Experience with the System of Rice Intensification in Northern THAILAND

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The paddy rice ecosystems in the upper north of Thailand can be broadly classified into lowland paddy and highland paddy ecosystems, with elevations ranging from 200 m to 1,000 m above mean sea level. The highland paddy ecosystem is rainfed and produces subsistence rice. Increasing rice yield is an important strategy to overcome rice deficits and to reduce slash-and-burn practice. Lowland rice farmers, both irrigated (25% area) and rainfed (75% area) produce quality rice for home consumption and for cash.

Over 80% of rice land is planted to photoperiod-sensitive varieties in the rainy season, and among these 80% are glutinous rice. Dry-season rice, less than 5% of total rice planted area, is cultivated to supplement rice requirements and to lesser extent as a cash crop. The yield of photoperiod-sensitive rice varieties under the present cultivation practice ranges from 3.5 to 5.0 t/ha in the irrigated area. The yield of rainfed lowland rice is highly variable and much lower. Only 30% of farm households achieve rice yields greater than 3.75 t/ha. Therefore, bridging the yield gap and stabilizing rice productivity with low external inputs is essential to improve the situation of rainfed lowland rice farmers.

Information on the principles and practices of SRI was first introduced in Chiang Mai in late 2000 by Klaus Prinz of the McKean Rehabilitation Center (MRC). He had participated in a workshop organized by the International Institute for Rural Reconstruction (IIRR) in the Philippines where SRI was discussed. This information was passed to the Multiple Cropping Center (MCC) of Chiang Mai University in late 2000, where an on-station study was initiated. Further contacts with CIIFAD at Cornell and Association Tefy Saina in Madagascar were established by the MRC and MCC to get more details on SRI.

It is envisaged that the practice of SRI could add value to the on-going work of the MCC on green manure crops in rice farming. Evaluation of SRI was first attempted by MCC in an on-station study in order to gain experience with the methods and to use the experimental plot as a demonstration for farmers who participated in MCC's green manure research program.

Evaluation and Results

On-station studies were conducted in 2001 by MCC first in the dry season (February-June) and then in the rainy season (August- November). A current dry season experiment for 2002 is still in progress.

The soils in the Chiang Mai Valley are derived from alluvial deposits and may be classified as old, semi-recent and recent alluvials. Old alluvial soils are found on the edges of the valley, while the recent alluvials are scattered along the main rivers. The MCC station is located on old alluvials having sandy loam to sandy clay loam soils (sand:silt:clay = 61.5 : 13.8 : 24.7) with pH 5.0-5.3, organic matter 1.09-1.16%, P= 35-200 ppm, and K = 40 ppm.

The valley receives an average annual rainfall of 1200 mm, of which 95% falls from May to September. The rainfall pattern is bimodal, with a dry spell period of 3-4 weeks from late June to mid-July. Average temperature is about 26° C but there are well defined hot and cool periods. Rice cultivation in the hot-dry period beginning February faces cool night temperatures that retard seedling growth. In the SRI experiment, 17-day-old rice seedlings reached the 3-leaf growth stage with a seedling height about 15 cm.

Dry season (February-June) 2001

Two glutinous rice varieties (San Patong-1, Hom Sakon Nakorn) and three non-glutinous ones (Hom Nin, Hom Suphan and Malidang) with photoperiod-insensitive growth traits were planted under conventional and SRI water management regimes. Young seedlings aged 17 days old were used to compare with the common use of seedlings about 34 days old. Plant spacing of 25x25 cm was used with a single plant per hill.

The average yield of conventional management practice (34-day-old seedlings and flood irrigation throughout) provided 4.81 t/ha, while the SRI plots produced 4.35 t/ha. The overall effect of young seedlings showed a promising result, with average yield of 4.76 t/ha as against 4.39 t/ha with older seedlings. The varieties showed differential response to SRI and the conventional management practice. The non-glutinous rice, Hom Suphan, provided an SRI yield of 5.64 t/ha, an increment of 24 percent yield over use of conventional methods, 4.54 t/ha (Table 1). It was also recorded that the SRI used only 30 percent as much water as was consumed by the conventional method from transplanting to flowering. From flowering to maturity, the water management of both systems was the same.

A farmer-field day was staged on May 10, 2001. The field demonstration was supplemented with information and pictures provided by Professor Norman Uphoff, showing SRI practice from Madagascar. The farmers were intrigued by the vigorous growth of a single young seedling per hill as compared to the conventional practice. One farmer who produced community rice seed later adopted the younger seedling (25 days) and single plant practice in the production of foundation seed in the following rainy season 2001.

