

The Adoption of the System of Rice Intensification (SRI) in Tram Kak District, Takeo Province, Cambodia: The Case Study of Leading Farmers

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ABSTRACT

The objectives of this study were to determine the leading farmers' adoption and to define the farmers' problems and their suggestions.

The respondents of this study were leading farmers (first adopter of SRI), who were living in Tram Kak District, Takeo Province. Focus group method was used for collecting data and information.

Leading farmers had followed the steps of the system of rice intensification (SRI) after attending the training course which was organized by Centre d'Etude et de Développement Agricole Cambodgien (CEDAC). They utilized the trained knowledge especially in fertilizer usage, and the advantages and disadvantages of chemical and organic fertilizers. In addition, the perception of leading farmers on the SRI principles and practices was at very high adoption level, and they also disseminated knowledge, practices, and experiences to family members and other farmers both in and outside district by face-to-face, informal meeting, and group discussion methods. The rice paddy yield increased from the former average 2 tons (t) per hectare (ha) to 2.8 t/ha when farmers changed to SRI implementation. The problems found; low soil fertility, labor shortage, lack of irrigation system, drainage and water sources, lack of organic fertilizer, natural disaster, lack of diseases and pests control knowledge. Farmers were looking forward for help to ease their problems from either government or NGOs.

Key words: leading farmer, adoption, system of rice intensification (SRI)

บทคัดย่อ

การวิจัยครั้งนี้มีวัตถุประสงค์เพื่อศึกษาการยอมรับระบบการปลูกข้าวแบบปราณีต รวมถึงปัญหาและเสนอแนะของเกษตรกรผู้นำ เก็บข้อมูลโดยใช้วิธีสนทนากลุ่มย่อยกับกับเกษตรกรผู้นำที่ปลูกข้าวโดยใช้ระบบ SRI ในตำบลตรมกอก จังหวัดตาแก้ว ผลการวิจัยพบว่าเกษตรกรผู้นำได้ปฏิบัติตามขั้นตอนของระบบการปลูกข้าวแบบปราณีต หลังจากได้รับ

การฝึกอบรมจากหน่วยงาน CEDAC ได้นำความรู้มาใช้โดยเฉพาะอย่างยิ่งการใช้ปุ๋ย ประโยชน์จากการใช้ปุ๋ยอินทรีย์และปุ๋ยเคมี นอกจากนี้เกษตรกรผู้นำมีการยอมรับระบบการปลูกข้าวแบบปราณีต ในด้านหลัก การและการปฏิบัติอยู่ในระดับสูง และยังมีการถ่ายทอดความรู้ หลักการปฏิบัติและประสบการณ์ให้กับสมาชิกในครอบครัว เพื่อนบ้านทั้งในตำบลและต่างตำบล ด้วยการบอกต่อ การประชุมแบบไม่เป็นทางการ การสนทนากลุ่ม และมีผลผลิตข้าวเพิ่ม

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ขึ้นจาก 2 ตันเป็น 2.8 ตันต่อเฮกแตร์ ปัญหาที่พบคือดินไม่มีธาตุอาหาร ขาดแรงงาน ระบบชลประทาน และแหล่งน้ำ ขาดปุ๋ยอินทรีย์ ศัตรูพืชและขาดความรู้ในการจัดการศัตรูพืช และต้องการความช่วยเหลือจากทางราชการหรือหน่วยงานที่ไม่แสวงหาผลประโยชน์

INTRODUCTION

System of Rice Intensification (SRI) was originally developed in Madagascar in the 1980s. It comprises a set of individual rice management practices that can help small farmers to increase their rice yields significantly without depending on hybrid seeds, mineral fertilizers and pesticides. The SRI began promoting throughout Asia in 1997 by Norman Uphoff, a political scientist and director of the International Institute for Food, Agriculture and Development at Cornell University in Ithaca, New York, and then its ideas were introduced into Cambodia in 1999 by the director of CEDAC (Centre d'Etude et de Développement Agricole Cambodgien), a local NGO, with the first farmer-based field experimentation starting in 2000 in Kandal Province. In that year, only 28 farmers were willing to participate in the evaluation of SRI. By 2006, nearly 60,000 farmers were using SRI, and it was expected that this number would increase to be more than 80,000 farmers in 2007 (there are about 1.8 million rice farming households in Cambodia) (Koma, 2007). Due to the significant contribution of SRI to improve the livelihoods of rice farmers and the environment of the country, the Cambodian Government had officially endorsed SRI in 2005. Moreover, in 2006 the Royal Government of Cambodia has integrated SRI promotion into its National Development Plan (2006-2010).

