Food Security and Nutrition Policy Support Project (FSNPSP)

Rural Development Program Kampot & Kampong Thom (RDP)

Potential of the System of Rice Intensification (SRI) for Cambodia

CONSULTANCY REPORT

by

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List of Abbreviations and Acronyms

ADRA	Adventist Development and Relief Agency
are	100 square meters
CAAEP	Cambodian Australian Agricultural Extension Project
CARD	Council of Agriculture and Rural Development
CARDI	Cambodian Agricultural Research and Development Institute
CARE	CARE- Cambodia
CBRDP	Community-Based Rural Development Project
CCK	Chamreun Chiet Khmer Organization (a local NGO)
CEDAC	Centre d'Etude et de Développement Agricole Cambodgien
CIIFAD	Cornell International Institute for Food, Agriculture and Development
cm	centimeter
CO	Christian Outrage
CRS	Catholic Relief Services
CSD	Council for Social Development
DAALI	Department of Agronomy and Agricultural and Land Improvement
DAP	Di-ammonium phosphate (fertilizer)
DED	Deutscher Entwicklungsdienst (German Development Service)
DOT	District Outreach Team
FA	Farmer association
FAO	Food and Agriculture Organisation
FSF	National Food Security Forum
FSN	Food security and nutrition
FSNPSP	Food Security and Nutrition Policy Support Project
GB	Great Britain
GRET	Group de Recherche et d'Echanges Technologiques
GTZ	Gesellschaft für Technische Zusammenarbeit (German Technical Cooperation)
h	hour
ha	hectare
ha^{-1}	per hectare
IFAD	International Fund for Agricultural Development
IFSP	Integrated Food Security Program
IO	International Organization
IPM	Integrated Pest Management
K	Potassium
KCC	Key Consultants Cambodia
KF	key farmer
km	kilometer
kg	kilogram
LEISA	Low External Input and Sustainable Agriculture

MAFF	Ministry of Agriculture, Forestry and Fisheries
man-day^{-1}	per man-day
Mio.	millions
min	minutes
MPF	Multi purpose farm
MRD	Ministry of Rural Development
N	Nitrogen
NAS	Nak Akphivath Sahakum (a local NGO)
NGO	Non Government Organisation
NPK	Nitrogen, Phosphorus, Potassium (compound fertilizer)
P	Phosphorus
PADEK	Partnership for Development in Kampuchea
PDAFF	Provincial Department of Agriculture, Forestry and Fisheries
PDP	Provincial Development Program
PTST	Provincial Technical Support Team
PRASAC	Support Programme for the Agricultural Sector in Cambodia
RDP	Rural Development Program
SED	Standard error of the difference
SRI	System of rice intensification
t	metric tonnes
TA	Technical Advisor
TOR	Terms of References
VSF	Veterinaires Sans Frontieres
WFP	World Food Program

I Executive Summary

1 The concept of SRI

The system of rice intensification (SRI) was developed in the highlands of Madagascar to increase yields and income. It comprises a set of management practices which are expected to be applied in a flexible manner. The underlying principles are:

- Rice is not an aquatic plant;
- Rice seedlings loose much of their growth potential if transplanted more than 15 days after emergence;
- The transplanting shock from uprooting the seedlings in the nursery to transplanting in the field should be minimized;
- Wide plant spacing leads to enhanced root growth and accompanying tillering;
- Soil aeration and organic matter creates beneficial conditions for plant root growth and subsequent plant vigor and health.

These principles are transferred into a set of practices which should be applied to local conditions and environments:

- Transplanting of young seedlings, preferably 8-12 days old and not older than 15 days;
- Selection of only strong seedlings for transplanting;
- Transplanting the seedlings after uprooting without delay, preferably within 30 min;
- Seedbed at transplanting should be moist but not flooded;
- Shallow transplanting depth, preferably 1-2 cm deep in the soil;
- Transplanting of 1-2 seedlings per hill;
- Wider spacing with 25x25 cm to 50x50 cm apart;
- Planting in square pattern or at least in rows to facilitate weeding;
- Alternate flooding and drying of the field during vegetative growth;
- Early and frequent mechanical weeding to control weeds and to aerate the soil;
- Add nutrients to the soil, preferably in organic form such as compost or mulch.

From Madagascar yield increases of 50-100% have been reported without the need of additional external inputs. These encouraging results have prompted CEDAC, a Cambodian NGO, to include SRI as an option for farmers to increase rice production and income.

Introduced to the first farmers in 2000 in Kandal province, SRI was soon adopted by an increasing number of farmers. Moreover, SRI was also perceived by an increasing number of government and NGO projects as a promising low cost approach to increase rice yields and farmers' incomes. On the contrary, efforts to increase rice production through conventional technologies like improved seeds and mineral fertilizer often rely on subsidies and sustainability is questionable. Up to now, national rice production in Cambodia averages between 1.6 and 2.0 t ha^{-1}.

2 Training and applied practices

Farmers practicing SRI were found to have a better resource endowment than other farmers. They were better educated, more organized in farmer associations and had more land for rice production. Since SRI has been introduced only relatively recently, it is not surprising that more innovative farmers with adequate resources to cover for the potential risk associated with a new technology have taken the lead to experiment with SRI. However, in the future poorer farming households might be specifically addressed by purposely identifying them to serve as farmer promoters/key farmers.

Most farmers received their information about SRI through training events (75%). Cross visits and field demonstrations were usually part of the training program. On average, training comprised 5 sessions. In addition, 3-4 follow up visits were conducted to 60% of the SRI farmers. Experience of the implementing projects show that it is beneficial to place the training events close ahead of the rice planting season to convince more farmers to start the experimenting process. Due to the many unusual management practices of SRI compared to conventional rice cultivation, it is difficult to convince farmers to start with it even after cross visits. It was concluded that SRI requires an intensive training and dissemination process with a high demand for human and financial resources.

3 Application of SRI practices

Many farmers applying SRI followed to a large degree the recommended management practices. The seed rate was reduced from 90 kg ha^{-1} with conventional practice to only 30 kg ha^{-1} applying SRI which is particularly important because the farmer can save input costs at a time when financial resources are scarce.

Furthermore, on average with SRI 17 day old seedlings were transplanted within three hours, planting density was significantly reduced and only one to two seedlings were transplanted at a much wider spacing (26 cm).

SRI components which were not (or could not) be applied by a substantial proportion of SRI farmers were row planting, the alternation between flooding and drying during the vegetative period of the rice crop and timely and frequent weeding.

Practicing SRI was connected to a sharp reduction of mineral fertilizers. Large differences in the use of fertilizers for conventional rice cultivation were observed among the provinces. Relatively high application rates were found in Kampot, Takeo and Prey Veng. The reduction of mineral fertilizers was compensated by an increased use of compost. Most farmers have used animal manure also for conventional practices but with the use of SRI, animal manure is now converted to higher quality compost. On the other hand, green manures are hardly used by farmers despite being promoted by the projects, because of social economic constraints.

4 Impact at field level

Over a wide range of farming environments and years, rice grain yields increased from 1629 kg ha^{-1} with conventional practices to 2289 kg ha^{-1} with SRI, an increase of 660 kg ha^{-1} or 41%. This trend of considerably higher yields when changing from conventional practice to SRI under farmers' management was consistent when analyzing the data separately for different provinces and years. Therefore, regardless of the province and year average grain yields obtained with SRI clearly outperformed the conventional practices. Improved seeds seem to respond better to SRI than local varieties.

Adaptability analyses conducted separately for each province revealed that highest yield increases can be expected under favorable environmental conditions. Such conditions are met where soil fertility is higher, rainfall is sufficient and well distributed, the risk of crop losses due to flooding or drought is minimal and crop management is sufficiently good. Conversely, the potential of SRI to increase yields in poor environments is rather low. These findings were confirmed by the farmers' choices of fields to apply SRI. SRI fields were usually located closer to the homestead and assessed by farmers to be of higher soil quality.

SRI has been introduced to Cambodia only recently. Hence, long-term yield trends are not available so far. However, at least in the medium term, the achieved yields have not declined. Farmers applying SRI for three consecutive years were able to maintain the increased yield level. Although a partial nutrient balance for N and P was found to be positive for both rice systems, it is strongly recommended to establish long-term trials to monitor changes in nutrient stocks over time with appropriate methods.

The overall labor balance for required family labor over the whole season of rice production was neutral. SRI required the same amount of labor as conventional practices. The need for hired labor, especially during uprooting and transplanting, was significantly reduced but at a fairly low level. While the labor demand for weeding and compost preparation increased, the required labor for uprooting and transplanting was significantly reduced when applying SRI. The period for uprooting and transplanting rice seedlings is the major labor bottleneck in rice cultivation. SRI effectively contributes to break that labor peak. Moreover, female household members are the main actors during uprooting and transplanting. Hence, the shift in labor allocation through SRI particularly benefits female household members.

Only 40% of the farmers applying conventional management practices weed their rice fields and weeding is done rather late. In contrast, 93% of the SRI fields were weeded at least once and the first weeding was performed on average 19 days after transplanting. In some locations where weeding is not part of the common management practice, farmers seek off-farm employment after transplanting and leave their farm. For such farmers, the additional weeding requirement when practicing SRI might pose an adoption constraint due to high opportunity costs.

Gross margin calculations revealed a clear advantage of SRI over conventional practices. On average, gross margins increased from 120 US \$ ha^{-1} to 209 US \$ ha^{-1}, an increase of 89 US \$ ha^{-1} (+74%). The economic marginal difference is equivalent to 890 kg ha^{-1}. Two factors contributed to the large difference. Farmers saved 23 US \$ ha^{-1} for variable costs like seeds and mineral fertilizers and SRI substantially increased rice yields leading to an increased gross benefit by 66 US \$ ha^{-1}. The economic risk not to achieve the same gross margin ha^{-1} was also lower for SRI than for conventional practices. SRI also increased labor productivity. While the gross margin man-day^{-1} for conventional practice was only 1.6 US \$, for SRI it was 2.5 US \$.

5 Impact at household and national level

Where the rice area cultivated under SRI was sufficiently large, food security of the respective farming households improved. Applied on 30 are and above, SRI significantly reduced the number of months households were deficient in rice supply. When SRI was applied for the first time, the area under SRI was 28 are, representing 21% of the total farm. Farmers with more experience with SRI applied SRI on 66 are or

42% of the total rice area. As many as 17% of all SRI farmers had converted the total rice area to SRI. These figures alone document that SRI works well at least for a substantial part of farmers.

For farming households using SRI for the first time, the surplus produced with SRI was equivalent to the household's needs for rice for 2.2 months. For the more experienced farmers the rice surplus from SRI was equivalent to the household's need for as much as 4.6 months. Hence, SRI significantly contributes to rice self-sufficiency.

SRI requires the use of only very young seedlings and the required weeding after transplanting is recommended to be done early. However, single headed households, households with elderly farmers without children and very large farms would not have the necessary labor force to weed early. If applied on all of their rice area, the weed competition would presumably wipe out the possible gains. In these cases, hired labor is required to practice SRI but then SRI could no longer be considered a low external input technology. Hence, only a proportion of the total production area of households should be expected to be cultivated with SRI.

According to CEDAC, the number of SRI farmers reached more than 9,000 in 2003 and they expect up to 50,000 for 2004. Such high estimates still need to be confirmed by adoption surveys using standard randomized sampling procedures. Despite these uncertainties, the economic potential at the national level even with low adoption rates is substantial. For instance, an adoption rate of 10% of experienced SRI farmers who apply SRI on 42% of their rice area would account for an annual benefit of 36 Mio. US $. Such benefits are high enough to justify additional costs for training in SRI within the agricultural extension system.

