world, particularly in Indonesia, we see the conditions that we have to keep pace with. There are major emerging global issues concerning water scarcity and environmental degradation. There are concerns about maintaining and improving land productivity as a key factor for the success of any intensification program for rice over the long run. We expect these problems can be addressed through ICM implementation throughout the country as it makes fewer demands on water and aims to build up soil quality and health.

Table 5: Rice yields and R/C values with ICM methodology and farmers' practice, dry season, 2001

Location Province/	SRI Yield (t/ha)	Conventional Yield (t/ha)	Production Increase (%)
North Sumatra			
Aras	6.0	5.0	20.0
Tanjung Kubah	6.1	5.0	22.0
West Sumatra			
P. Pakandangan	4.7	3.8	24.0
West Java			
Sukasenang	5.0	4.6	8.7
Bojongjaya	5.9	6.1	-3.3
Central Java			
Sugihan	7.5	7.0	7.1
Kliwonan	6.4	4.8	33.3
East Java			
Gunungrejo	9.3	7.4	25.7
Tembalang	8.5	7.3	16.4
West Nusa Tenggara			
Jangala	7.4	6.5	13.9
South Sulawesi			
Matoanging	6.5	5.8	12.1

This methodology that is being developed and evaluated, to raise lowland rice production within different agro-ecological zones, has to be continually improved with a farmer-centered approach, to evolve specific systems for rice intensification that are most effective, in site-specific ways, for a given agro-ecosystem.

The good and healthy performance of our ICM crop has attracted the interest of hundreds of farmers around the study areas. Local staff and cooperating farmers have become highly impressed with ICM. From this point on, the future development and spread of this methodology will depend very much on the farmers themselves.

With better handling of the main components of ICM, much higher rice productivity can be achieved than at present. It is expected that the current rice yield ceiling can be lifted by utilizing available technologies and practices within our ICM framework. Although rice yields have been stagnant in Indonesia for the past 5-7 years, we now see a way to resume their growth.

Table 6. Rice yields and R/C values with ICM methodology and farmers' practice, dry season, 2001, and wet season, 2001-2002

Province/Location (Season)*	SRI Yield (t/ha) [R/C in brackets]	Conv. Yield (t/ha) [R/C in brackets]	Production Increase (%)
West Sumatra			
P. Pakandangan (W)	5.3 [2.98]	3.5 [1.71]	51.4
Central Java			
Kliwonan (2nd D)	8.0 [na]	7.6 [na]	5.3
East Java			
Gunungrejo (2nd D)	7.6 [2.06]	6.8 [1.91]	11.8
Tembalang (2nd D)	8.4 [2.59]	5.7 [2.08]	47.4
Bali			
Petiga (2nd D)	7.6 [2.59]	5.7 [2.08]	33.3
Tunjuk (D)	6.9 [na]	5.7 [na]	21.1
West Nusa Tenggara			
Tanjung (W)	7.1 [3.28]	5.7 [3.42]	24.6
Balo (D)	5.9 [2.92]	4.3 [2.22]	37.2
South Sulawesi			
Pinrang (D)	8.0 [3.00]	6.5 [3.08]	23.1

In some villages, due to available irrigation water, lowland rice is cultivated twice in the dry season (2nd D); otherwise season is denoted by D for dry and W for wet.

Pleased with the ICM results so far, starting in the dry season of 2002, three more provinces, Bengkulu, Lampung, and Yogyakarta District, are being included as additional sites for ICM development. Senior officials in the Indonesian Ministry of Agriculture, including the Minister himself, upon learning about ICM during their visits to Sukamandi station have taken great interest in getting ICM evaluated and introduced in all major rice-growing regions.

Acknowledgment

The data from IPM farmer group trials in Ciamis, West Java, supplied by Mr. Enceng Asikin and Mr. Koeswara, and from the ADRA Mother and Child Health and Agriculture Project in West Timor, supplied by Mr. Bruce Ewart, were highly appreciated.