STATEMENT OF THE PROBLEM

Rice is the main staple food for Asian people, especially for Cambodian people. Nesbitt (1997)

defined that the English phrase “to eat” is *pisa bei* in Khmer, which literally means “eat rice”. More than 90% of wet season rice cultivated areas is rainfed lowland rice. In this ecosystem, rice is cultivated on a variety of different soil types and under different rainfall intensities and patterns (Anthofer, 2004). Tram Kak is one among ten districts of Takeo Province, which have more potential for growing rice and more population than other districts. Most of people living in Tram Kak Distirct are engaged in rice production where their rice yield is very limited. Officially, the national average yield of rice is estimated to be between 1.65 and 2 tons per hectare in the wet season (MAFF 1995-2003; FAO/WFP 1999). This low productivity is to be seen as the result of many factors including lack of rice field management and cultivation technology such as: land preparation, weed management, fertilizer using, soil fertility improvement, pest management, and non-availability of quality seeds, etc. Besides, it can be noted that a number of socio-economic factors have aggravated the rural livelihood situation. In order to overcome these situations, a study needs to be conducted to answer the following questions: What are the important roles of agricultural extension to enhance farmer preference on SRI? Does SRI appropriate for farmers cultivation in Tram Kak District? Why do farmers not adopt the SRI? Why do farmers adopt only some part of SRI principles? What are the problems of farmers in adoption of SRI? What are their suggestions/recommendations to overcome the problems?

LITERATURE REVIEW

Adoption is a process of an individual mind. The degree of adoption in an individual is related to his social status based on his income, education, and occupation, the so-called “status dimension”. All individuals in a social system do not adopt an innovation at the same time. They adopt an innovation in an ordered time sequence with the “time dimension” involved in the adoption process.

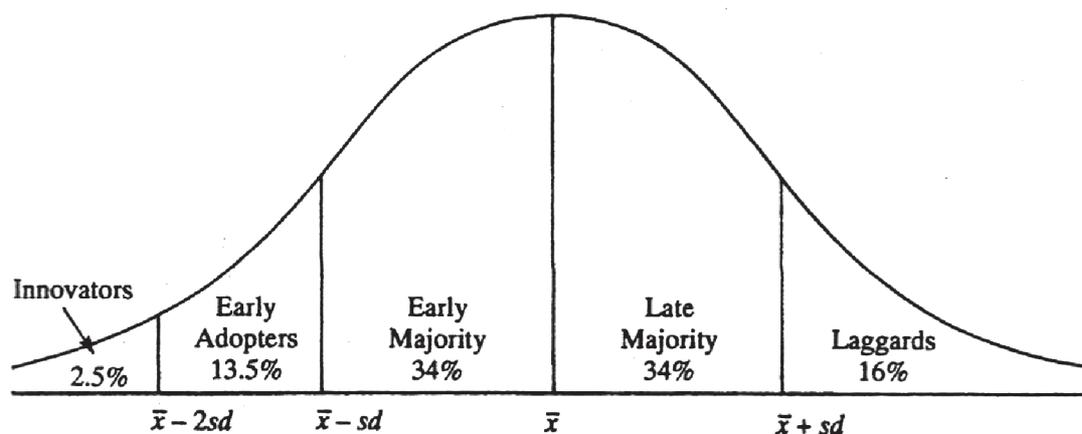


Figure 1 Adopter categorization on the basis of innovativeness

Source: Rogers, 2003

Mosher (1978) indicated that the process of the adoption of innovations composed of five successive steps: (1) awareness, (2) interest, (3) evaluation, (4) first trial, and (5) either repeated use or rejection.

Rogers (2003) reported that the rate of adoption is the relative speed with which members of a social system adopt an innovation. It is generally measured as the number of individuals who adopt a new idea in a specified period, such as a year. So the rate of adoption is a numerical indicator of the steepness of the adoption curve for an innovation.

The perceived attributes of an innovation are one important explanation of the rate of adoption of an innovation. The rate is measured by using an innovation or a system rather than an individual as a unit of analysis. Most of variance in the rate of adoption of innovations, from 49 to 87 percent, is explained by five attributes: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1995).