6 Recommendations

- ❑ **Despite certain knowledge gaps on SRI, it is a worthwhile option to be considered for agricultural extension on a larger scale.**
- ❑ **A more participatory approach of extension-farmer interaction is required with the need of intensive training of staff. (Positions for subject matter specialists on the technical side of SRI and for the participatory extension approach should be put in place).**
- ❑ **The enthusiasm created among farmers when applying SRI should be utilized as an entry point for further development interventions.**
- ❑ **Researchers and practitioners should learn from each other. Both sides have their role to play, and with combined efforts a deeper understanding of SRI is possible.**
- ❑ **The existing SRI task force should be further institutionalized (embracing MAFF, CARDI, CARD, IOs and donors supporting agriculture as well as NGOs) and coordinate the process to promote SRI in Cambodia**

II Introduction

1 Rice production and food security

Rice is the main staple food and rice farming provides income and employment opportunity for around 65% of Cambodia's population[1]. Rice is also the most important crop with regard to food security. FAO (1994) estimated that rice supplies 75% of the food intake on average, with per capita consumption needs estimated at 151 kilograms of white rice or 250 kg of paddy (=1.4 tons per average household per year). Although food security has been achieved at the national level the rural population still depends to a large degree on rice production. Raising rice yields and income might offer opportunities for the farmers in the long run to diversify farm enterprises to produce other more valuable crops. 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, and FAO/WFP 1999). This is relatively low compared with other countries in the region.

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. Only about 13% of Cambodia's rice growing area is irrigated or supplementary irrigated during the dry season. Dry season rice is generally sown in November and harvested in April.

Some of the constraints to rice production are short droughts and flooding. While the major rains occur between May and the second week of November, mini-droughts often occur during these months for three weeks or more. Crops affected by drought suffer badly without supplementary irrigation (NESBIT, 1997). Heavy rains during September and October are essential for a good rice crop. They flood the fields to a level that kills weeds but allows the rice to flower and to set seeds. Too much rain causes flooding in the lower fields and too little results in the crop running out of water before grain maturity (NESBIT, 1997).

Improvement of rice productivity is one of the main objectives of any agriculture and rural development program in Cambodia. In the last decades the Royal Government of Cambodia, NGOs and IOs have implemented agriculture productivity improvement programs with different approaches and strategies to increase rice yields of small farmers, which are expected to improve food security, increase rural incomes, and reduce the vulnerability of rural households. Fertilizer split application and the introduction of improved high-yielding varieties as well as integrated pest management (IPM) were promoted on a large scale. However, the environmental sustainability and the economic viability of high input approaches for poor farmers are still questionable especially taking into consideration that rice production on a national scale has not yet been able to increase yields beyond 2 tons per ha.

2 Introduction of SRI in Cambodia

The **System of Rice Intensification (SRI)** was originally developed in Madagascar. 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 underlying principles are:

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[1] About 85% of Cambodia's 12 million people live in rural areas, and about two-thirds of this rural population depend mainly on rice farming.

- ❑ Rice is not an aquatic plant;
- ❑ Rice seedlings loose much of their growth potential if transplanted more than 15 days after emergence;
- ❑ The transplanting shock from uprooting the seedlings in the nursery to transplanting in the field should be minimized;
- ❑ Wide plant spacing leads to enhanced root growth and accompanying tillering;
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These principles are transferred into a set of practices which are to be expected to be applied to local conditions and environments:

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- ❑ Shallow transplanting depth, preferably 1-2 cm deep in the soil;
- ❑ Transplanting of 1-2 seedlings per hill;
- ❑ Wider spacing with 25x25 cm to 50x50 cm apart;
- ❑ Planting in square pattern or at least in rows to facilitate weeding;
- ❑ Alternate flooding and drying of the field during vegetative growth;
- ❑ Early and frequent mechanical weeding to control weeds and to aerate the soil;
- ❑ Add nutrients to the soil, preferably in organic form such as compost or mulch.

From Madagascar yield increases of 50-100% have been reported without the need of additional external inputs. These encouraging results have prompted CEDAC, a Cambodian NGO, to include SRI as an option for farmers to increase rice production and income.

Although some of the techniques and principles of SRI have been already known to Cambodian farmers, there were no experiences in growing rice by systematically combining or integrating the crop cultivation techniques described by SRI. It is important that SRI is perceived as a set of practices which can be applied flexibly rather than as one technological package.

Introduced to the first farmers in 2000 in Kandal province by CEDAC, SRI was soon adopted by an increasing number of farmers. Moreover, SRI was also perceived by an increasing number of government and NGO projects as a promising method to increase rice yields and farmers' incomes. With the assistance of CEDAC, Oxfam GB and Oxfam America, GTZ-CBRDP in Kampot and Kampong Thom, PRASAC in Kampong Chhnang, Takeo, Kampong Speu, Prey Veng and Svay Rieng Provinces, and several NGOs (Aphiwat Satrey, ADRA, Krom Aphiwat Phum, CCK, Chethor, NAS) in other provinces have included the SRI approach in their programs.

According to estimates made by CEDAC, approximately 2600 farmers were applying SRI elements in 2002. In 2003, an estimated 10,000 farmers use SRI elements.

First results with SRI indicate that it might be a promising approach towards an environmental-friendly intensification of rice production in Cambodia. Especially for small farmers with limited land endowment and little capital to invest in agricultural inputs it may be a valuable option. First on-farm data of the projects suggest yield increases of about 150% compared to conventional practices. However, the specific enabling and constraining factors for achieving these impacts, the economic net returns, and the feasibility of implementing this strategy for poor farmers on a broad scale in order to reduce household vulnerabilities and increasing food security are not well known. Although the use of SRI by rice farmers has been supported by relevant line ministries at the provincial level, the approach is little known at the national level and has not found its way into policy documents and strategies.

3 Objective of the study

In order to facilitate the systematic analysis of experiences with SRI in Cambodia, GTZ (FSNPSP and CBRDP) in cooperation with CEDAC organized a consultancy mission in early 2004. The Council of Agriculture and Rural Development (CARD), a coordination structure for agriculture and rural development in Cambodia within the Council of Ministers, welcomed this evaluation research and expressed its interest to discuss the outcome of the mission under the umbrella of the National Food Security Forum (FSF) in the framework of a national workshop on SRI The findings of the mission should also find their way into sector policy discussions at the national level (MAFF, CARDI and MRD respectively). The main stakeholders of the consultancy mission were:

(1) Food Security and Nutrition Policy Support Project (FSNPSP)

The GTZ -supported Food Security and Nutrition Policy Support Project (FSNPSP) an advisory project on food security in Cambodia is based at the national level within the Ministry of Planning that supports the implementation of the Nutrition Investment Plan and the National Poverty Reduction Strategy of Cambodia. It also co-operates closely with relevant line ministries and CARD.

The project pursues an advisory approach to assist partners in government departments, NGOs, and international organizations in the development and implementation of ecologically, economically, and socially appropriate policies and strategies to improve the food security situation. Capacity building, networking, knowledge- and information management with regard to FSN are key activities of the project.

(2) Community-Based Rural Development Project (CBRDP)

The Community-Based Rural Development Project (CBRDP), operating in Kampong Thom and Kampot provinces, originated from the earlier GTZ supported Provincial Development Program (PDP), Kampong Thom province and the Integrated Food Security Project (IFSP), Kampot province. The CBRDP is jointly financed by a loan from the International Fund for Agricultural Development (IFAD), a contribution from the World Food Program (WFP) and supported by the German Development Cooperation (GTZ) and the German Development Service (DED) through the Rural Development Program (RDP) and AusAid through the Cambodian Australian Agricultural Extension Project (CAAEP) and the Royal Government of Cambodia.

Both earlier GTZ-supported projects had a strong agricultural support component and partly differing agricultural extension approaches. The CBRDP teams in

Kampot and Kampong Thom today basically continue with their earlier extension approaches, adjusted to the CBRDP framework. In both provinces, the use of improved rice varieties and the use of mineral fertilizer in split applications are promoted. Since 2000, after project staff had been trained by CEDAC, SRI is also promoted in Kampong Thom as a further technical option in rice production. Since 2003, SRI is also applied by farmers in Kampot.

(3) CEDAC

Centre d'Etude et de Développement Agricole Cambodgien (CEDAC) is a Cambodian NGO founded in 1997 with initial assistance from GRET, a French NGO. Since its establishment, CEDAC has been working with farmers and other organizations in Cambodia to develop and disseminate innovations in ecological agriculture. The priority has been the improvement of rice-based farming systems in rainfed lowland areas. CEDAC has been working on rice intensification since 1998 with a focus on soil improvement and related nutrient management practices.

CEDAC received the first information about SRI through a publication in the LEISA newsletter in December 1999 (RABENANDRASANA, 1999). In 2000, additional information was provided by CIIFAD (UPHOFF, 1999; UPHOFF, 2000). During the wet season 2000, SRI was included into the sustainable rice intensification program and applied by the first farmers after receiving training on its principles and practices. Since then CEDAC has taken the lead in promoting SRI in Cambodia. All other projects and organizations promoting SRI received their training on SRI by CEDAC.

(4) Department of Agronomy and Agricultural Land Improvement (DAALI) within the Ministry of Agriculture, Forestry and Fisheries (MAFF)

DAALI is one of the technical departments of the Ministry of Agriculture, Forestry and Fisheries, which deals mainly with farming systems, seed production and management, soil management, integrated pest management (IPM), crop protection as well as technology transfer amongst others. Under DAALI there are research stations, agricultural development centers and state farms which play a key role not only as experimental sites for new technologies but also as seed producing sites.

Being a governmental institution focusing on technical innovations in agriculture, DAALI has welcomed this study and also seconded one staff as a co-consultant in order to gain a deeper understanding of SRI.

The involvement of DAALI as a key stakeholder in the research was crucial to make this new concept better known at the national level, to improve linkages with agricultural research and extension and to ensure the further promotion of this approach.

The **consultancy mission had the following overall objectives**:

- ❑ The potential of SRI methods are systematically assessed and analyzed with regard to the economic and social feasibility as a sustainable strategy for enhancing food security and reducing poverty among Cambodian farming households.
- ❑ Policy and decision makers at the national level are aware of the potential and constraints of the SRI approach
- ❑ First discussions on integration of SRI in sector policies and national strategies and widespread implementation take place.

Based on the objectives the following outputs were expected:

- ❑ Experiences/documents with SRI in the sub-region are reviewed;
- ❑ An inventory with regard to SRI practices in Cambodia, analyzing success and failure in implementing SRI with special consideration of socio-economic and agro-geological factors, is available;
- ❑ The socio-economic feasibility/viability for implementing SRI elements in Cambodian context for different types of farm households is assessed;
- ❑ Recommendations on the suitability of different SRI elements considering its impacts on rural livelihoods and improved food security are analyzed;
- ❑ Recommendations on the feasibility of SRI elements under different agro-ecological conditions (soils, climate, etc.) are available;
- ❑ "Best practices and lessons learned" with regard to disseminating SRI concepts to the stakeholders at national level, as well as to farmers, are analyzed.

Preliminary findings of the consultancy mission were presented during a national workshop on 8 April 2004 in Phnom Penh. The output of that workshop is documented in a separate report.

Plate 1. Farmer group discussion held in Kandal province conducted by the two co-consultants.