Rainy season (July-November) 2001

Both on-station and on-farm studies of SRI were conducted in the rainy season of 2001. The on-station SRI experiment was carried out in conjunction with green manure crop in rice. Two species of green manure crops were used. *Sesbania rostrata* was shown to be more promising in a rice farming system, while *Crotalaria juncea* was more effective for dryland cropping. One glutinous variety (Hom Sakon Nakorn) and two non-glutinous rice varieties were used in the experiment. Rice seedlings 10 days old and a single plant per hill were used for all the treatments. The overall yield of the rainy season crop was lower than that of the dry season. Average yields of the conventional and the SRI methods were 3.04 and 2.19 t/ha, respectively. The green manure crop, *Sesbania rostrata*, provided better rice yield than *Crotalaria juncea*. It seemed that the effects of green manure on rice yield was more pronounced under continued flooding than with a wet-dry watering system (Table 2).

Another varietal trial was designed to compare the effect of SRI and conventional methods. Three glutinous and three non-glutinous were planted with single seedlings 10 days old at 25x25 cm spacing.

The overall yield with conventional methods outperformed SRI, averaging 4.16 and 2.59 t/ha, respectively (Table 3). It was observed that the young seedlings grew faster under continuous flooding than with the wet-dry irrigation method. Weed infestation was more severe in the SRI plot. The wet-dry sequence prior to flowering as recommended in the SRI practice could hardly be maintained in the rainy season planting. So the soil condition was not kept properly "dry" as required. This could cause deviation from the expected SRI result.

On-farm experiments 2001

On-farm observation plots were carried out in two lowland districts (San Sai and Mae Taeng) in Chiang Mai province with 8 farmer-cooperators who had previously participated in the MCC field-day on May 10, 2001. These farmers had adopted *Sesbania rostrata* as a green manure crop in their rice production system, and sought ecologically appropriate practices to reduce their production costs. They were engaged in community seed production, and so they found a single plant per hill suitable for the production of foundation seed. An additional test site under highland conditions was carried out with one Karen farmer.

The lowland observation plots showed that with the photoperiod-sensitive, glutinous rice variety, RD6, and non-glutinous variety, KDML 105, using 10-day-old seedlings would delay flowering and maturity. Tillering of young seedlings was similar to the older seedlings as practiced by farmers. The overall means of the conventional and SRI were 5.36 and 3.23 t/ha. (Table 4).

The Karen farmer on the highland compared single and three plants per hill with 25x25 cm spacing. Young seedlings were used, and the SRI water management system was adopted. The average rice yield of single plant per hill practice was 2.16 t/ha while the three plants per hill yielded 1.45 t/ha. Strong competition between rice plants within the hill resulted in lower yield of local highland rice.

The McKean Rehabilitation Center (MRC) initiative

During the rainy season 2001, MRC initiated an observation plot at the Center and extended on-farm cooperative trials with assistance from the MRC extension personnel. One observation plot in one village showed vigorous seedling growth with over 30 tillers per plant. Yield data have not been reported but the MRC extension team shared available reports on experiences and recommendations from Madagascar and Sri Lanka with other members of the Northern Thai Sustainable Agriculture Network and the Khao Kwan Foundation in Central Thailand. The team drafted a Thai-language manual in order to facilitate local extension of SRI. The manual is based on translations of English papers from CIIFAD and from Sri Lanka. As it became obvious that local farmers were very much concerned about matters such as organic nutrient supply, alternative insect, snail and crab control methods, and weeding tools, other relevant information had to be looked for, translated and integrated in the manual.

In initial talks with staff and farmers, the general concepts were understood sufficiently; however, it became obvious that farmers are particularly concerned with water management and eradication of weeds. MRC received illustrations on hand weeders from Tefy Saina and ECHO and also located two models of IRRI-designed manual weeding tools at the Agricultural Engineering Division, which were loaned to the MRC. However, neither a local workshop nor a tool manufacturer was able to make additional sets in time.

Learning

The SRI practice requires a good understanding of the rice plant, its growing environment and its management. The production process must also be changed considerably in order to achieve the potential rice yields proposed under SRI.

Land preparation

The visual material from Madagascar revealed that land preparation is critical for the success of SRI. The land was puddled and leveled and drained before rice transplanting. This system is not commonly practiced by northern Thai farmers, who puddle the soil and flood the field. Transplanting is carried out under flooded conditions. However, the land preparation for SRI will be similar to rice production systems in the Lower North and the Central Thai regions where rice is broadcast. Such mud conditions will permit better seed-soil contact for broadcasted rice and better seedling stand in the use of SRI.