The criterion for adopter categorization is innovations, the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system. Innovativeness is a relative dimension, in that an individual has more or less of this variable than others in a system. Figure 1 showed the adopter categorization on the basis of innovativeness; the

innovativeness dimension, as measured by the time at which an individual adopts an innovation or innovations, is continuous. The innovativeness variable is partitioned into five adopter categories by laying off standard deviations (sd) from the average time of adoption (\bar{x}) (Rogers, 2003).

1. Innovators: Venturesome: is almost an obsession with innovators. Their interest in new ideas leads them out of a local circle of peer networks and into more cosmopolite social relationships. Being an innovator has several prerequisites. Control of substantial financial resources is helpful in absorbing the possible losses from an unprofitable innovation. The ability to understand and apply complex technical knowledge is also needed. The innovator must be able to cope with a high degree of uncertainty about an innovation at the time he or she adopts.

2. Early Adopters: Respect: is a more integrated part of the local social system than are innovators. Whereas innovators are cosmopolites, early adopters are localites. They are considered by many to be "the individual to check with" before adopting a new idea. They are generally sought by change agents as a local missionary for speeding the diffusion process. Because they are not too far ahead of the average individual in innovativeness, they serve as a role model for many other members of a

social system. They help trigger the critical mass when they adopt an innovation.

3. Early Majority: Deliberate: it adopts new ideas just before the average member of a social system. They interact frequently with their peers but seldom hold positions of opinion leadership in a social system. The early majority are one of the most numerous adopter categories, making up one third of all members of a social system. They may deliberate for some time before completely adopting a new idea. Their innovation-decision period is relatively longer than that of the innovators and the early adopters.

4. Late Majority: Skeptical: it adopts new ideas just after the average member of a social system. Like the early majority, the late majority make up 1/3 of the members of a social system. Innovations are approached with a skeptical and cautious air, and the late majority do not adopt until most others in their system have already done so. The pressure of peers is necessary to motivate adoption.

5. Laggards: Traditional: it is the last in a social system to adopt an innovation. They possess almost no opinion leadership. They are the most localite of all adopter categories in their outlook. The point of reference for the laggard is the past. Decisions are often made in terms of what has been done previously, and these individuals interact primarily with others who also have relatively traditional values.

Sudjai (1989) studied Farmers' Adoption of Rice Production Technology on Rice Promotion Project in Changwat Chachoengsao. The results revealed that 64.37 percent of the farmers adopted the technology as follows: recommended seeds, land leveling, weed control, rodent and crab control, sun-dried of paddy for 3-5 years, proper amount and time for fertilizer application, separated seed storage, proper time for harvesting. Moreover, less than 60 percent of the farmers adopted technology as follows: draining-out water before harvesting, multiplication seed plot, insect control by counting, threshing 16 percent moisture paddy, type of

fertilizer for second application, land preparation and cleaning after threshing. On the other hand, the results from hypotheses test of 160 farmers revealed that there was no difference in rice production technology adoption among the farmers who were different in education level, total annual income, size of rice production area and frequency of government official's visits. The significant suggestions of the farmers were the disease and pest resistant seed varieties and suitable for the specific area should be provided, and the recommended formula and enough quantity of fertilizer should be available in time.

In another study, Boonsong (1997) studied Some Factors Affecting Farmers Cropping Practices after Rice Planting in Rainfed Area: A Case Study of Tambon Nemsai, Amphoe Meung Trat, Changwat Trat. The findings revealed that the average of cropping practices after rice planting was 3.6 farm labors, 4.2 rai of land, and 36,938.2 baht of their income. The most media perception was television. Most of them used farm mechanic for soil preparation and they collected their own seeds for the new planting. They used both organic and chemical fertilizers and most of them had no problems about damaged pests. They graded their products before selling to the middle-man in the community and the price was specified by farmers. There was only 59.2 percent of the sample who had the most average knowledge in cropping practices after rice planting recommended technology. Furthermore, the hypothesis testing indicated that there were only the experiences in cropping practices after rice planting significantly correlated with the knowledge of cropping practices after rice planting recommended technology at the .05 level.

Moreover, Somsri (1995) studied Farmers' Adoption of Corn Production Technology Under the Hybrid Corn Promotion Project, Changwat Chumphon. The findings revealed that 65 percent of farmers adopted corn production technology. More than 78 percent of farmers adopted soil preparation, fertilizer application, seed rate per rai, and harvesting, while less than 78 percent of them adopted pest and

diseases control, herbicide application, and improving corn's quality. In addition, the hypotheses tested from 161 farmers revealing no difference in adoption of corn production technology among the farmers with different backgrounds in educational level, total income, farm sizes, and extension activity participation.