III Methodology

The study was conducted by a consultancy team comprising three consultants

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- **Kosal Oum**, MAFF, co-consultant, e-mail: **kosaloum@yahoo.com**

and six enumerators **between 16 February and 9 April 2004**. The major component was a survey based on individual interviews both of SRI and non-SRI practicing farmers. Group discussions with farmers and stakeholder discussions at various levels (project managers, implementing field staff, farmer promoters, village leaders) supplemented and verified the survey results. Pretest and modification of the questionnaire was done in Kandal between 23 and 28 February 2004. Survey data for the questionnaire were collected between 1 and 25 March 2004.

1 Survey design

The survey was carried out in five provinces: Kandal, Kampong Thom, Kampot, Takeo and Prey Veng (Fig. 1). The survey provinces were pre-selected ahead of the mission with the objective to cope with available logistic, to cover a diversity of farming environments and to cover target areas of different projects.

In each of the five provinces the objective was to randomly choose four villages in which 20 SRI farmers were selected for the interviews. In selected villages where less than 20 SRI farmers could be identified, a neighboring village was added and 10 SRI farmers were randomly selected in each of these two villages. In addition,

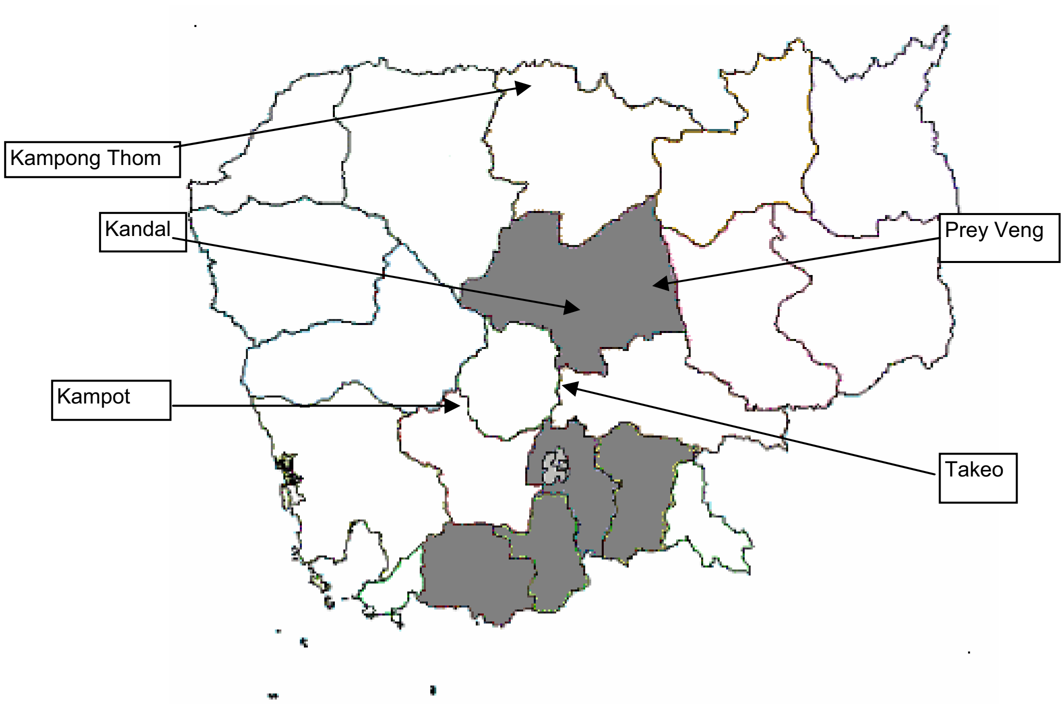

Figure 1. The provinces Kampong Thom, Kandal, Prey Veng, Takeo and Kampot in which the survey was carried out.

5 non-SRI farmers per village (20 per province) were randomly selected from village lists to serve as a control group. The interviews with the 400 SRI farmers and 100 non-SRI farmers were carried out by two survey teams, each comprising three enumerators and one co-consultant (supervision and data-entry) during the period from 1 to 25 March 2004. Except for Kandal, where both teams worked together, each survey team worked in two different provinces.

To verify the information obtained by the individual interviews two farmer group discussions in each province comprising SRI and non-SRI farmers were conducted. In addition, stakeholder discussions at various levels and in all 5 provinces helped to identify specific advantages and problems farmers and projects were facing when introducing and promoting SRI.

2 Treatments and data selection

All data presented derive from the survey and were **obtained through questionnaires**. Standard procedures for yield measurements were not employed due to the short time frame of the survey and the quantity of farmers surveyed. Yield estimates based on questionnaires may be considered as not accurate enough. However, the explorative nature of a survey allows screening a large amount of data, which easily compensates for the inaccuracy of the estimate.

Treatments consisted of SRI practices applied on one field and conventional practices applied on the same field before it was cultivated with SRI. **Conventional practices** comprise any rice technologies/practices the farmer applied on the particular field in question. Using the same field helped to minimize the estimation error because the error was the same for both treatments but it included also a time effect. However, this was intended because any farmer practicing conventional rice cultivation has to bear the additional risk of possible flooding and drought which might occur in the succeeding year when he takes the decision to apply SRI. Given the large number of replications, taken in different locations, facing different environmental conditions and data taken from different years was expected to give a better average picture than comparing SRI and conventional practices from different fields of the same farmer in one year. Moreover, 17% of the SRI farmers had converted their whole rice area to SRI. Excluding these farmers from the analyses would have produced a wrong picture.

Unlike in many other on-farm trials, **fields, which were affected by either flooding or drought, were purposely not excluded from the analysis**. Such natural disasters occur quite frequently (NESBITT, 1997) and are a part of the risk the farmers are facing when cultivating rice. That procedure partly explains the rather low yield levels for both the SRI and the conventional practices. However, receiving similar results for the conventional practices as the national average of rice production confirms the usefulness of such an unconventional approach. It also explains why we did not get the ‘miraculous’ yield levels reported from other sources including the secondary data reviewed from the various projects.

Most of the secondary data we screened from the projects (CEDAC, CBRDP) were also obtained through questionnaires. Yields achieved with SRI are reported to be between 3 and 4 t ha^{-1} on average (KOMA, 2002) or even 6-8 t ha^{-1} (UPHOFF, 2002). When screening our data and relating yield estimates made by farmers to the field size the data show a highly significant inverse relationship between plot size and yield (Fig. 2). Therefore, extraordinary high yield estimates occur only on small plots and are based on wrong estimations of farmers. Very low yields are also coming from small plot sizes but are hardly reported in the literature. The same applies to corresponding yields for the conventional practices. In addition, small plots are easily manageable by farmers and can be treated with specific care. However, to assess the realistic potential achievable on a larger scale only larger field sizes should be included in such an evaluation. Therefore, **only SRI fields of at least 30 are in size were included in any of the quantitative analyses like yields, man-days (labor) or gross-margins. For qualitative assessments, however, all farmers were included in the analyses.**

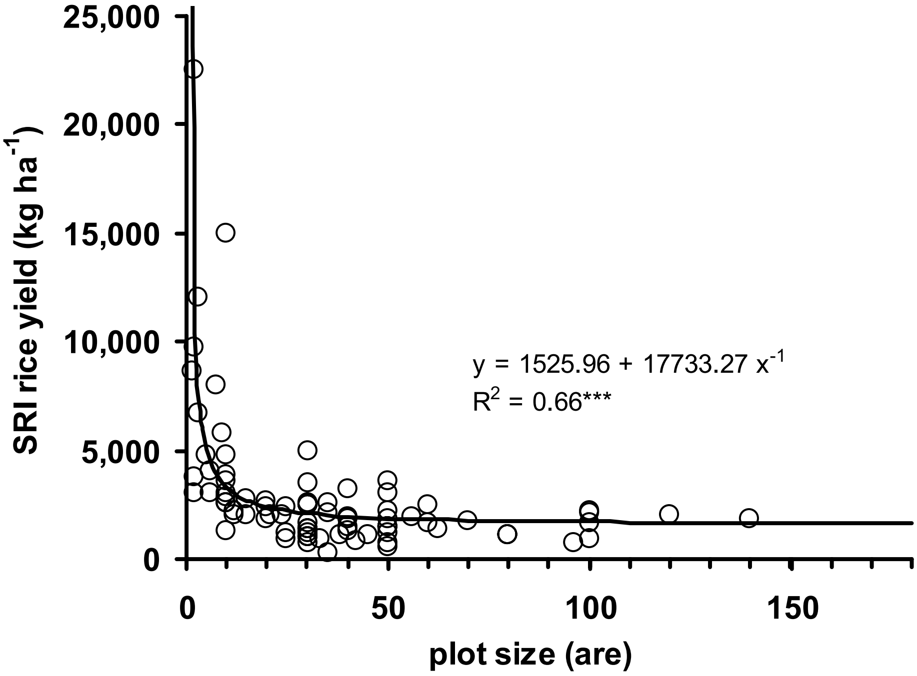

Figure 2 Relationship of plot size and rice yield estimations based on farmer's responses in Kandal province.

3 Data analysis

3.1 Statistical analysis

Comparisons of farm household characteristics and of conventional rice cultivation were made between SRI practicing farmers and non-SRI practicing farmers. In such cases where quantitative data were taken at different farmer's locations, simple t-tests (un-paired) were performed.

To assess the impact of SRI, only the SRI farmers were selected for the analysis. Rice fields before SRI (conventional practice) were compared with the same fields the following year applying SRI. In such cases with paired data sets, paired-samples t-tests were performed.

In both cases, the standard error of the difference (SED) was calculated. The level of significance was indicated by the number of asterisks: $P > 0.05$ (n.s.: not significant), $P \leq 0.05$ (*), $P \leq 0.01$ (**), $P \leq 0.001$ (***); P is the error probability.

Qualitative data were compared with simple Pearson chi-square tests.

3.2 Adaptability analysis

Crop yields taken in different farming locations are very variable due to the diversity of small scale farming environments. Significance tests focus only on the reliability of the mean difference between the two treatments. Moreover, the mean yield of several individual data does not reflect how variable the yield data are distributed.

The concept of adaptability analysis helps to discover the distribution of yields at different farming environments and to identify whether a technology is more suitable for locations of low or of high productivity levels or whether it is a robust technology suitable for all farming environments. Adaptability analysis can only be performed if paired data sets are available, i.e. a field with conventional rice production in the first year and SRI in the succeeding year. The mean yield of both treatments (conventional and SRI) is calculated for each farmer's location and plotted in a graph on the x-axis (see Fig. **13**). The individual yield (for each treatment) is plotted on the y-axis. Therefore, for each farmer's location (x-axis) two data points are in the graph. For the data points of each data series (conventional and SRI treatment) a regression can be performed which shows the trend of the data: The interpretation for the adaptability analysis depends how the two trend lines are positioned to each other. If they are parallel to each other, the improved technology achieves the same yield increase in all farming environments, regardless the productivity level of the location. Such technologies can be classified as robust. Technologies more suitable for poor locations (higher yield increases in poor environments than in good environments) and for superior locations (higher yield increases in good than in poor environments) may also be identified (ANTHOFER *et al.,* 2004).

3.3 Risk assessment

When a farmer has the option to choose between two technologies under consideration (e.g. conventional practice vs. SRI) he aims to achieve a yield increase or difference compared to his common practice. Farmers may have different expectations towards a yield improvement of a new practice to be attractive for them. Therefore, it is important to know the risk for a farmer not to achieve a desired yield improvement. The risk model applied was the one described by ESKRIDGE (1990).