Drainage

The wet-dry water management practice requires a good drainage system. In the Chiang Mai Valley, the management of irrigation systems at field level is community- or group-based. Allocation and distribution of water at the lateral canal level are group decisions, so this would affect the working schedule if an individual farmer plans to use water differently from the other farmers. However farmers who have access to farm ponds will be able to be more independent, and to use SRI water management methods.

The rainy season with highest precipitation in August and September makes the control of any system of alternating wet-dry irrigation. All the photoperiod-sensitive varieties are at the vegetative stage during this period and when their tillering is at maximum. The commonly grown varieties, RD 6, RD 15 and KDML 105, will flower between October 21 and 26 when rainfall is receding. Therefore, SRI will require very good drainage and water control system. Highland paddy rice on terraces as practiced by the Karen would have better drainage and water control for SRI than the lowland valleys.

Young seedling and single plant per hill

After the field day in May 2001, a few farmers have accepted the principle of single plant per hill, but they are skeptical about using young, 10 to 15-day-old seedlings. The common practice of rice transplanting during the rainy season is a shared labor or exchange system. This would make transplanting single plants per hill more difficult to control. Farmers perceive that transplanting 3-4 plants per hill is easier to handle than single plants when the work is done under flooded conditions.

However, it was observed that a farmer who produces foundation seed has accepted the single-plant practice, though he still uses 25-day-old seedlings. This practice is found to be suitable for seed production, since any off-type plant can be easily rogued out. Moreover, the farmer can practice single-plant selection to obtain pure lines.

Nursery preparation

We have learned that seedling preparation works best either when rice seed was sown in line on a tray or when it was sown in line on raised beds similar to a nursery for preparing vegetable seedlings. This method of dry nursery is found to be more commonly practiced by the Karen farmers on the highland where water is limited, while lowland rice farmers are used to broadcasting seed in a prepared space near paddy fields. A large quantity of seed is used this way.

Our survey in the 2002 season in three provinces of the Upper North (Lamphang, Phayao, and Chiang Rai) showed that the average rice seed used in nurseries to prepare for transplanting 1 ha of land was 64 kg. With a single plant per hill, the amount of seed was just 10 kg, and with machine planting, the seed requirement for 1 ha of land was 44 kg.

Weed control

Weed population in rice fields reflects land use practice and plot history. Rainfed lowland rice with a single rice crop and a six-month fallow is found to have less weed population. Rainfed lowland rice farmers incorporate fallow vegetation into the soil and allow it to decompose before transplanting. In the irrigated lowland where rice-based cropping systems are common, weed infestation after dry-season cropping is more severe.

Without proper land preparation, weeds can be a serious problem in rice fields. A few farmers have used herbicides in their rice fields. However it was found that when *Sesbania* was used as a green manure crop before rice, a dense population of *Sesbania* was able to suppress weed growth. Therefore, the use of *Sesbania rostrata* for weed control and nutrient replenishment, together with proper land preparation, could reduce weed incidence.

Water management

Our results do not show convincing evidence of SRI. The first dry season trial in 2001 provided similar performance between conventional and SRI methods. Perhaps at certain stages of growth, the SRI rice plants were allowed to go through "unnecessary" drought stress. In addition, we planted several rice varieties with different maturities on the same field receiving the same water regime. All these factors could affect the realization of yield potential.

Since our SRI results were not convincing, and varied from season to season, the assessment on water management, nutrient (particularly nitrogen), and light intensity effects on different rice varieties should be carried out under proper land preparation and nursery management. At present, certain components within SRI practice have been adapted by a few farmers, namely, planting of single, younger seedlings. There will need to be better understanding and field practice of SRI, as well as more convincing yield improvements, before SRI could be disseminated.

Sustainability

Given the high productivity of over 10 t/ha reported with SRI practices in many countries, there are large amount of nutrients, particularly nitrogen, exported out of the nutrient pools. This means that the rice production system would require integrated nutrient management in order to maintain high rice yields. Therefore, SRI practice should be developed in conjunction with a nutrient replenishment system. At present it appears that the use of green manure crops in rice farming system could enhance SRI potential.

Prospects

The principles and practices of SRI are not widely spread in Thailand, but it is encouraging to see the growing interest of NGOs on the use of SRI to increase rice yield, for instance, the McKean Rehabilitation Center, the Northern Alternative Agriculture Network, the Khao Kwan Foundation in Suphanburi Province (Central Thailand), and the Catholic Commission of Thailand.