OBJECTIVES OF THE STUDY

The objectives of this study were:

1. To determine the leading farmer's adoption of SRI; and
2. To define the farmers' problems and their suggestions.

DEFINITION OF TERMS

Socio-economic status: refers to social and economic factors of rice farmers such as age, sex, educational level, type of occupation, farming experience, land holding size, number of family labor, off-farm employment, and farmer's association membership.

Leading farmer: refers to farmers living in Tram Kak District, who are the first involved with the SRI package.

Adoption: refers to farmer's acceptance, implementation, transferring, and participation in SRI package.

Knowledge/training: refers to an individual learning of the innovation's existence and gains some understanding of how it functions.

Group discussion: refers to all interested farmers getting together and organizing a group for the purpose of training and consultation in order to share experiences.

Informal meeting: refers to farmers sharing their knowledge and experience; there are free topics and can be done at any places such as temple under tree shade, farmer's house, etc.

Farmer to farmer: refers to the farmers sharing or dissemination their knowledge/experience on SRI to other farmers living in or out of the village.

Participation: refers to farmers in Tram Kak District involving in the new agricultural methodology, SRI.

Transfer: refers to the dissemination of farmer's experiences on SRI to the family members, neighbors, and other farmers.

Environment aspect: refers to paddy field management reducing the chemical load in the environment, benefiting people's health and also populations of fish, frogs, crabs, birds and beneficial invertebrates as well as the diversity of these groups.

System of Rice Intensification (SRI): refers to a methodology for increasing the productivity of irrigated rice fields by changing the management of plants, soil, water and nutrients. It comprises a set of rice management practices originally developed in the highlands of Madagascar.

METHODOLOGY

The qualitative research design was used in this study. The method for collecting data and information was focus group. The participants (asked from district agriculture official, local farmers, and local authority) attended in focus group were leading farmers (first adopter of SRI), who were living in five communes (Trepeang Thom Khang Cheung, Popel, Taphem, Otdom Soriya, and Cheang Tong) of Tram Kak District, Takeo Province. The study was conducted in October 2007.

RESULTS AND DISCUSSION

Takeo Province located in southwest of the country. The distance from Phnom Penh City was 87 kilometers (km). The province is bounded by Kandal Province in north, Kandal Province and Vietnam in east, Kompot and Kampong Speu Province in west, and Kampot Province and Vietnam in south. It consists of 10 districts. Tram Kak was a district among those, it located in the west part of the province. District distanced 12 km from the province town. Tram Kak had large potential for growing rice

farmers had their own land cultivation, but a few farmers had not enough land for cultivation so they had to tenant some land for adding their cultivation. Regarding to farm labor, it was ranged from 2 to 7 persons per family, the average of farmer labor were 3-4 persons, some family had not enough labor in cultivation they had to hire labor outside for addition, and a few families had exchanged the labor for their rice production. Referred to the farmer's association membership, all of the farmers (leading farmer/first adopter) living in Tram Kak District were members of local NGO, CEDAC (Center for Studies and Development of Cambodian Agriculture, in English, and Centre d'Etude et de Développement Agricole Cambodgien, in French), since year 2001. In addition, some farmers had participated in other associations/organizations such as: Support Program for the Agricultural Sector in Cambodia (PRASAC), Veterinaires Sans Frontieres (VSF) Agriculture Sector Development Program (ASDP), and Baksey Phnom.

Leading farmers living in Tram Kak District produced their rice production by using traditional cultivation for a long time following the practices of their ancestors. Their conventional practices were:

- Land preparation: in early of wet season, early of May, when the first rain fell, it was the time for farmers to plough their field. After that they ploughed it again to make their soil softened. Generally, farmers ploughed their land 2-3 times referred to fertile or infertile soil. At the same time they also prepared the seedling bed.

- Sowing seed: after preparing seedling bed, farmer dried seeds for one day, then put it in a small jar with water to purify the good seeds for sowing. After getting the good seeds, they soaked it for a night and incubated for 2 nights, then took it to sow in the nursery. Normally, farmers sowed seeds around 80-100 kg for transplanting in one hectare of rice field.

- Transplanting: before transplanting the seedlings, they made a level of their land by

using urea, DAP or 16-20-00, and cow dung, green or compost fertilizers for basal, and then started to transplant the seedlings (seedlings took root up from sowing bed had been incubated for 2-3 nights before transplanting). Normally, farmers put 3-5 seedlings per hill, and seedling was 25 to 30-day-old for medium and 30 to 45-day-old for long-term rice.