Based on the paired data of the SRI plots, it was possible to estimate the risk for a randomly chosen farmer among the SRI farmers not to achieve a predefined difference compared to the conventional practice. The method allows a risk comparison when there is a choice between different treatments (ESKRIDGE and MUMM, 1992)

3.4 Economic analysis

Partial budget analyses were found to be suitable to estimate the economic impact because only relative small changes on the farm business (seeds, fertilizer) had to be assessed while all other parts remain the same. The **gross margin per hectare** was calculated by subtracting variable costs from the gross return. To assess also the return to labor, the gross margin per man-day was calculated by dividing the gross-margin per hectare divided by man-days of family labor. **Economic risk assessments** applying the same methods described above were performed as well.

To assess the labor force available in a household, **male adult equivalents** were assigned to different gender and age groups (BAUM *et al.,* 1999, Table **1**). Whether a household member is actively involved in farming activities was directly obtained during the questionnaire.

Table 1. Adult equivalent for labor calculations (adapted from BAUM *et al.*, 1999)

Labor class	Age (years)	Man-units or ME (man equivalent)	Equivalent man-days per month*
Small child	< 7	0.0	0
Large child	7 – 14	0.4	10
Male adult	15 – 64	1.0	25
Female adult	15 – 64	0.8	20
Male/female adult	≥ 65	0.5	12.5

* refers to peak periods with 25 working days per month; for other periods 22 working days are suggested.

Plate 2. Farmers during a group discussion in Kampong Thom province

IV Survey Results

1 Farmers, information and training

1.1 Farmers practicing SRI

Significant differences between farmers practicing SRI and other farmers practicing only conventional rice cultivation methods existed. SRI farmers had a significantly higher educational level than non-SRI farmers (Table **2**). In addition, SRI farmers had a much better resource endowment (Table **3**). On average, they had more rice cultivation area per household member and more livestock. With technical assistant of-CEDAC farmers themselves formed farmer associations to be better organized. Farmers practicing SRI are usually innovative farmers willing and able to take the risk of potential crop failure when testing a new practice.

In Madagascar, innovative farmers were also the main users of SRI. They were described as having "above average intelligence, having sometimes even completed university education, very keen observers, well organized, and very motivated /interested in farming". They also had at least some carefully managed cattle (STOOP, 2003)

Table 2. Education of SRI and non-SRI farmers.

	SRI	Non-SRI
No formal education	21.9 %	29.3 %
Primary school, not completed	38.2 %	35.0 %
Primary school	5.5 %	12.9 %
Lower secondary school	26.9 %	15.7 %
Secondary school and higher	7.5 %	7.1 %

Table 3. Household characteristics in SRI and non-SRI practicing households.

	SRI	Non-SRI	SED[1]
Female headed households	16.5 %	20.0 %	χ^2= 0.91n.s.
Member of a farmer association	58.1 %	41.9 %	χ^2= 69.8***
Number of household members	5.36	5.19	0.17n.s.
Labor force (man-units household^{-1})	3.37	2.90	0.13***
Labor force (man-units ha^{-1})	3.73	4.73	0.35**
Number of cattle	3.6	3.1	0.21*
Number of pigs	1.33	0.87	0.18*
Hiring of casual labor	39.6%	33.1%	χ^2= 1.79n.s.
Rice consumption household^{-1} month^{-1}	128.1	114.4	5.3*
Rice area per household member	27.6	21.3	6.3**

[1] SED: standard error of the difference; in cases of qualitative parameters the chi-square value is presented (χ^2).

In Cambodia, having more innovative farmers as the main users of SRI is not surprising as the method has been introduced just recently. In the long term, however, other farmers, especially poorer households, should be actively included in the process of experimentation as well.

1.2 CEDAC's approach of training and dissemination of SRI

CEDAC uses SRI as an entry point for participatory innovation development. The strategy or approach comprises several steps (adapted from Dr. Yang Saing Koma, see workshop documentation):

1.2.1 Entry stage (1 – 1.5 years)

- village general meeting before or at the start of the rice growing season;
- Training and coaching support to groups of experimenting farmers (monthly) at village level during the rice growing season;
- Field days, inter-village cross visits and village general meetings to disseminate experiences made (during and at the end of the growing season);
- Meeting to elect key farmers (KF) at the end of the rice growing season (3-5 KF per village)

1.2.2 Stage 2 (0.5 – 1 year)

- Training and coaching support to a group of key farmers at inter-village level in developing and disseminating SRI and other technical innovations (key farmers from 3 to 5 villages form a group for training);
- Training and coaching support to key farmers in organizing farmer association at village level

At the end of this stage, farmers have formed village-based farmer associations to play an active role in agricultural development in the community.

1.2.3 Stage 3 (1 -2 years)

- Capacity building for representatives of farmer association through group training, workshop and exchange program;
- Continued training for active key farmers or farmer promoters
- Supporting farmer associations (FA) in organizing agricultural extension in their own community and neighboring villages
- Assisting FA in organizing confederation or network. FA and the confederation are important partners in agricultural research and extension

At the end of this stage, there will be a strong farmer association and network and availability of active and qualified farmer promoters.

1.2.4 Outreach of the program

- Year 1: each field staff works with 8 to 10 farmer groups from 10 villages, each group has 10 to 15 farmers;
- Year 2: each field staff works with 10 to 15 farmers group from 10 to 15 villages;
- 3 year: each field staff works with 15 to 20 farmer groups from 15- 20 villages.

After three years, each field staff has worked with 15 to 20 farmer groups or associations, with around 200 to 300 farmers directly. The number of farmers reached by field staff with the help of or through key farmers and/or members of farmer groups will be around 800 to 1000 (farmer to farmer, village general meeting etc.). The total number of farmers reached by one field staff can be around 1000 to 1300.

Although this approach is very intensive and time consuming, it seems to work very well and is adopted with few modifications by other projects in Cambodia promoting SRI as well. CEDAC has conducted a lot of training courses not only for farmers but also for project implementing staff. **Group discussion with farmers confirmed that the process initiated by CEDAC had a much wider impact than technology dissemination alone. Farmers appear to be much more confident to solve their problems through farmer associations. Within that approach SRI is used as an entry point to further development interventions.**

1.3 Sources of information

According to the results gained by the individual questionnaires, the most beneficial source of information about SRI practices were training sessions, field demonstrations and cross visits, which are all linked with each other since the visit of demonstration plots or cross visits to SRI farmers in other villages are usually part of the training program. CBRDP mainly works with demonstration plots, while in the CEDAC areas cross visits are more common. Basically there are no major differences between the two, and the main purpose is to expose the farmer to the new practice and to give him the opportunity to discuss the SRI management practice with the farmer hosting the demonstration/cross visit field.

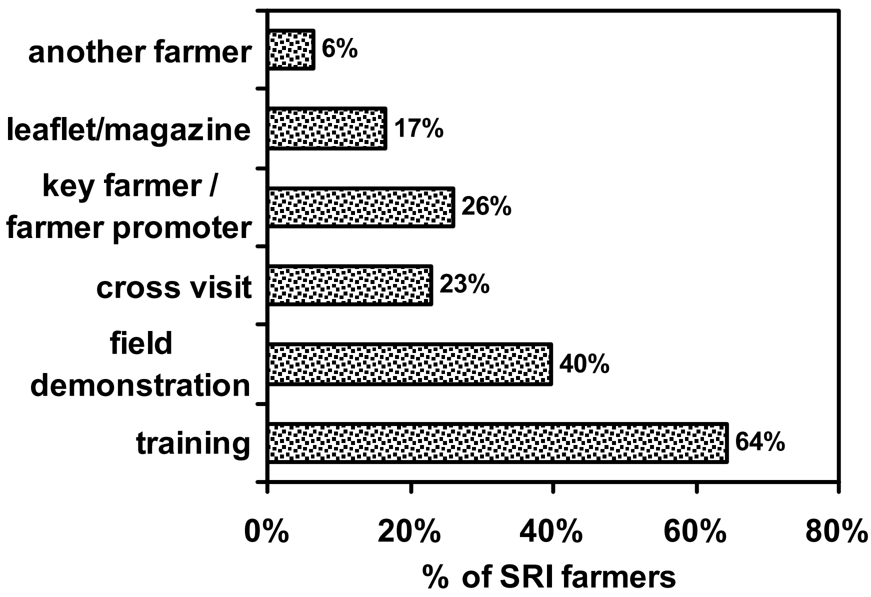

Figure 3. Sources of information on the application of SRI valued as most beneficial by practicing SRI farmers (multiple responses possible)

1.4 Training

The vast majority of all farmers were satisfied with the training activities (28% very satisfied, 71% satisfied). Project staff was involved in 91% of all training activities while farmer promoters/key farmers facilitated 17% of these activities. Discussions with project staff also revealed that training activities should be ideally placed closely ahead to the rice growing season to increase the number of farmers who actually start implementing SRI. If the time gap is too long, many farmers hesitate to try out SRI due to the very uncommon nature of the learned practices.

Although heavily emphasized in all projects, farmer promoters/key farmers were not valued in the same way as an important source of information. Follow-up visits were conducted only to 60% of the farmers but farmers who received these follow up visits were visited 3-4 (3.72 ± 0.19) times. However, only 16% of the visited farmers were of the opinion that farmer promoters were able to solve their problems. Another 57% of the visited farmers mentioned that their problems with the application of SRI were partly solved while for 27% of the farmers the visit was not very helpful. Obviously, there are issues arising with the application of SRI which cannot be solely solved by training and discussion but which are presumably parts of the nature of SRI (e.g. more weeding required) or are due to the physical nature of the farm land (e.g. frequently affected by flooding).

Practices most actively remembered from SRI trainings were the transplanting of only 1-2 young seedlings per hill, the establishment of raised seedbeds, nutrient supply in organic form such as animal manure or compost and flat rice fields (Table **4**). Farmers also applied most of these remembered practices. It was surprising that there were no practices, which farmers remembered from training sessions but for certain reasons were not applied in the field. If SRI is taught as a methodology to be applied in a flexible manner why are farmers applying virtually all practices they know from the training? It will be shown later that farmers applied many more components than might be expected from the results in Table **4**, but the actively remembered practices are presumably the most important ones for the farmers.

Table 4. SRI components actively remembered by farmers who participated in training courses and application of practices they remembered.

	Remembered (%)	Applied (%)
Reduced rice seeds	23.8	23.8
Seed bed preparation	50.6	50.4
Flat rice fields	46.6	46.6
Select only vigorous seedlings	15.7	15.7
Transplanting 1-2 seedlings per hill	59.1	59.1
Transplanting young seedlings	47.4	45.1
Fast transplanting	8.0	7.5
Planting in rows	32.7	32.7
Wider plant spacing	24.8	24.2
Shallow planting	23.4	22.8
Alternating flooding and drying	19.7	19.7
Early and frequent weeding	29.5	29.5
Nutrient supply (in organic form)	49.4	49.4

Applied practices refer only to practices the farmer actively remembered from training courses regardless of his application of additional practices.