Green manure crops in rice farming systems are now being evaluated among various institutions: the MCC, farmers' organizations, local administration and extension agents, and the Land Development Department. The diffusion process of SRI could make use of the existing network through the technical support from the MCC, MRC and farmer-facilitators.

In Northern Thailand where the average farm size is small, about 0.8 ha, increasing rice yield through SRI techniques would permit farmers to diversify their land use by switching some of their land, labor, and water to non-rice production for income-generation and increasing rural employment.

Rice seed farmers who are now working with the MCC could incorporate SRI methods in their production of foundation seed on smaller plots during the dry season so that certified seed could be produced in the following rainy season.

Perhaps the most significant use of SRI would be for productivity enhancement of paddy rice in the highlands where rice deficits among ethnic communities still persist. In 2002, the MCC and the Karen community have developed pond agriculture as a way to enhance food security. Karen farmers allocate part of land for a farm pond ($15 \times 8 \times 2\ m^3$). Increasing rice productivity per unit of land is an important objective. A modified SRI practice that works under those conditions would help close the food gap in the Karen community.

A participatory approach is now being accepted by the Department of Agricultural Extension as an alternative diffusion process. Collaboration and coordination among various institutions at the local level are improving. Farmer field schools and a farmer-to-farmer learning process have been promoted. So SRI that works for different niches is important for improving rice productivity of small farmers. The successful cases from various countries not only provide information support but also inspiration for others to try.

The principles and practices of SRI pose great challenges to rice scientists and development workers. There are still a lot of missing links. The alternate wet-dry system of water management from transplanting to flowering creates physical and bio-chemical changes that can enhance the growth and development of rice plants. The period is critical for vigorous growth-maximizing tiller production and subsequent high seed yield. Understanding the processes and changes that occur during this period would help develop practices for sustainable rice production of small farmers.

Table 1. Average rice yields (kg/ha) as affected by planting young (17-day) and old (34-day) seedlings under SRI and conventional management practices, MCC, February-June 2001

	Conventional		SRI	
Varieties	17 days	34 days	17 days	34 days
1. San Patong-1	5.83	4.66	5.05	4.04
2. Hom Sakon Nakorn	4.88	4.53	4.20	4.21
3. Hom Nin	4.54	3.96	2.73	2.19
4. Hom Suphan	4.88	4.54	5.64	5.18
5. Mali Dang	5.73	6.38	4.15	4.21
Average	**5.17**	**4.81**	**4.35**	**3.97**

Table 2. Average rice yields (kg/ha) as affected by green manure crops (GMC) under SRI and conventional water management practice, MCC, August-November 2001

	Conventional [1]		SRI	
Varieties	GMC [2]	Control	GMC	Control
1. Hom Suphan	2.86	2.66	2.25	2.28
2. Hom Nin	3.74	2.73	1.94	1.70
3. Hom Sakon Nakorn	3.61	2.61	2.75	2.21
Average	**3.40**	**2.67**	**2.31**	**2.06**

[1] *Both conventional and SRI methods used young seedlings (10 days) with single plant/hill.*

[2] *The green manure crop used in Hom Suphan was* Crotalaria jancea, *and in Hom Nin and Hom Sakon Nakorn,* Sesbania rostrata

Table 3. Average yields (kg/ha) of glutinous and non-glutinous rice varieties under SRI and conventional water management practices, MCC, August-November 2001

Varieties	Conventional	SRI
Glutinous rice		
RD 6	3.87	2.52
Hom Sakon NaKorn	4.30	2.15
San Patong-1	4.46	2.27
Non-glutinous		
KDML 105	4.44	2.87
Pathum Thani-1	4.03	2.16
Hom Suphan	3.88	3.55
Average	**4.16**	**2.59**

Table 4. Average rice yield (kg/ha) from on-farm SRI trials in two districts, Chiang Mai Province, August-November 2001

Site	Variety	Conventional	SRI
Mae Taeng district			
Wichit	RD 6	5.00	3.20
Thawin	RD 6	4.25	3.60
Chumnong	KDML 105	6.00	3.55
Rien	KDML 105	5.15	2.25
Average		**5.10**	**3.15**
San Sai district			
Uthaiwan	RD 6	4.60	3.65
Subin	RD 6	5.70	2.80
Praphan	KDML 105	5.85	3.80
Uthai	KDML 105	5.70	3.00
Average		**5.36**	**3.31**
Overall mean		**5.23**	**3.23**