- Field and water management: when they finished their transplanting, farmers kept the water about 20-30 cm in their rice field for protecting the weed growing. Using urea fertilizers 40 kg/ha for first time top-dressing at tillering stage and second time at panicle initiate stage by using fertilizer the same amount as first time. Some farmers went to visit their field 2-3 times during the cultivation season, their activities such as: weeding, rehabilitated field bund, added or reduced water in the field, and destroyed rat holes, etc.

- Harvesting: farmers started to harvest when their rice maturity in 85 percent up. The average rice yield in Tram Kak District was around 2 t/ha.

Knowledge/training and extension methods

A local NGO in Cambodia, CEDAC initiated the system of rice intensification (SRI). During 2001-2002, sixty six farmers had attended the training course, which was organized and sponsored by CEDAC. The subject rose in that training course was SRI package. Before conducting the training course, CEDAC's staff went to ask head of the village in each commune such as: Po Pel, Cheang Tong, Tropeang Thom Khang Cheung, Ta Phem, and Odom Soriya (Figure 2) Commune to find and list some farmers who were interested in innovation technique. When they had the names and addresses of farmers, the CEDAC started to conduct training courses, which were held in the CEDAC head-quarter office in Tram Kak District and at some farmer's house. After the training course, all of participants were invited to visit the SRI practices in Kampong Speu Province (one of other provinces

started to cultivate SRI, and it's a province nearby Tram Kak District, too) for helping them in SRI cultivation. In the first year, the farmers did not dare to cultivate in their whole land, just tried with a small land size, only 0.05 to 0.1 ha. After they obtained a good result (yield increased), in the second year, and up to now farmers spread their land size in SRI cultivation and the number of farmers also increased.

The CEDAC staffs, government agents/ Ministry of Agriculture Forestry and Fisheries (MAFF), such as: extension workers, technical staff went to farmers' field which practiced SRI package for 4-5 times in each commune, Tram Kak District during the cultivation season for helping farmers to solve their farming problems which occurred at that time. Moreover, CEDAC staff, extension agents, as well as technical officials were also organized the short-term training, group discussions, field demonstration and shared experience about SRI with farmers. Farmers in Tram Kak District were involved with the extension program since 1995 and participated with CEDAC in 2001. Upon their participation with CEDAC and extension program, they gained a lot of benefits from the program such as increased the interaction among the farmers themselves and in the social activities as well, better thinking and confidence to make decision in their cultivation. Furthermore, farmers were able to share experiences with extension

agents in order to integrate information.

Farmer's perception in Tram Kak District was very high level in fertilizers usage, SRI principles, and practices. Regarding to SRI principle, they said, there were 12 principles as follows:

1. Leveling and water management;
2. Weeding;
3. Flooding should be avoided during the growth stage (only 5-10 cm water high laying on rice field);
4. Transplanting with wide spacing, 25cm X 25 cm;
5. Transplanting in row (from hill to hill in equal length);
6. Transplanting in shallow (1-2cm) with roots laying horizontally;
7. Transplanting 1 seedling per hill;
8. Transplanting of young seedlings, preferably 12-15 days;
9. Uprooting only strong seedlings and transplanting quickly;
10. Seedling bed should be maintained like a garden, watering intermittently and not keep submerge;
11. Using good seeds and full grains; and
12. Adding nutrients to the soil, preferably in organic forms such as compost or mulch to improve soil fertility.

Chemical fertilizers

Advantages

- Growth of seedlings were speedy and strengthen;
- Obtained good result (high yield);
- Received time benefits;
- Could be visibly result; and
- Could be available and easy to transport.

Compost fertilizers

Advantages

- Not affecting to human health;
- Increased of micro-organism,

Disadvantages

- Caused soil hardened;
- Reduced micro-organism, and population of fish, frog, crab, etc.;
- Obtained with-out tasty rice grain;
- Spent a lot of money;
- Caused environmental pollution, and lead to damage human health.

Disadvantages

- Took long time to produce;
- Growth of seedlings were slowly;

- and population of fish, frog, crab, natural enemy, etc. in the rice field;
 - Reduced of environment pollution;
 - Sustained in soil fertility and make it softened;
 - Received tasty and whitened rice grain;
 - Could be available around the house (raw materials);
 - Reached good environment and home beautifulness.
- Spent more labor, both making and transportation;
 - Transported to rice field was difficult;
 - Consisted of few amount of macro-elements.