2 Application of SRI practices

2.1 Crop management

Despite the rather low to moderate percentages of farmers remembering certain SRI practices, focused questions on SRI practices revealed a different picture. Many SRI farmers drastically changed their rice management practices when they decided to apply SRI (Table **5** and **6**)

Before shifting to SRI practices, the seed rate for conventional rice cultivation was the same for SRI and non-SRI farmers. When changing from conventional to SRI practice, the seed rate was drastically reduced but not as much as it is usually stated. UPHOFF (2002) reported about possible seed rates of 6 kg ha^{-1} while in the current study SRI farmers reduced the seed rate from 90 to 30 kg ha^{-1} only. According to discussion with project staff farmers are more careful in the first year of SRI experimentation. Later, the amount of seeds used in the nursery is further reduced. These statements could not be confirmed. Farmers using SRI for the first time used the same quantity of seeds as farmers with more SRI experience. To exclude the possibility that farmers used the same nursery for both the conventional practice and for SRI, which would lead to an overestimation of the seed rate for SRI, a further analysis included only those farmers who applied SRI on all of their fields. The results were still the same with no significant change. It is assumed that farmers establish a much larger seed nursery that they would need to be prepared for possible replanting in case the seedlings die back. The rather moderate reduction of the seed rate can be viewed as a farmers' strategy to avoid the risk of a total loss. Having enough additional seedlings enables the farmer to replant seedlings in a 'worst-case scenario'.

Table 5. Rice management practices of SRI farmers on conventional and on SRI fields

	conventional	SRI	SED
Seed rate (kg ha^{-1})	90.3	29.8	6.7***
Seedling age at transplanting (days)	45.2	16.8	0.59***
Time between uprooting and transplanting (hours)	39.8	2.7	0.90***
Number of seedlings $hill^{-1}$	4.8	1.3	0.69***
Planting depth (cm)	4.0	1.2	0.05***
Planting distance (cm)	16.7	25.6	0.36***

'conventional' refers also to present SRI fields which were formerly managed in the farmer's conventional way especially in cases where farmers have shifted all their fields to SRI.

SED is the standard error of the difference; probability level of significance: $P \leq 0.001$ (***)

Kampong Thom and Prey Veng were the only provinces were farmers also broadcasted rice seeds instead of transplanting seedlings. Among the SRI farmers, 6.6 and 8.8% formerly only broadcasted the seeds in Prey Veng and Kampong Thom, respectively. In addition, 28.8 and 23.8% of the farmers applied both methods with their common rice cultivation practice in Prey Veng and Kampong Thom, respectively. Since important components of SRI address how to transplant the rice seedlings, **the potential of SRI in areas where broadcasting is more common is assumingly lower.** Farmers broadcasting the seeds could still apply other SRI elements, but it is likely that the adoption potential in such areas is considerably lower given the observed trend that farmers treat SRI as a package rather than as a flexible set of practices as initially intended.

Table 6. Management practices applied by SRI farmers on conventional and on SRI fields

		Conventional (%)	SRI (%)
Selection of seedlings for transplanting	At random	100	14.0
	Only strong seedlings	0	86.0
Planting arrangement	At random	99.5	28.0
	In rows	0.5	68.3
	Both	-	3.8
Water level during transplanting	Just moist	3.5	92.3
	Flooded	96.3	2.5
	Both	0.3	5.2
Water level during the vegetative stage	Permanently flooded	64.3	22.4
	Alternating flooding/drying	35.7	77.6
Weeding	Once	39.4	66.8
	Twice	0.7	19.2
	Three times	-	7.2

'conventional' refers also to present SRI fields which were formerly managed in the farmer's conventional way especially in cases where farmers have shifted all their fields to SRI.

Other practices with regard to quick transplanting of young seedlings in low numbers per hill were closely followed the SRI recommendations (Table **5**). 56% of the SRI farmers transplanted the seedlings when they were not older than the recommended 15 days and another 32% transplanted seedlings between 15 and 20 days old. Likewise, more than 95% of the farmers transplanted the seedlings within 15 hours while only 11% of farmers transplanted within that time when practicing conventional rice cultivation.

These results are partly surprising because the group discussions revealed that many farmers found it riskier to transplant younger seedlings at lower spacing and density. If that is the case, why do they not adjust the SRI practices to their perception of risk? Does the training they receive really enable them to apply SRI components in a flexible manner, or is SRI applied as a package despite opposite claims? Among project staff the perception dominates that SRI works best when more practices are applied at a time. This is explained by claims of synergistic affects when applying several (or possibly all) practices. It is possible that farmers feel themselves pressured to apply as many components as possible although it would be more meaningful to apply these practices, which fit to the particular circumstances of the individual farming household and the natural conditions.

The only practices where the application of SRI components were not (or could not) be applied by a substantial proportion of SRI farmers were row planting and the alternation between flooding and drying during the vegetative period of the rice crop. Group discussions with farmers confirmed that several farmers found it too time consuming to plant seedlings in rows. Planting at random is also observed in other cereal based economies where intensification is rather low and the opportunity costs for the time consuming row planting is perceived as too high compared with the increased yields obtained through row planting. Once crop production intensifies, there is usually a trend towards optimization of plant stands through row planting. Market-oriented farmers are usually more open to such crop husbandry practices, while poorer subsistence oriented farmers might invest their time in more profitable off-farm activities.

Water management according to SRI recommendations during the vegetative period of the rice crop is perceived by many farmers as difficult or even impossible to apply. This can be partly explained by the natural conditions of rice farming in Cambodia. Most farmers rely on rainfed rice with only limited possibilities to control the water level. After moderate rainfall events, farmers cannot afford to release the rainwater after a short time because there is a permanent risk that the rice field completely dries out with a resulting complete loss of the crop. Draining the water within larger fields with small ditches might be feasible in some cases, but it is also time consuming. The responses by the individual interviews do not fully reflect the issue. Many fields are prone to drought and, therefore, many fields also dry out without the active involvement of the farmer. Alternate flooding and drying of rice fields was also mentioned to be a management practice by 35% of the farmers on the conventional rice plots. However, it is assumed that this is caused by the rainfall pattern rather than by the farmer himself. No doubt, there is a substantial difference to the SRI plots, but 22% of the SRI farmers state having flooded conditions also on the SRI plots.

In summary, most of the recommended SRI practices were followed to a large degree by SRI practicing farmers. The most difficult practice to apply in the predominantly rainfed rice systems is obviously the water management with alternating flooding and drying of the rice fields.

2.2 Nutrient management

SRI itself is not a synonym for organic agriculture but it is an almost ideal practice for farmers and/or projects which have decided to produce rice without the use of external inputs such as pesticides, herbicides and mineral fertilizers. CEDAC is very much engaged in promoting organic agriculture, which is also reflected in their view on mineral fertilizers. Training sessions focus strongly on the negative effects of mineral fertilizers, and project staff and farmers of other stakeholders have adopted that per-

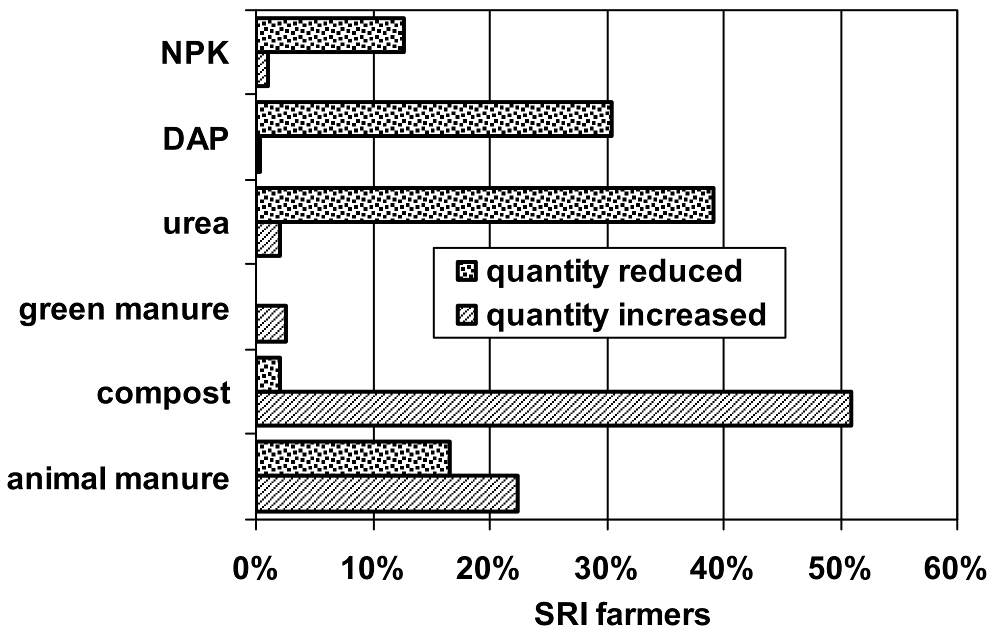

Figure 4. Changes of farm own (animal manure, compost, green manures) and external inputs (mineral fertilizers) for fertilizing rice on fields when changing from conventional rice practice to SRI.

ception from CEDAC. Therefore, the types of inputs for crop fertilization sharply shifted from mineral fertilizers towards an increased use of compost when farmers started applying SRI (Fig. **4**).

Large differences in the use of mineral fertilizers for conventional rice cultivation were observed among the provinces (Fig. **5** to 7). Comparatively high amounts of urea, DAP were applied in Kampot, Takeo and Prey Veng while NPK was mainly used in Prey Veng. Regardless of the differences between provinces, the shift from conventional practice to SRI always resulted in a significant reduction of mineral fertilizer use.

The reduction of mineral fertilizers was compensated by an increased use of compost (Fig. 9). The use of animal manure (Fig. **8**) partly increased and partly decreased because farmers tended to utilize animal manure as compost. All projects promoting SRI strongly focus on compost preparation and the utilization of other farm-own resources. Green manures like leguminous cover crops, *Sesbania* spp. grown on rice ditches and prunings of other agroforestry trees are promoted as well but the interest shown by farmers is very low**.** Although technically feasible options, such technologies often prove to be not suitable for farmers due to high opportunity costs either for labor or for land they occupy.

Any crop production requires plant nutrients, and SRI is no exception. Correctly, one of its principles is to add nutrients to the soil. Nutrients in organic form are to be preferred and there is a common understanding that the soil organic matter plays a crucial role for the nutrient holding capacity especially in tropical agro-ecosystems. The question here is not whether it is meaningful to use organic inputs but whether sufficient organic resources are available to sustain yields and the natural resource base especially when other nutrient sources such as mineral fertilizers are reduced. Nitrogen might be added to the soil-plant system through symbiosis with suitable bacteria, this does not hold true with other elements beside N.

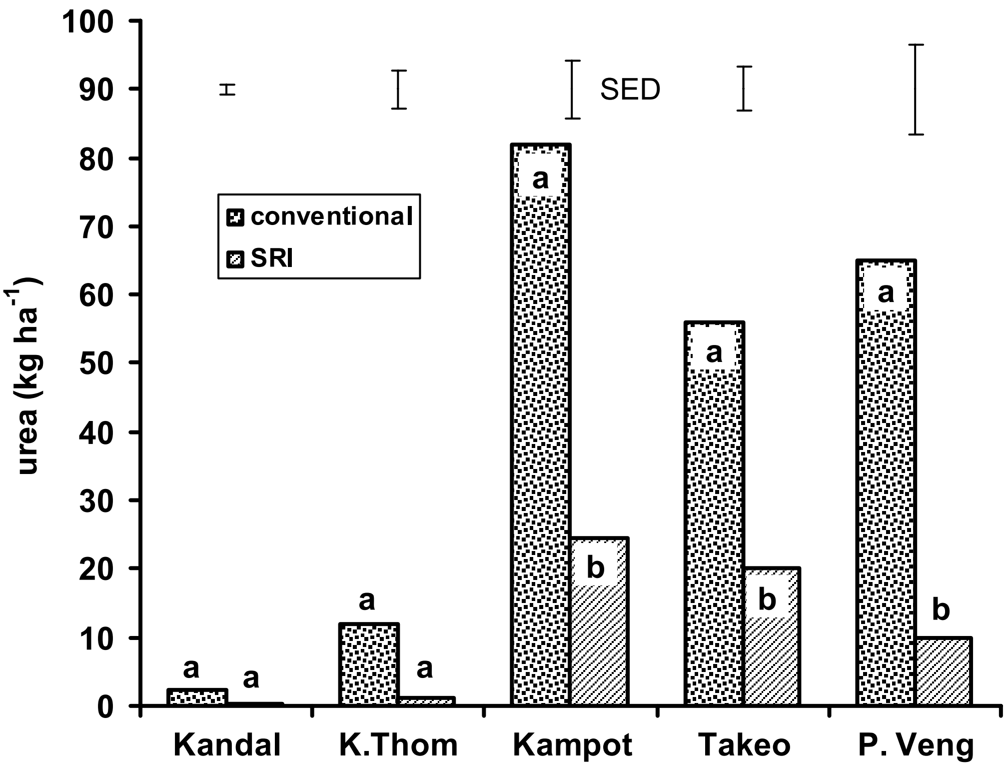

Figure 5. Urea application rates with conventional practice and with SRI.

