CAMBODIA

Best Rice Practices in Cambodia

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Introduction

This report shows case studies on the best practices of rice farming and marketing in Cambodia. It includes the significance of the agricultural sector in the economy of Cambodia and the profile of its agricultural products.

The information in this report came from the review of published and unpublished documents of NGOs, and the Ministry of Agriculture, Forestry and Fisheries' (MAFF) annual report and survey. The study, however failed to get the suggestions and comments of more NGOs and government representatives.

Agro-Ecological Background

Geography

The Kingdom of Cambodia is located in the South-Western part of the Indochina peninsula bordering the Gulf of Thailand. It is surrounded by Thailand on the west and north, Laos on the north and Vietnam on the east and southeast. It occupies a total area of 181,035 sq. km with a land area of 176,520 sq. km. The country's capital city is Phnom Penh.

The dominant features of the Cambodian landscape are large, almost centrally located with Tonle Sap Great Lack, the Basac River and the Mekong River system crossing the country from the north to

the south. The country is divided into 24 provinces, 4 municipalities, 183 districts, 1,609 communes and 13,406 villages.

Climate

The climate in Cambodia, like the rest of Southeast Asia, is dominated by monsoon that is known as the tropical wet and dry because of their distinctly marked seasonal differences. Monsoon brings in the rainy season from mid-May to mid-September or early October. The northeast monsoon causes drier and cooler air that last from early November to March. The hot season is experienced in April and early May.

Temperatures are fairly uniform through out the Tonle Sap area with minimal variations from the average 250° Centigrade. January is the coldest month and April is the warmest. The average rainfall annually is between 100 and 150 centimeters, with the southeastern part of the country experiencing the heaviest downpour. Humidity is relatively high at night throughout the year, usually exceeding 90 percent. The average humidity at daytime during dry season is about 50 percent or slightly lower while it may reach up to about 60 percent during the rainy season.

Topography

The country can be divided into three distinctive areas:

- The Lowland regions that consist mainly of plains around the Tole Sap Great Lake Basin and Mekong, with elevations of less than 100 meters or around 20-30 meters above sea level. The Mekong River, Cambodia's largest river is around 450 km long and its tributaries mainly provide for the country's water supply.
- The Highland and mountainous regions have an average elevation of about 1500 meters. Aural, the highest mountain is 1813 meters high and located in the southwestern part of the country.
- The Costal regions are found in Kampot, Kohkong province and Shihaknouk ville.

Demographics and the Agriculture Sector

Agriculture represents a major share of 37 percent of the GDP. Productivity of agriculture production is low with US$166 for every

worker and US$480 per hectare. The GDP per capita for the rural population is US$119 that is consistent among the households across the provinces in Cambodia, except Phnom Penh.

Cambodia is still a largely agrarian society with 85 percent of the population living in the rural areas. Most of the population in the rural areas is employed in agriculture, forestry and fishery activities with 71 percent of them being self employed.

There are 1.6 million farm households and most of them are involved in rice production. The population of Cambodia in 2003 is 13.77 million. With a population growth rate of 2.5 percent and 42 percent of the population under the age of 14, there is really a need to improve the productivity of agriculture[1].

Agriculture Land Use and Rice Production

Rice is, by far, the staple food of the people and 85 percent of the total population is engaged in agriculture. Production is characterized by the rudiments of farming using traditional ways of production and high dependence on natural condition especially rain with some still lacking with draft animals.

Rice occupies 90 percent of the total agricultural area and is the major agricultural product in terms of area, volume, and income. About 2.5 million hectares were planted to rice in the 1960s. Cambodia currently cultivates approximately 2.33 million hectares according to MAFF data in 2004-2005.

Rice yield is still low due to poor agriculture methods on using seeds and fertilizers. The soils have the same sandiness, low caution exchange capacity, low pH and low level of organic matter. The average rice yield is only 1.977 tons/hectare. Wet season brings about yield of 1.72 tons/hectare and 3.53 tons/hectare during dry season. The total rice yield in 2004 was 4,170,284 tons (Table 1).

The rice ecosystems in Cambodia are divided into four major types: (1) Rainfed and lowland including areas with supplementary irrigation; (2) Rainfed upland; (3) Deepwater/floating; and (4) Dry season with irrigation. The planting seasons are during the rainy and dry seasons.