Related to differentiate between conventional rice growing and SRI, they were indicated as follows:

- | Conventional rice | SRI |
|--|--|
| - Used in large amount of seed; | - Used in less amount of seed; |
| - Kept more water in seedling bed and sowed in thick density; | - Prepared seedling bed as vegetable garden and sowed in thin density; |
| - Transplanted both weakness and strengthen seedlings; | - Transplanted only best seedlings; |
| - Transplanted old seedlings (more than 1 month); | - Transplanted young seedling (less than 20 days); |
| - Incubated seedlings 1-2 nights before transplanting; | - Transplanted immediately after uprooting from seedling nursery (not over than 30 minutes); |
| - Transplanted unequal distance from hill to hill and tightly; | - Transplanted in line, wide and spacing hill was equal; |
| - Kept the water all the time in paddy field during transplanting and growing stage; | - Kept a thin layer of water in the field. |
| - Could be difficult for weeding; | - Could be easy for weeding; |
| - Depended on chemical fertilizer used, mostly; and | - Mixed small amount of chemical with compost fertilizers as basal and top-dress; and |
| - Average yields around 2 tons per hectare. | - Average yields around 2.8 tons per hectare. |

Furthermore, they also indicated clearly about fertilizer using, for instance: there were two kinds of fertilizers, chemical/inorganic fertilizers (urea, DAP, 15-15-15, 16-20-00, 16-16-8-13s, etc.) and organic fertilizers (cow dung, green manure, legumes, compost). Most of farmers used DAP a bag/ha and urea also, but some farmers used 16-20-00 or 16-16-8-13s as basal. While compost or cow dung was also used as a basal, mixing with chemical

fertilizers then ploughed for second time, before transplanting; Furthermore, green manure, legumes, etc. (cut in small pieces and short size) were also used as basal, and plough at the first time (first rain fall) that it would decompose at the transplanting time. On the other hand, urea was used as top-dress fertilizers which it was applied 2 times in wet season rice cultivation; the first time applied at tillering stage and the second time at panicle initiate stage.

The time for applying top-dress fertilizers was in the morning when the sun shines clearly, which let the rice leaf dry, and/or in the evening before the sun almost set. Furthermore, they didn't apply before raining time. However, farmers also indicated the advantages and disadvantages of chemical and compost fertilizers as follows:

Adoption of leading farmers in Tram Kak District on SRI package

Acceptance

In relation to acceptance of SRI package, all farmers revealed their similar ideas as that, after attended the training course and visited SRI cultivation at other provinces, leading farmers thought and decided immediately to follow the SRI package because it was a promising technique and brought farmers wealth, wisdom, and happiness. Moreover, it was our habits that wanted to know and test something strengths and innovation techniques. Most of them said that, "We really wanted the possible techniques for improvement our daily life, why we would not accept the SRI package? Even we had seen with our own eyes that SRI increased rice yield." They added that "We didn't loss anything at all, just tried with a small plot (0.05 - 0.1 ha) of our rice field at the first year, if it (SRI package) is impossible we will not cultivate it again the year after; but its result was good (yield increased) so we had to adopt it." Some farmers indicated that, we not only accepted SRI package but also got more knowledge on agricultural practices such as vegetable growing, compost fertilizer making, pest and disease control, and fish raising.

Implementation

Farmers in Tram Kak District used vary rice varieties such as Senpidor, Phaka Mlish, CAR (Cambodia Rice) 11, Neang Mlish, Neang Khmao, Neang Tey, Chhmar Prum, Kung Sor, Bey Kour, Banla Phdau, Ed Chhmouss, Srov Kro Ham, and Srov Dom Neb in SRI cultivation. The farmers had collected seeds from research stations, seft-collection,

and neighborhoods.

In relation to their rice production based on SRI, most farmers ploughed their paddy field 2-3 times referred to their fertile or infertile soil, and then leveling before transplanting. They prepared seedling nursery like a vegetable garden and divided in to small plot, then sowed rice seeds in slight density and watering two times per day (morning and evening). There were two types of farmer's experience in sowing rice seeds; there were dry and wet seedling nursery. Farmers revealed their experience that, dried seeds for one day then put it in a small jar with water and stirred it by using wood or bamboo stick to separate the good seeds (the good seeds and full grain dropped to the bottom, while haft grain and incompleted rice seeds floated on the top) for sowing. After getting the good seeds, they soaked it for a night and incubated for 2 nights, then took it to sow in the seedling nursery; in this stage they were divided in to dry and wet seedling nursery. For dry seedling nursery, they said that, put the seed on the nursery and rolled the wood stick or sugar-palm/coconut trunk to bury seed into soil, and covered it by using soil with a small amount of ashes (the way to protect from ants, in order to prevent seed in the nursery), then rolled it again and watering; a week later, seedlings emerged in 2-3 cm high. On the other hand, they sowed in slight density (about 0.5 kg/m²) seed in wet nursery with 2 cm high of water.