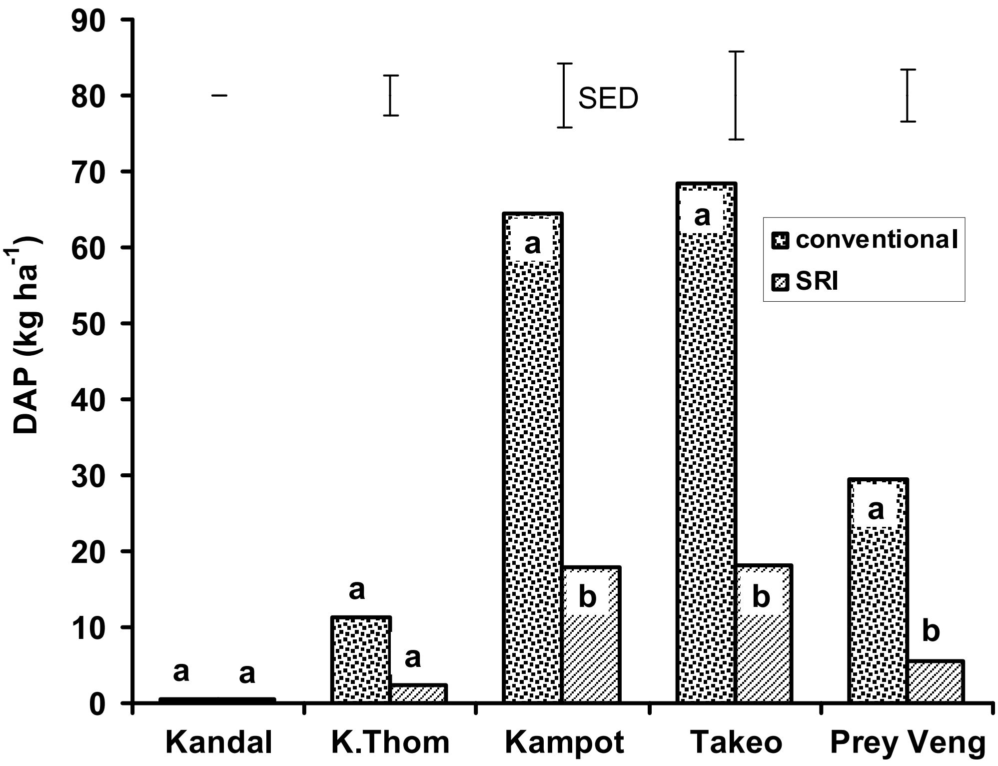

Figure 6. DAP application rates with conventional practice and with SRI.

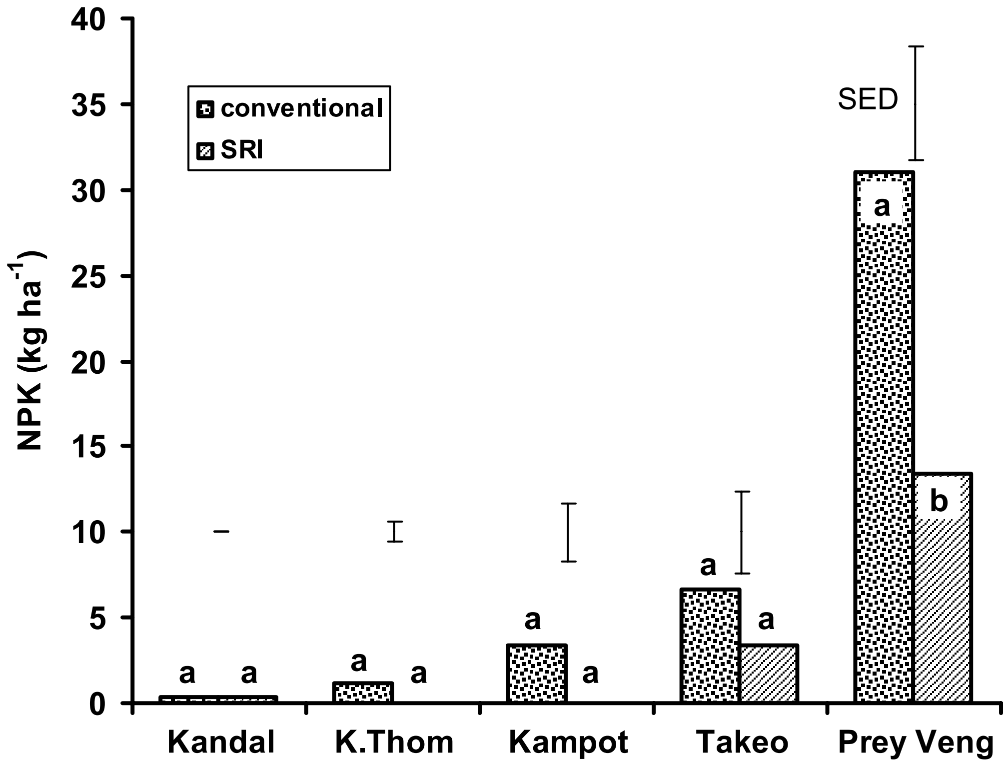

Figure 7. NPK application rates with conventional practice and with SRI.

Many rice growing areas in Cambodia are deficient in P (WHITE *et al.,* 1997). Adding P via plant material is almost impossible. Agroforestry tree leaf biomass typically containes 0.2-0.3% P (YOUNG, 1989). For example, the P content of 3 t ha^{-1} of various tree prunings in the Ethiopian highlands was found to contain only 2.7-11.7 kg P ha^{-1} (ANTHOFER *et al.,* 1998). Where should these quantities be produced if the major part of the farmland is occupied by rice?

Different approaches have emerged to assess and monitor land quality and its change over time. The classical but technically more difficult approach is the comparison of change in soil nutrient stock, preferably over several seasons or years (PIERI, 1992, 1995). Besides cost constraining factors to maintain such experiments, there are difficulties in the selection of efficient analytical methods (DRECHSEL and GYIELE, 1999). Furthermore, long-term experiments with statistically comparable treatments are difficult to maintain as on-farm trials under farmers‘ management.

An alternative method to assess soil fertility dynamics is the nutrient balance. Whilst the soil is considered to be a black box, the quantities of nutrients entering and leaving a field are analyzed and the balance is estimated. The model assumes that over time soil fertility is determined mainly by the degree to which nutrient exports are balanced by nutrient imports. Internal fluxes between nutrient pools are considered to be more or less in equilibrium. (VAN DER POL, 1992).

Partial N and P balances only considering mineral fertilizers, animal manure and compost as inputs and rice grain yields as outputs resulted in positive balances for both systems in this study (Table **7**). However, nutrient losses due to volatilization, leaching or flooding and nutrient inputs due to sedimentation are not considered in that balance. Although the balance appears to be in order, it should be considered that the difference between the two systems has a negative balance for both N and P which means that the additional nutrient losses caused by increased grain yields and reduced mineral fertilizers are not compensated by additional organic inputs. **To assure sustainability, the aspect of the nutrient balance should be further inves-**

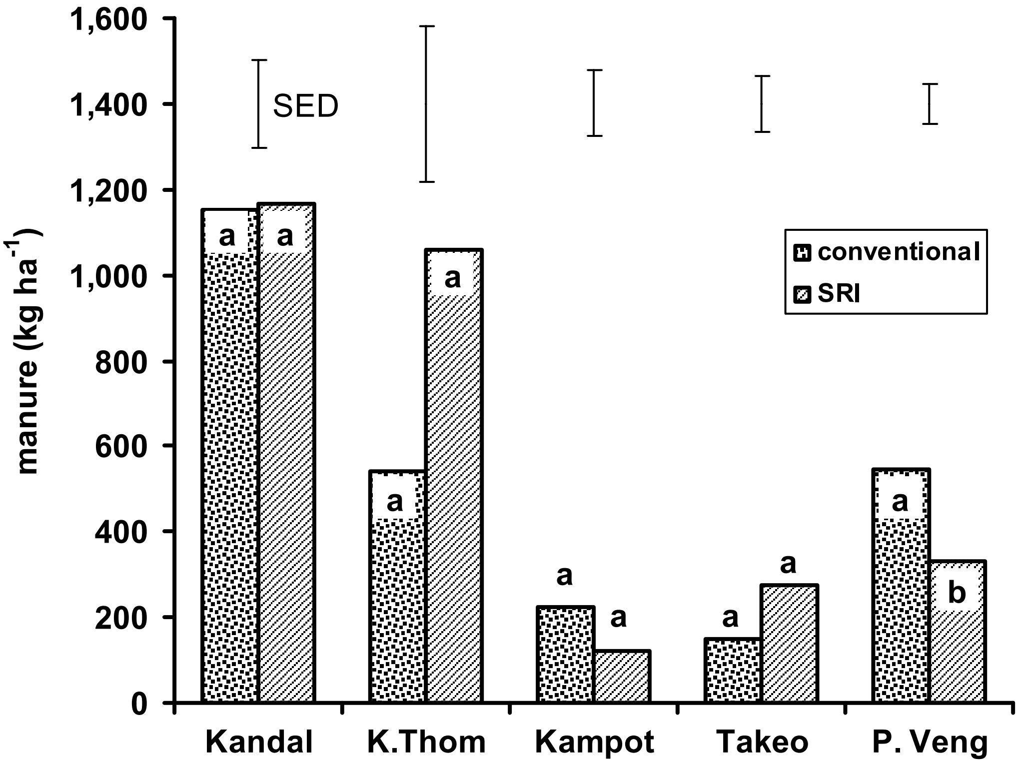

Figure 8. Use of animal manure with conventional practice and with SRI.

tigated with adequate research methods.