1 National Institute of Statistics 2001

Table 1: Rice Production 1998-2003

Year of Rice Production	1998	1999	2000	2001	2002	2003	2004
National Production (MT)	3.50	4.04	4.02	4.09	3.80	4.71	4.17
Average Yield of Rainfed Low land rice (in T/ha)	1.60	1.80	1.90	1.90	1.70	1.95	1.72
AverageYield of dry season rice (T/ha)	2.9	3.03	3.18	3.20	3.18	3.17	3.53
Areas devoted to rainfed lowland rice (Mha)	1.87	1.90	2.05	1.90	1.82	2.03	2.04
Areas devoted to dry season rice (Mha)	0.23	0.24	0.25	0.26	0.29	0.28	0.29

Source: Agriculture Statistics 1998-2003

Eighty percent of the total population is farmers, mainly involved in rice production. The majority of the rural poor are subsistence rice farmers with small land holdings, typically of around 1-2 hectares.

Around 3,427 tons per year of pesticides are being used as part of agricultural input costing as much as US$20 million per year. The total fertilizer used is about 250,000 tons/ year or around US$50 million.

Table 2: Rice Production Balance 2004-2005

Description	Unit	Wet Season	Dry Season	Total
Planned	Ha	2,174,000	287,600	2,461,600
Cultivated area	Ha	2,048,360	298,529	2,346,889
Destroyed area	Ha	260,027	5,098	265,125
Replanted area	Ha	27,286	-	27,286
Harvest area	Ha	1,815,619	293,221	2,108,840
Yield	T/Ha	1.725	3.539	1.978
Production	T	3,132,581	1,037,703	4,170,284

The seeds reserve in 2005 decreased by 13 percent from 2004. The post harvest losses reached 542,137 tons.

The total harvests from paddy reached 3,628,147 tons. With 64 percent recovery rate from milling, the available rice for consumption was 2,322,014 tons. The food requirement per year is 1,905,896 tons at 143 kg for 13,327,946 people. The projected surplus in rice supply is 416,118 tons and the surplus in terms of paddy is 650,184 tons.

Background of SRI in Cambodia

Rice production in Cambodia, like in many other countries in the region, dominates the agricultural sector. Rice farming provides food, income and employment for about 65 percent of the Cambodian population.

However, the average yield of rice production is comparatively lower at 1.9 tons/hectare than for example, in neighboring Thailand and Vietnam. About 80 to 85 percent of the national rice production is largely the result of only one rain-fed crop per year.

Increasing rice production in Cambodia has been an explicit goal of many development efforts from international and national projects during the last decade. The approaches to increase rice yields focused on the identification and dissemination of improved varieties, recommendation of appropriate fertilizer application and Integrated Pest Management (IPM).

The System of Rice Intensification (SRI) is a methodology to increase productivity of irrigated rice by changing the method of managing the plants, soil, water and nutrients. These practices contribute to healthier soil and plants through greater root growth and nurturing of soil microbial diversity.

SRI was developed in Madagascar. It was found as a sustainable rice farming technology that can help small farmers increase their rice yields to more than 10 tons/hectare without depending on hybrid seeds, chemical fertilizers and pesticides.

A Cambodian NGO, Centre d'Etudes et de Développement Agricole, Cambodgien (CEDAC) has gained considerable know-how on soil and nutrient management in rice production since its creation in 1997. Its director, Dr. Yang Saing Koma got the Malagasy techniques of SRI and armed with his experiences, launched the first field trials of SRI during the wet season in 2000 with 28 farmers in five provinces of the rain fed agricultural low lands of Cambodia. Now, more than 400 farmers are participating in on-farm trials in the same provinces of Kampong Cham, Prey Veng, Kampong Thom, Kandal, and Takeo.

GTZ conducted a study survey, titled, "The Potentials of System of Rice Intensification for Cambodia" in cooperation with CEDAC, OXFAM, Cambodia Agriculture Research and Develop-

ment Institute (CARDI), PADEK, MAFF and other agencies involved in promoting SRI in Cambodia. The study aims to come up with a systematic analysis of SRI experiences in Cambodia. The intention was to gain more understanding on the impact of SRI adoption, and discuss the benefits of this low cost rice intensification approach to improve the household food security in Cambodia.