When seedlings reached for 15 to 20 days, farmers uproot the best seedlings from nursery and transplant to the paddy field in a shallow water dept (1-2cm); some farmers transplanted seedlings around 25 to 30 days. Most farmers transplanted a seedling per hill and 25cm X 25cm spacing, while other farmers transplanted 2-3 seedlings per hill and 20cm X 20cm spacing.

Regarding fertilizer usage, all of them mixed compost fertilizers, cow dung, green manures with chemical fertilizers such as: DAP or 16-20-00 or 16-16-813s and urea (a bag/ha) as basal fertilizers and they applied 2 times of urea as top-dressing fertilizers; the first time, applied at tillering stage and

the second time before panicle initial stage (in each stage, they used 1/2 bag/ha).

Farmers in Tram Kak District were enthusiastic with their rice production; during the cultivation season, most of them went to visit their paddy rice 5-7 times and some went to visit only 3-4 times. The farmers' activities at their paddy field were weeding, rice field bund rehabilitation, pest and disease control, destroyed rat holes and water drainage. All of farmers harvested their rice crop at 85-90% maturity, during December to January upon their early or late cultivation.

Transferring

Beside practicing the SRI package, farmers in Tram Kak District also shared and disseminated their experiences and knowledge to family members and other farmers in their village, commune, district, and outside district as well. The methods of farmers' extension were:

- Farmer to farmer: farmer disseminated her/his knowledge to other farmers when they came to visit his/her home or field, or other places.
- Informal meeting: it was done on festival days and other religion ceremonies at the temple (pagoda in Khmer literacy) in the village or commune. They shared their knowledge and experience to each other, there were free topics in the meeting due to the conversation as their wishes.
- Group discussion: it was conducted under tree shade, farmers' house, field, temple, or others. They discussed, shared and disseminated their knowledge and experiences to each other.

Environmental aspect

After following the SRI package, most leading farmers said that the population of natural enemy, fish, frog, crab, etc. in the rice field had increased from year to year. It was caused by reducing of chemical fertilizers usage and instead by applied cow dung, green manure, and compost fertilizers in the field. They also added that, human health was better than the previous practices; some

farmers said that they and family members rarely had a headache as previous; while another said that he seldom got sick and his respiration was also better than ever. Upon the advantages of SRI, all of farmers indicated that they accepted and practiced SRI forever, and had never thought to stop to do it at all.

Production output

The goal of farmers in rice production was to achieve the increase of yield and family income. The results from focus group showed that the average rice yield from fields using SRI technique was 2.8 t/ha with production cost of 400,000 riels (1 USD = 4,000 riels) while fields using conventional practices produced only 2.0 t/ha with the production cost of 500,000 riels. This information should be available to farmers when they have to make decision on rice production techniques.

From the results mentioned above, it should be clear that why leading farmers adopted SRI technique. Burton (1984) reported some characteristics of innovative people that they tend to be younger, better educated, more involved in various kinds of organization and have more production resources under their control. These characteristics seem to fit well with leading farmers in Tram Kak District which are between 30-64 years of age, are able to read with primary school, secondary school or high school education, have 15-30 years experience of farming and have participated in some organizations/ programs such as CEDAC, PRASAC, ASDP, VSF, and Baksey Phnom. Anthofer (2004) found that there were significant differences between farmers practicing SRI and farmers practicing only conventional rice cultivation. SRI farmers usually have significantly higher education level than those of non-SRI farmers.

Farmers with interest in new ideas and need/want to test new techniques usually decide to adopt SRI package after attending the first training course in TRAM KAK District which was organized and sponsored by CEDAC. SRI is a promising technique which could make farmers to become wealthy and

healthy with their wisdom. Rogers (2003) indicated that adoption is a decision to make full use of an innovation as the best course of action available. He also added that innovator's interest in new ideas often leads them out of a local circle of peer network and into more cosmopolitan social relationships. In addition, Anthofer (2004) found that farmers practicing SRI were usually innovative farmers who were willing and able to take the risk of potential crop failure when testing a new practice.