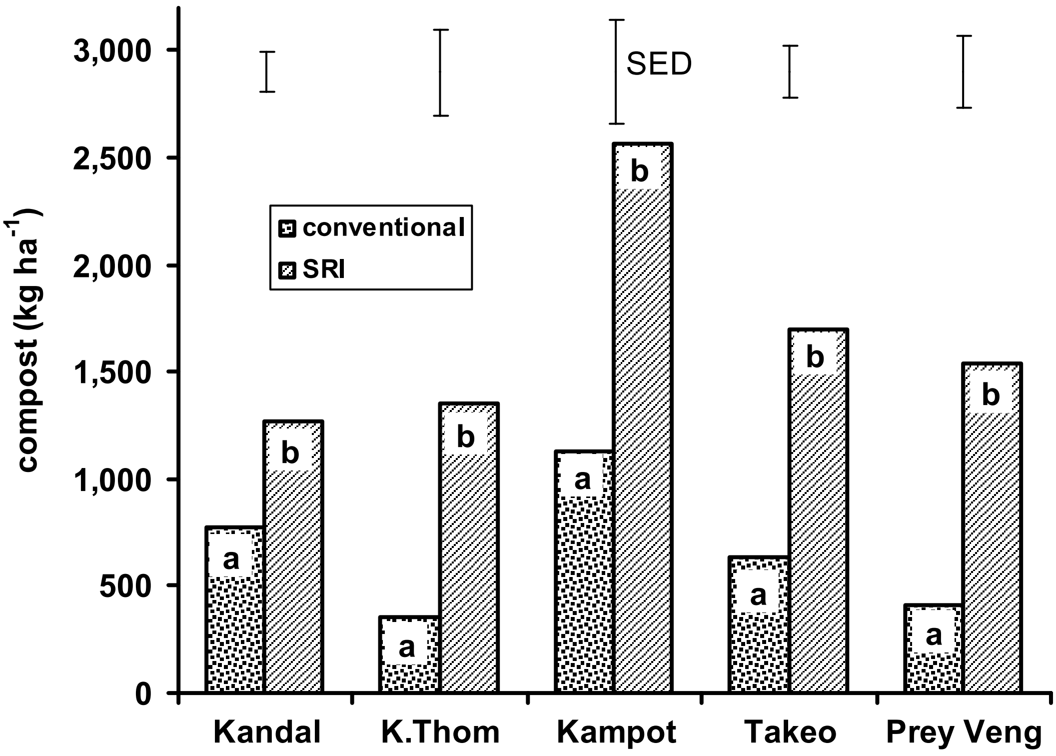

Figure 9. Use of compost on plots before and with SRI.

Table 7. Partial N and P balance of conventional rice cultivation and of SRI

	N			P		
	Conventional	SRI	Difference	Conventional	SRI	Difference
Input						
Urea	19.62	4.75	-14.87	0.00	0.00	0.00
DAP	5.72	1.45	-4.28	6.36	1.61	-4.75
NPK	1.52	0.62	-0.90	1.52	0.62	-0.90
Animal manure	1.78	1.79	0.00	0.52	0.52	0.00
compost	14.62	35.86	21.24	2.72	6.67	3.95
	43.27	**44.48**	**1.20**	**11.12**	**9.43**	**-1.69**
Output						
Yield (grain + straw)	**29.81**	**41.89**	**12.08**	**5.05**	**7.09**	**2.05**
Balance	**13.46**	**2.58**	**-10.88**	**6.07**	**2.33**	**-3.74**

The nutrient balance of low external input systems is often negative for other elements than N (ANTHOFER and KROSCHEL, 2002). Nitrogen may be added through N fixation to the plant-soil system but other nutrients are mainly recycled or redistributed if the whole farm land is considered. According to certain group discussions with farmers, animal manure is now utilized as compost rather than applied directly. Farmers usually own a small number of livestock, which produces considerable quantities of dung and urine (Table **8**) but most animals are not kept permanently in suitable housing facilities to collect all the manure produced. Therefore, considerable losses can be expected. Moreover, composting of manure, together with other organic materials like straw, tree prunings or plant residues, improves the availability of nutrients and might reduce nutrient losses, but it hardly adds additional nutrients to the system. Farmers are unlikely to increase their number of livestock to produce more manure for composting. A common issue farmers mentioned was the availability of sufficient manure. Most farmers were of the opinion that the manure they were using was insufficient. That prompted them to the **strategy to concentrate the animal manure and/or compost application to the SRI fields**. The nutrient balance demonstrates that this approach seems to work quite well, but what happens with the remaining fields? **Are farmers establishing sustainable SRI fields at the cost of nutrient mining on the remaining fields?** There are many open questions with respect to the nutrient management which have to be further investigated in future studies. Another approach could be an **integrated nutrient management** with the use of both organic and inorganic sources for crop fertilization instead of condemning the use of mineral fertilizers.

Table 8 Average number of livestock per household and annual production of urine and manure per hectare

	Number per household	Dung (kg day^{-1})	Urine (l day^{-1})	Dung (kg ha^{-1} $year^{-1}$)	Urine (l ha^{-1} $year^{-1}$)
Cows	3.6	11	6.5	2868	6101
Horses	0.03	6	2.5	47	20
Pigs	1.33	2.0	1.5	693	520
Poultry	8.61	0.04	-	8979	-

Dung and urine production adapted from MÜLLER-SÄMANN and KOTSCHI (1994)

3 Impact at field level

3.1 Yields – adaptability and sustainability

Rice yields, both for the conventional methods as well as for SRI, were much lower than the extraordinary high yields for SRI and yield differences reported by other authors (KOMA, 2002). Despite these differences, rice yields increased from 1629 to 2289 kg ha^{-1} when the farmer changed his practice from conventional cultivation to SRI the following year on the same plot (Fig. 10).

An average increase of 660 kg ha^{-1} or 41% was achieved on a wide range of different agro-ecological environments, individual management practices and varieties. Despite pronounced differences between different farmers' locations, the pair wise comparison at each location revealed that SRI performed better in the vast majority of cases. This is established by the very small standard error of the difference.

Annual effects caused by different rainfall and other climatic conditions are merged in such an analysis with the treatment effect of the rice cultivation practice (SRI vs. conventional). However, a farmer who has to decide whether to cultivate his rice crop with conventional practices or with SRI also has to bear that additional risk of adverse climatic conditions. To get additional information on how SRI performs in different locations and years, the data set was stratified and analyses were conducted separately for different provinces (Fig. **11**) and for different years (Fig. **12**). Regardless of the location and year, grain yields obtained with SRI clearly outperformed the prevailing conventional practices. Improved seeds responded better to

SRI than local varieties, but the number of farmers using improved varieties was rather small to make a final judgment. However, these findings were also suggested in former studies (KOMA, 2002).

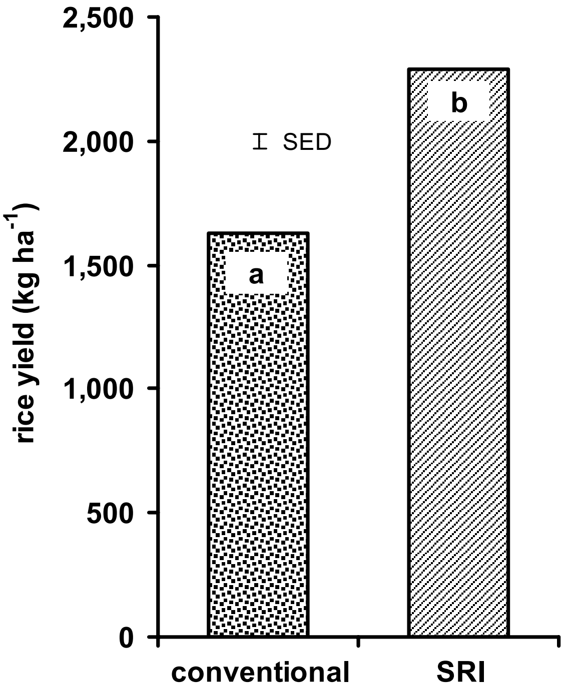

Figure 10 Rice yields with conventional practices and with SRI.

It is often claimed that SRI is a promising technology for poor farming environments, while at locations with better resource endowments, other technological options are superior over SRI (DOBERMANN, 2004). Results of the adaptability analyses conducted separately for each province demonstrate the opposite (Fig. **13**). When the average yield taken at each field with the conventional practice and with SRI during the succeeding years is used as an environmental index, the yield increases in locations with a low environmental index (left side on the x-axis) are rather low and insignificant. With increased environmental index or productivity level of a location, the yield increases achieved with SRI compared to conventional practice also increase. For instance, a farmer in Kandal province producing normally 1000 kg ha^{-1} with conventional practices is expected to produce 1258 kg ha^{-1} with SRI, a difference of only 258 kg. In contrast, a farmer who produces already 3000 kg ha^{-1} with conventional practices can be expected to yield 3999 kg ha^{-1} with SRI, an increase of almost 1000 kg. Nevertheless, the risk that a farmer gets a lower yield with SRI after changing from his conventional practice was only 15% (Fig. 14).

The increased difference with increasing environmental index was significant for $P<0.05$. Therefore, SRI has an above-average increase of yields compared to conventional practices with increased environmental conditions. Environment in that sense has to be viewed in a wider sense and comprises natural conditions like soil and climate as well as management. These findings are also reflected in the risk not to achieve a certain target yield (Fig. 14). The risk not to achieve low target yields of e.g. 800 kg ha^{-1} is quite similar for both practices, but at higher targets the risk not to achieve these levels is much higher for conventional practices than for SRI.

The choice of farmers of where to implement SRI supports these findings. Most farmers practicing SRI have additional fields where they apply conventional rice cultivation practices. When they have the choice, they tend to apply SRI on fields with a better soil quality (Table **9**). Likewise, farmers tended to apply SRI on fields closer to the homestead (Table **10**). Soil quality and distance to the homestead were also significantly correlated with closer fields being more fertile. It is not surprising that farmers apply a new technology on plots nearby the homestead to better observe the development on the plot and the results. Plots of farmers who applied SRI for the first time were located 363 ± 33 m apart from the homestead while plots of farmers applying SRI for two and more years were located 462 ± 92 m apart from the homestead. With increasing SRI experience, some farmers also choose further located plots, but these are still much closer located than plots where common farmers' practices are

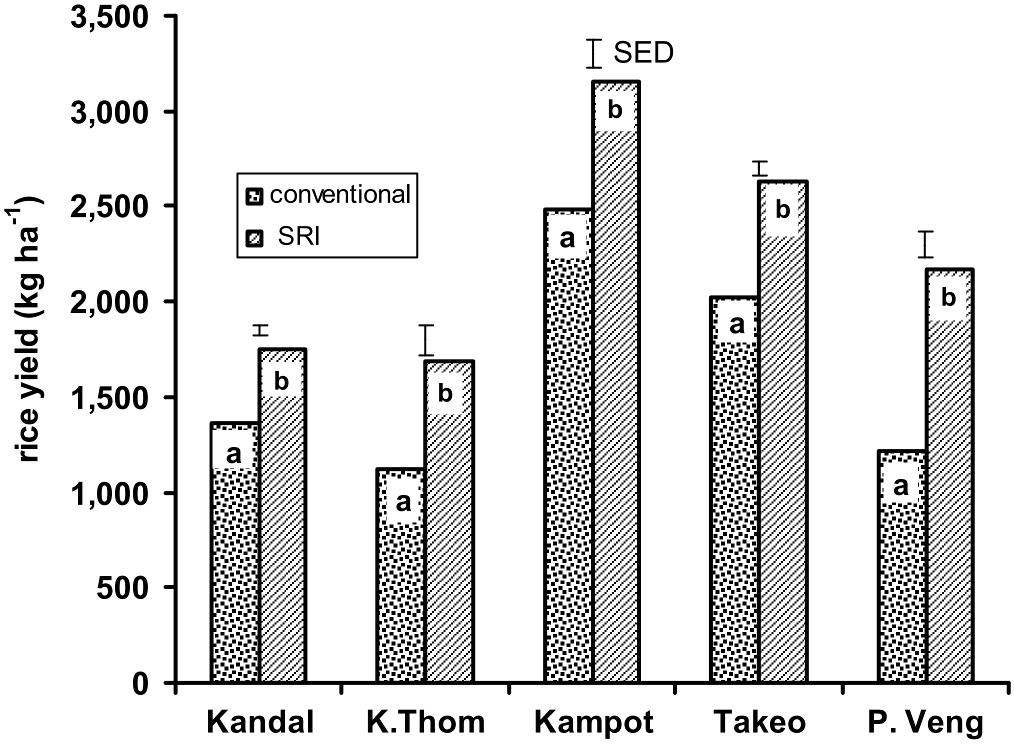

Figure 11 Rice grain yields with conventional practices and with SRI in the provinces Kandal, Kampong Thom, Kampot, Takeo and Prey Veng.