Table 3: List of NGOs that applied SRI

No.	NGO/Institution	No. HHs	No. villages	No. communes	No. districts	Provinces
1	CEDAC	10838	853	139	52	Kg.Cham, Kg.Chhnang, Kg.Speu, Kandal, Takeo, Prey Veng, Svay Rieng, Kg.Thom, Rattanakiri, Pursat, Kampot
2	Aphiwat Strey (AS)	195	36	7	3	Battambang
3	Krom Akphiwat Phum (KAWP)	475	24	11	7	Battambang
4	Chamreun Chiet Khmer Organization (CCK)	83	5	3	1	Takeo
5	Mlup Beitang (MB)	25	3	2	1	Kampong Speu
6	Rural Development Association (RDA)	6	3	2	1	Battambang
7	Kumnit Thmey Organization (KNT)	6	1	1	1	Battambang
8	Village Support Group (VSG)	55	7	1	1	Battambang
9	Nak Akphiwat Sahakum (NAS)	101	11	4	2	Kampong Cham
10	National Prosperity Association (NAPA)	38	15	4	2	Kampong Speu
11	Farmer Livelihood Development (FLD)	150	17	8	2	Kandal
12	Kumar Ney Kdey Sangkheum (KNKS)	127	9	6	1	Pursat
13	Ponleu Ney Kdey Sangkum (PNKS)	128	11	2	2	Prey Veng
14	Srer Khmer Organization (SRER KHMER)	230	8	4	4	Kandal, Battambang, Banteay Meanchey, Takeo
15	Khmer Association for Development of Raising animals (KADRA)	3	2	1	1	Svay Rieng
16	Chet Thor Organization (CHET THOR)	30	4	2	1	Svay Rieng

No.	NGO/Institution	No. HHs	No. villages	No. communes	No. districts	Provinces
17	Banteay Srei Organization (BANTEAY SREI)	77	15	6	6	Battambang, Siem Reap
18	Po Thom Elder Association (PTA)	7	7	2	1	Svay Rieng
19	Sante Sena Organization (SANTE SENA)	8	3	2	1	Svay Rieng
20	Australians Caring for Refugee (AustCare)	20	4	3	1	Odor Meanchey
21	Germen Technical Cooperation (GTZ)	2900	182	55	15	Kampot, Kampong Thom
22	Catholic Relief Services (CRS)	420	35	6	3	Svay Rieng
23	Oxfam Australia (OCAA)	84	16	7	3	Takeo, Kratie, Stung Treng
24	Youth With A Mission (YWAM)	25	5	2	1	Stung Treng
25	Watanakpheap Organization (WATANAKPHEAP)	150	7	2	2	Pursat
26	Adventist Development and Relief Agency (ADRA)	60	12	2	1	Siem Reap
27	CARE Cambodia (CARE)	200	60	12	1	Prey Veng
28	Lutheran World Federation (LWF)	25	5	2	1	Kampong Speu
29	Non Timber Forest Products Project (NTFP)	60	6	3	2	Rattanakiri
30	Partnership for Development in Kampuchea (PADEK)	135	13	6	3	Siem Reap, Prey Veng, Kg.Speu
31	Provincial Department of Agriculture, Forestry and Fisheries (PDAFF)	414	10	9	4	Takeo
32	Rachana Organization (Rachana)	17	8	2	1	Takeo
Total		17092	1397	318	128	17

Source: Annual Report of the System of Rice Intensification (SRI) Secretariat 2005.

Rice Farming Systems Best Practices

Land preparation

The soil must be kept moist but well-drained and aerated, with good structure and enough organic matter to support increased biological activity. The quality and health of the soil is the key to best production.