Improvement of rice productivity has been one of the objectives of any agricultural and rural development program in Cambodia. Therefore, leading farmers were encouraged and promoted to grow rice by following the SRI with technical supports from government agencies, CEDAC and other NGO's. These leading farmers will demonstrate and accelerate the dissemination of SRI achievement to other farmers.

SRI technique increases rice production through improved cultural practices on plants, water, soil and nutrient management rather than through the use of new or purchased inputs. These practices result in a sharp decrease of inputs such as seeds, chemical fertilizers and water supply which directly affect production cost. Anthofer (2004) reported that seed rate was reduced from 90 kg/ha in conventional fields to only 30 kg/ha in SRI fields. This is very critical to farmers at time when financial resources are scarce. Moreover, Tech (2004) found that spending on chemical fertilizer was reduced from 92,400 riels/ha in conventional fields to an average of 43,300 riels/ha in SRI fields which correspond to 113% reduction.

In addition, rice grain yield increased from 2 t/ha in conventional fields to 2.8 t/ha in SRI fields. The increase of 0.8 t/ha was accounted by the change of rice growing practices to SRI package. This benefit was observed over a wide range of agro-ecological environments and individual management practices.

Problems and suggestions of leading farmers regarding SRI

The study found seven important problems: low soil fertility, shortage of labor and high rates of labor, lack of irrigation system, lack of organic fertilizers, lack of technique for diseases and pests control, natural disaster, and difficult management of paddy field because of the distance from home. The leading farmers wish government and other NGOs, especially Ministry of Agriculture, Forestry and Fisheries (MAFF) promote the SRI package to other farmers in and outside district, send the technical officers to the village in order to train the farmers on agriculture field, provide easy methods to make the organic fertilizers and botanical pesticide, provide the better seeds, construct and rehabilitate the irrigation system, and find the available agriculture market.

CONCLUSION AND RECOMMENDATIONS

SRI is an important and good solution for millions of Cambodian farmers. It shows that there is a large biological potential in the rice plant that remains to be tapped. This potential can be effectively used if farmers are enabled to acquire better knowledge and skills for practices of plant, water control, soil improvement, nutrient and pest management that capture synergies between root and tiller growth which in turn lead to greater grain filling. SRI reduced input costs such as seeds and chemical fertilizers, together with an increased of farmer's gross income through high yields and an unchanged farm labor compared with conventional farming practices. SRI is a good way for improving nutrition, food security, and family income, when farmers thought SRI as not just a way to maximize rice yield, but as opening the way for them to diversify their rice-based farming system in the rainfed lowlands. However, leading farmers not only adopted the SRI package but also disseminated their

knowledge, practices, and experiences to members of family and other farmers in or outside district through face to face, informal meeting, and group discussion methods. On the other hand, both agriculture extension workers and NGOs, especially, CEDAC are playing an important role and stepping up their effort to develop and diffuse SRI throughout the Tram Kak District, Takeo Province as well as in the nationwide. The problems such as: low fertile soil, shortage of labor and high rates of labor, lack of irrigation system, drainage, and water sources, lack of organic fertilizers, natural disaster (flood and drought), and lack of technique for diseases, and pests control. Farmers were looking forward for help to ease their problems either from government or NGOs.

In order to improve the adoption of SRI technique, the recommendations should be considered as follows:

1. Up to now, researchers have ignored the potential of SRI and remain very critical of SRI, thus there need to study and research more on SRI.

2. The extension workers and researchers should contact each other in order to solve the SRI farmers' field problems as early as possible to minimize losses.

3. The technical aspects of SRI should be discussed with research institutions and, where found necessary, be modified according to new insight.

4. To ensure SRI to be widely adopted by Cambodian farmers, there is a need to let farmers having opportunities to meet and visit other SRI fields in order to let farmers decide by themselves either to follow SRI practices or not.

5. Sources of information are very important for farmer's adoption. Therefore, Department of Agricultural Extension (DAE) should be updating extension methods and mass media exposures, for instance: printed and electronic media should be evaluated and redesigned in a manner to suit farmers, and broadcasting time should be adjusted to suit farmers' convenience.

6. DAE should seek all available ways to promote and encourage non-SRI farmers to follow SRI practices.

7. NGOs, especially CEDAC should get involved in government official training because they already have several years experience on SRI.

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