Seedbed: the soil was a mixture of 60 to 70 percent of compost or cow manure and 30 percent of rice husk. The soil was leveled and kept moist, well drained but not saturated. 100 grams of seeds was sowed on a 5-sq.meter land or eight kgs. of seeds in a one hectare of rice field. Four to five kgs. were enough for the seedbed to produce strong seedlings. *Example suite: he prepared a seedbed of 20 sq. meters loosening the soil by digging and putting in 20 kg of cow manure. He leveled it and kept it moist but not wet. He sowed 1 kg of seeds at the end of April and found this is too much so he reduced the density of the seeds the following year.*

Field preparation: the rice field should be level after plowing and placing compost. The field was divided into several small plots if the farmers had difficulties leveling the field. Some portions of land may have lost but the total yield was actually higher because of improved distribution of nutrients and water. Small dikes were raised around the plots at 0.3 x 0.3 meters high and wide to ensure good water management. A 50-meter long dike was elevated in a day. *Example suite: his rice field was too small at 28 x 15 meters to be divided into plots and was already easy to level. The moisture was set before mixing the soil with 60 kg of cow manure. Then the field was leveled through the harrow.*

Transplanting

Following the SRI principles, transplanting occurred earlier than the traditional practice that was during the early wet season. To develop the optimum tillering potential of the seedlings, these were transplanted at a young age of 8 to 12 days old. However, farmers tried different ages of the seedlings, like 8 to 20 days because growth depended on the variety and its growing calendar. The process should not take beyond 30 minutes to avoid the drying of roots. The roots

were planted in an L shape to grow downward easily. Each seedling was transplanted one by one with a space of 25 to 50 centimeters during the rainy season, based on the richness of the soil and the cycle duration. This helped the seedling develop strong roots and numerous plants. Farmers should be able to test the soil to find out its optimal density according to its specific conditions. A half hectare of rice field would need about 24 man-days while the conventional practice requires 45 days. *Example suite: He transplanted 14 days old seedlings. He chose only the strongest ones, which represents only 1/3 of the total seedbed. These took him 1 ½ days to transplant one by one with the spacing of 30 centimeters.*

Seed selection

The variety was selected according to its adaptation to the local conditions. The objective was to produce with full grain and high germination rate that produced strong seedlings and plants. The weeds were eliminated to purify the part of the rice field that was dedicated to the seeds for the following season. *Example: one farmer in Prey Veng province experimented SRI for the first time during the wet season of 2001 in a rain-fed low-land ecosystem. He was able to keep the local variety he grew for many years with the planting cycle of about 5-and- a- half months.*

Water management

The farmer must be able to let water in and out of the field as needed. SRI field must be level so that a small amount of water will be distributed evenly. The amount of work needed to achieve this

requirement depends on the original state of the field and the farmers might not have adequate resources to achieve a level paddy field.

The farmer needs to inspect the water level daily. With traditional methods, the farmers can be away from their fields for a week or more in a given time. Daily trips to the field may be difficult for fields in the remote areas or for farmers who do not have the time to do this.

The rice field should be clear of flood water during transplantation. The soil should be moist and muddy only. This will improve soil aeration during the vegetative growth phase.

Water management is essential to ensure that the plant constantly gets good supply of nutrients and oxygen. Use of natural fertilizers must be kept at a minimal water level of 1 to 2 centimeters especially during the whole vegetative growth stage. It helps microorganisms produce nitrogen for rice and provides for oxygen.

Soil/nutrient and pest management

The farmers were developing a set of improved management practices for better soil nutrients and pest control. Most of the ideas and techniques were based on the principles and techniques of ecological soil and pest management. They were quite compatible with SRI.

Labor intensive

For many rice producers, SRI required intensive labor that gave poorer farmers an opportunity to work in fields of other farmers and earn cash to meet immediate consumption requirements. Since wages were the primary source of cash, the opportunity cost of labor was too high to justify its adoption.

However, some farmers could not afford to wait for the returns of SRI that take months to materialize. They also needed to meet the plant's nutritional requirements before rice harvest.

Marketing

Production: CEDAC has a wide production network of 20,000 farmers applying SRI practices. More than 100 traditional rice varieties existed in Cambodia and farmers were encouraged to produce their local varieties. Som Mali, jasmine rice with long white grain and flow-

ery perfume, was produced in significant quantities for existing marketing efforts. One hundred tons of Som Mali were expected to be available for commercialization in 2006. SRI farmers' groups refrained from using agrochemicals.

Process: Processing is being done at the CCRD mill in Pursat that is being certified as organic and at other large rice mills in Battambong area.

Package: Rice for the national market was packaged in bags of 25 to 50 kg. Vacuum packaging machines were accessible from the few existing food industry facilities.

Transport: CEDAC arranged the transportation around the country but was expensive due to high cost of gas. Transportation abroad was cost effective only in large quantities at a minimum of 15 tons by container through sea shipping.

Selling: CEDAC focused on establishing the local market. It has its own shop in Phnom Penh and offices in four towns outside Phnom Penh. Supermarkets existed in bigger cities. National rice fair was planned for 2006. No organic outlets are in place yet.

GTZ took care of the international market and had contacts to various traders in Holland and Germany. Export in general was extremely complicated due to lack of trade agreements and high level of corruption. For the national marketing, GTZ was selling their organic certified rice as 'New Rain Rice' together with a private investor at a supermarket in Phnom Penh.

Service: CEDAC can offer information services on organic products and SRI.

Administrative: Technical facilities were available and one person was responsible for the management of CEDAC shops.

Control Quality: CEDAC established its internal control systems together with the producer groups. No national quality standards and certification was available. International certification was expensive so none of the CEDAC producer groups were certified but GTZ has three certified producer groups.

Policy advocacy/lobbying

A working group was formed under the leadership of MAFF/ Department of Agronomy and Agricultural Land Improvement (DAALI) to encourage SRI promotion, strengthen coordination and improve the documentation of best practices and lessons learned in the implementation of SRI. This was a thematic sub-group under the umbrella of the Technical Working Group on Agriculture and Water (TWGAW). The members agreed to establish a Permanent Secretariat to support their activities.

The working group aims to:

- improve linkages and co-operation among implementing agencies, donors and policy-makers with regard to SRI at all levels;
- document and update information on SRI with regard to the experiences/best practices, lessons learned, new research results and the potential impact;
- disseminate this information among the stakeholders in Cambodia and abroad;
- promote the integration of the SRI approach in sector strategies and policies (NPRS);
- lobby for the integration of SRI in ongoing and future projects and programs and secure resources to expand the SRI activities;
- initiate and follow up research linkages among scientific research institutions, such as CARDI, DAALI and Royal University of Agriculture research centres;
- support DAALI and Department of Agricultural Extension in developing extension packets and identify training needs concept.

Success stories

A) Sour Som from Angsnoul district, Kandal province

Mr. Som has a plot of 0.4 hectares. From 1981 to 1995, he produced 200 to 480 kgs of rice depending on the climatic condition and rainfall pattern. He applied 3,600 kgs of organic fertilizers made up of cow manure, rice straw and other organic matter every year. However, he realized he was not getting his desired rice yield because of poor water and nutrient management.

In 1996, he decided to split his plot into six small plots and improve land leveling. This helped improve the water and nutrient management in his land and his production increased to 580 - 720 kgs in the same plot. All other inputs, such as seed, labour and organic manure were the same.

In 2000, he tested the principles and techniques of SRI in two of his six plots. His harvest increased further to 920 kgs. Due to the significant increase of paddy production, he decided to adopt SRI in all of his six plots.

In 2001, he converted about 15 percent of his paddy field into a pond and garden. He raised fish and grew different kinds of crops, including vegetables, fruit trees, herbs and multipurpose trees. He used a part of his rice field for other purposes to gain more income from selling other products from his fish pond and garden although he expected to get more from his rice produce as well. His rice yield from the six small plots was 1.5 tons/hectare. He also got green leaf manure from tree and shrubs growing on his rice dike.

In 2002, he applied SRI in all of his rice fields and produced 3.5 tons/hectare. He planted vegetables next to the bank of pond and rice field dike.

In 2003, he applied SRI in the total area again and his yield was 3 tons/hectare. However, his rice plants were stricken with a disease and suffered from drought. It was a good thing he also planted vegetables and fruit trees along the rice field dikes and pond bank.

Mr. Som realized his farm can provide food for his family and can generate income for his family. He was able to secure the food and health of his family and neighbors. The quality of life of his household has improved. His wife and three daughters need not worry about their employment as they can work in the farm and earn reasonable income.

Mr. Som was also able to find more time to manage his small rice mill at home. Unlike the other families in the community, he was able to send his daughters to work in the garments factory and work in construction sites in Phnom Penh.

His neighbors and even farmers and extension workers of different NGOs came to him to learn concrete experiences of ecological agriculture and farmer group mobilization.

In 2001	- Seed : 3 kgs - Labour : 40 days - Compost and cow manure : 3,600 kgs - Applied some cow urine at the tillering stage - Fence: 1,000,000 riels: (US$250) (CEDAC Loan: 400,000 riel, Own investment: 600,000) - Labor for digging pond: 160,000 riels	Total rice production: 1.5 tons Yield on SRI plot: 4 tons/hectare Gross Income from selling vegetable was about 500,000 riel or about US$130 (excluding family's food consumption)
In 2002	- Seed : 3 kgs - Labour : 40 days - Compost and cow manure : 3,600 kgs - Applied some cow urine at the tillering stage - Vegetable seed: 15,000 riels	- Rice yield : 3.5 tons/hectare (Total rice production: 1.4 tons) - Income from vegetables: 420,000 riels - Vegetables for family consumption
In 2003	- Seed : 3 kgs - Labour : 40 days - Compost and cow manure : 3,600 kgs - Applied some cow urine at the tillering stage - Vegetable seed: 15,000 riels	- Rice yield : 3 tons/hectare (Total rice production: 1.2 tons) - Income from vegetables: 540,000 riels - Vegetables for family consumption
In 2004	- Seed : 2.5 kgs - Labour : 35 days - Compost and cow manure : 2,000 kgs - Applied some cow urine at the tillering stage - Vegetable seed: 15,000 riels	- Rice yield : 2.62 tons/hectare (Total rice production: 1.02 tons) - Income from vegetables: 500,000 riels - Vegetables for family consumption
In 2005	- Seed : 3 kgs - Labour : 35 days - Compost and cow manure : 1,800 kgs - Applied some cow urine at the tillering stage - Vegetable seed: 15,000 riels	- Rice yield : 3.1 tons/hectare (Total rice production: 1.2 tons) - Income from vegetables: 600,000 riels - Vegetables for family consumption

Note: 1$ = 4,000 riels

Period	
1981-1995	-
1996-1999	-
In 2000	-

(Continued

B) Case of farmer, Oeur Sorphorn in Steung Sen district, Kampong Thom province

Mr. Eur Sophorn is a 55 years old farmer who lives in Pagnachi village, Tboung Krapeu commune, Stung Sen district, Kompong Thom province. He has five members in his family. His main occupation is growing rice and other crops such as vegetables and fruit, and pig raising. His wife is a small-scale grocery seller.

Before converting to SRI, his rice production was not enough to support his family. His conventional rice production yield was between 1.2 and 1.6 ton per hectare. Furthermore, he used to spend more money on external inputs for rice production.

He attended the CEDAC SRI training in 1999. He applied SRI principles in an area of 0.37 hectares in 2000. In 2001 and 2002, the area under SRI production was 0.34 hectares. He used the zero tillage method on 0.043 hectares resulting in a rice yield of 187 kgs or 4.34 ton per hectare in 2002.

He applied the following zero tillage techniques:

- Seed: He used the Phkar Rochek seed variety that was an old variety. He used a total of 1.2 kgs of rice seeds. He selected the good seeds before sowing by placing these seeds in water, stirred and removed the floating seeds. He then soaked the remaining seeds in water for one night. Then, he removed the seeds from the water and stored these in a damp condition for an additional night.
- Seedbed preparation: He prepared the rice seedling seedbed in the same way as he would prepare a cabbage seedbed. After sowing, he spread natural fertilizers on the seeds and covered these with coconut leaf to protect the root of the seedling from sunlight.
- Land preparation: First, he cut the previous season's stubble and grass from the rice field and leveled the soil. Then he dug small ditches through the entire stretch of the field at around 4 meters between ditches. Following this, he gathered stubble, grass, banana leaf, coconut leaf, straw, animal manure and ash to cover the soil to increase soil fertility. After having prepared the soil cover, he filled it with water for 7 days.

- Transplanting: He drained the rice field with water until the soil was moist. When the seedling was 15 days old, he began uprooting it carefully. The seedlings were transplanted shallowly into rows in the rice field, using a string as a guide. He transplanted the seedlings keeping a distance of 30 centimeters per seedling.
- Caring: After transplanting, he added water to the rice field to wash the insects away and drained the field again. The soil's moist condition remained for 7 days, after which time the field was flooded for 4 to 5 days. The field was then drained and the cycle repeated. Flooding the field prevented the grass from growing. The average tillage was 25 stems per hill with a maximum of 35 stems and a minimum 15 stems per hill. All stems produced panicles.

Lesson learned and recommendations after applying zero tillerage for two years:

- Local variety seeds were better because these were resistant to local diseases and grow faster.
- After harvesting, the stubble covering the soil should be cut.
- Add leaf, manure and other elements to the rice field. Cover the soil by growing green manure.
- Maintain the soil cover for the whole season to protect its fertility from sunlight.
- Prepare the soil before transplanting by reorganizing the soil covering and adding more green manure to loosen it.

- Following transplanting, water should be kept in the field if the seedlings are young to protect these from insects. However, the soil should be kept moist when planted older seedlings.
- The water cycle idea of 7-day-moist, 4-5-day-flood was effective.

Farmer's impression

The implementation of zero tillerage required less labor and time than conventional rice production. It resulted to faster growing and more rice plant stems per hill, less prone to diseases, weeds and insects, maintained good soil fertility, and less vulnerable to sunlight because the soil was covered. He decided to implement zero tillerage over all his rice field area the following season.

Conclusion and recommendations

Generally, SRI led to more benefits for the farmers and improved their livelihood. The plots where SRI was applied slowly increased every season because it required lesser cost but produced higher yield. The gross income margin increased despite drought, flood, and other natural disasters.

Moreover, SRI can reduce the use of labor, chemical fertilizer and pesticide, and the quality of rice produced was safe for the health. SRI is also a step toward developing the farmer's orientation and attitudes and eventually, the community. SRI is a suitable technique for farmers to improve their livelihood system and conserve natural resources.

Most of the expenditures such as chemical fertilizers, labor and water can be reduced. Farmers should be encouraged to use natural fertilizer and dig a small canal around the field for better water management. Farmers can also utilize a part of their rice field area for other purpose crops.

The SRI techniques that were quickly adopted by cooperating farmers were one-by-one transplanting using young seedlings, natural fertilizer use, weeding and soil loosening, large space for transplanting, seed selection, and land leveling. On the other hand, some farmers did not take on the other SRI techniques, such as transplanting in rows and transplanting just 2 to 3 seedlings per hill.

The farmers also faced certain problems with SRI practice, such as flooding, drought, insects and diseases, weeds and lack of natural fertilizer. Some of their rice fields were also located in remote areas so they could not go to their field as often as possible to strictly follow the procedure. The farmers complained difficulty in applying SRI because of lack of water management facilities. Many fields did not have access and control of the water supply.

SRI Principles and Practices Recommended by CEDAC

The list of good practices in rice cultivation that was recommended to farmers can be summarized as follows:

Improved seed and seedling management practices

- Select full-sized grain seeds for sowing and planting.
- Prepare a raised-bed nursery, similar to vegetable bed.
- Sow lower density of seeds to ensure these are strong.
- Select only strong seedlings for transplanting.

Improved methods of uprooting and transplanting

- Uproot the seedlings gently and carefully to avoid damage to the plants and roots.
- Transplant quickly, after 15-30 minutes, if possible, after uprooting.
- Transplant carefully and with shallow rooting.
- Transplant fewer seedlings per clump, preferably one seedling pre clump.
- Transplant younger seedlings, preferably 8-12 days or less than 15 days old.
- Wide spacing and transplanting in square pattern.

Improved methods in water control

- The field should not be flooded or only with minimal standing water during transplanting.
- Avoid permanent flooding of the rice field during the vegetative stage; preferably with minimal water only, just enough to meet the needs of the plant so the roots will grow deeper.

Improving method of weeding

- Early and frequent weeding; preferably, the first weeding should be around 8-10 days after transplanting at 4 times a day
- Use a rotary weeder or similar tool to ensure that soil is loosened.

Improved methods in soil fertility and nutrient management

- Application of compost should be around 3-5 tons per hectare, preferably.
- Use rice straw, rice stubble and rice husk for soil improvement, returning to the soil what was harvested from it
- Grow green manure and cover the soil before and after rice harvest

CEDAC also encouraged diversification of zero-tillerage rice technology to include duck raising, fish growing as natural elements of the rice field's ecological system and part of rice intensification program.

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