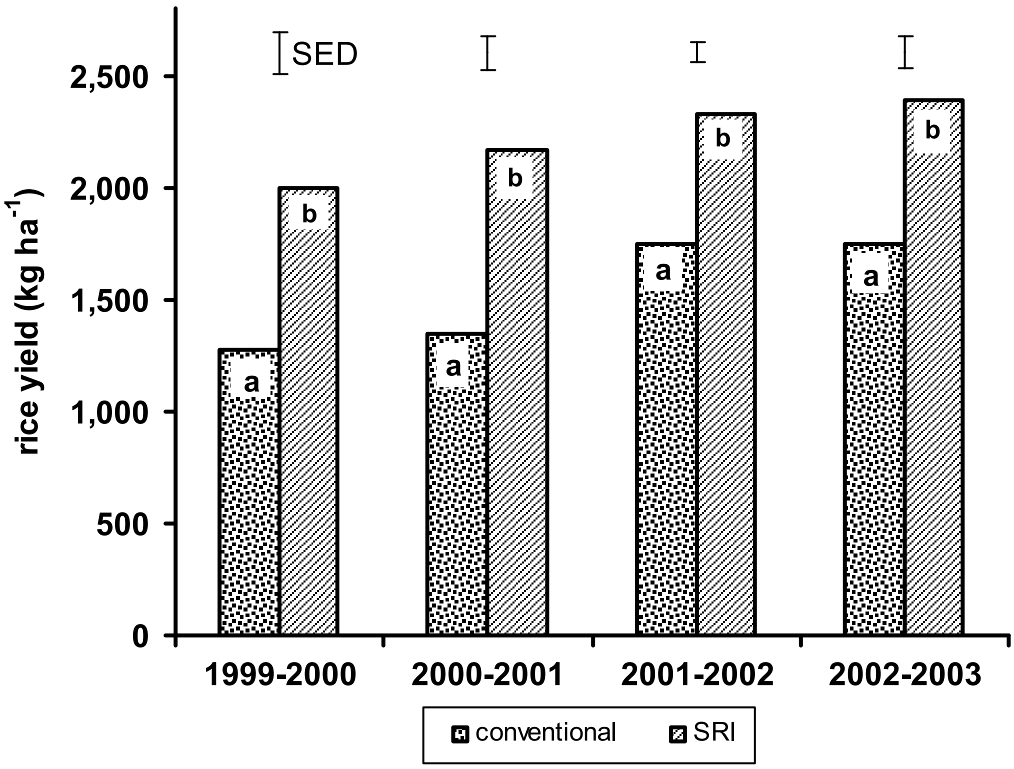

Figure 12 Rice grain yield differences when farmers changed their management practice from conventional in the first year to SRI in the succeeding year on the same field.

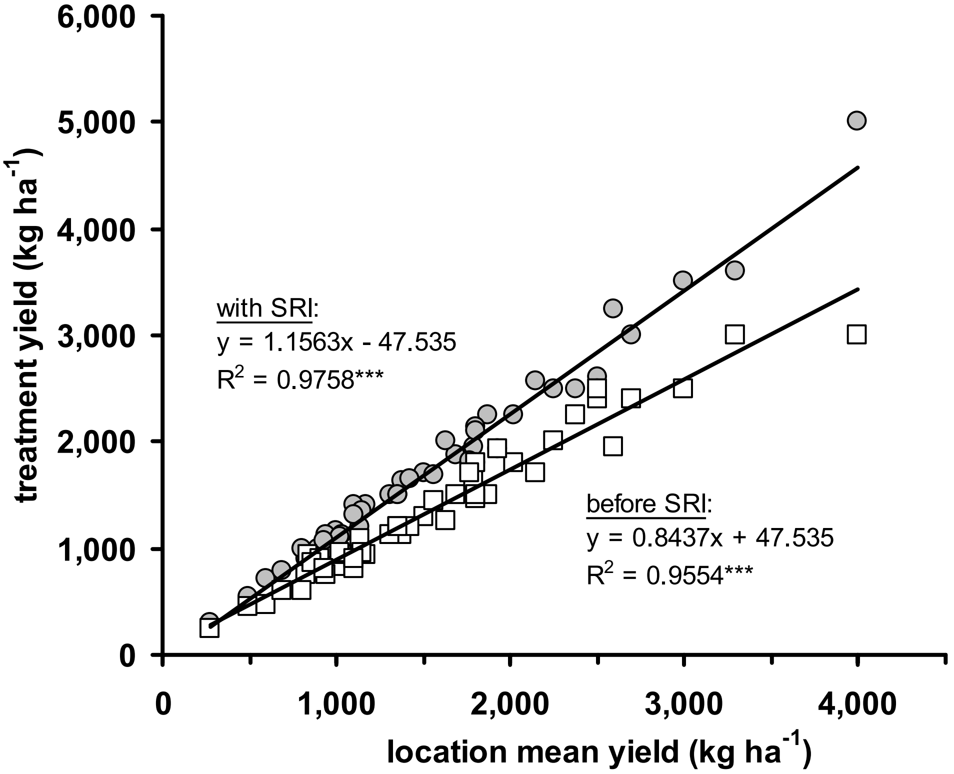

Figure 13 Adaptability analysis comparing yields on fields before applying SRI (conventional practice) and the succeeding year with SRI in Kandal province.

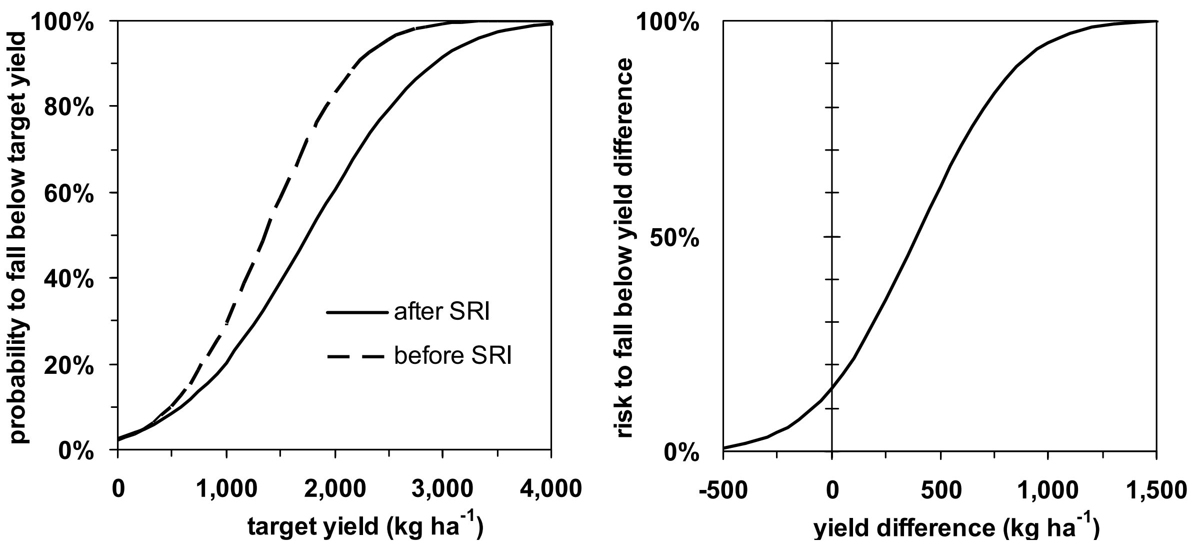

Figure 14 Risk (probability in %) for a randomly chosen farmer not to achieve a desired target yield on fields before using SRI (conventional practice) and with SRI (left) and the risk for a farmer not to achieve a desired yield difference when changing from conventional practice to SRI.

Table 9 Relationship between soil quality and farmer's choice of rice technology

Soil quality	Technology		Total	Results
	SRI	Common practice		
Poor	104 (17.4%)	234 (30.0%)	338 (24.5%)	χ^2=48.979***
Medium	395 (66.1%)	489 (62.8%)	884 (64.2%)	
Good	99 (16.6%)	56 (7.2%)	155 (11.3%)	
Total	598	779	1377 (100%)	

Soil quality was self assessed by farmers.

Table 10 Distance of the plot to homestead and farmer's choice of rice technology

Province	Technology		difference	P
	SRI	Conventional		
Kandal	509 ± 55	829 ± 52	315 ± 76	***
Kampong Thom	719 ±205	1004 ± 76	285 ± 219	n.s.
Kampot	373 ± 64	822 ± 93	449 ± 110	***
Takeo	170 ± 34	476 ± 45	306 ± 56	***
Prey Veng	238 ± 37	782 ± 68	545 ± 85	***
Total	405 ± 43	805 ± 32	401 ± 52	***

applied. Besides the need to go more frequently to the SRI fields for water management or weeding, the higher additional yield farmers can achieve on soil with better quality are assumed to be major reasons for the farmers' choice. **Therefore, highest yield increases are expected under favourable environmental conditions. Such conditions are met where soil fertility is higher; rainfall is sufficient and well distributed, the risk of crop losses due to flooding or drought is minimal and crop management is sufficiently good. Conversely, the potential of SRI to increase yields in poor environments is rather low.**

To assess the sustainability of a technology, long-term trials are usually required. In the framework of a rather short survey we tried to identify farmers who have experience with SRI for several years. Based on these data, the impact of SRI on yields beyond the first year of implementation was assessed. Likewise to the data obtained from other SRI farmers, there was a sharp increase in yields when changing from conventional practice to SRI (Fig. 15). These levels could be maintained for at least three consecutive years. Therefore, at least in the medium term, no adverse effects are expected.

One potential issue of SRI has not been discussed so far: The water management is one of the most unique components of the SRI set. **The radical change from anaerobic soil conditions to aerobic conditions may have consequences not yet foreseen.** The mechanical weeding as proposed not only seeks to control weeds but also enforces the process of soil aeration. These practices remain in complete contrast to management practices of cultivated crops other than rice. As mentioned before, soil organic matter plays an important role in the tropics for nutrient management and crop production. Exposure of soil with oxygen, e.g. through ploughing, should be minimized because when in contact with oxygen and water, the soil organic matter mineralises rapidly which can lead to soil degradation (KRAUSE *et al.*, 1984). During the last years increased efforts have been undertaken to maintain the organic matter through minimal tillage, which limits the contact of the organic matter with oxygen (CARSKY *et al,* 1998). Are these findings not valid for rice? In other cereal based cropping systems, no long-term sustainable crop production is feasible without permanently adding nutrients to the soil (BURESH *et al.,* 2001). In contrast, under flooded conditions, long-term rice trials established about 30 years ago, yields could be maintained at a fairly high level (DOBERMANN *et al.,* 2000).

Therefore, there is the potential risk that soil aeration leads to increased mineralization of soil organic matter. In the short term, mineralization may lead to increased yields; in the long run, however, increased nutrient exports through harvest may lead to soil fertility decline (DOBERMANN, 2004). **Therefore it is strongly recommended that long-term trials are established and monitored for changes of soil chemical properties.**

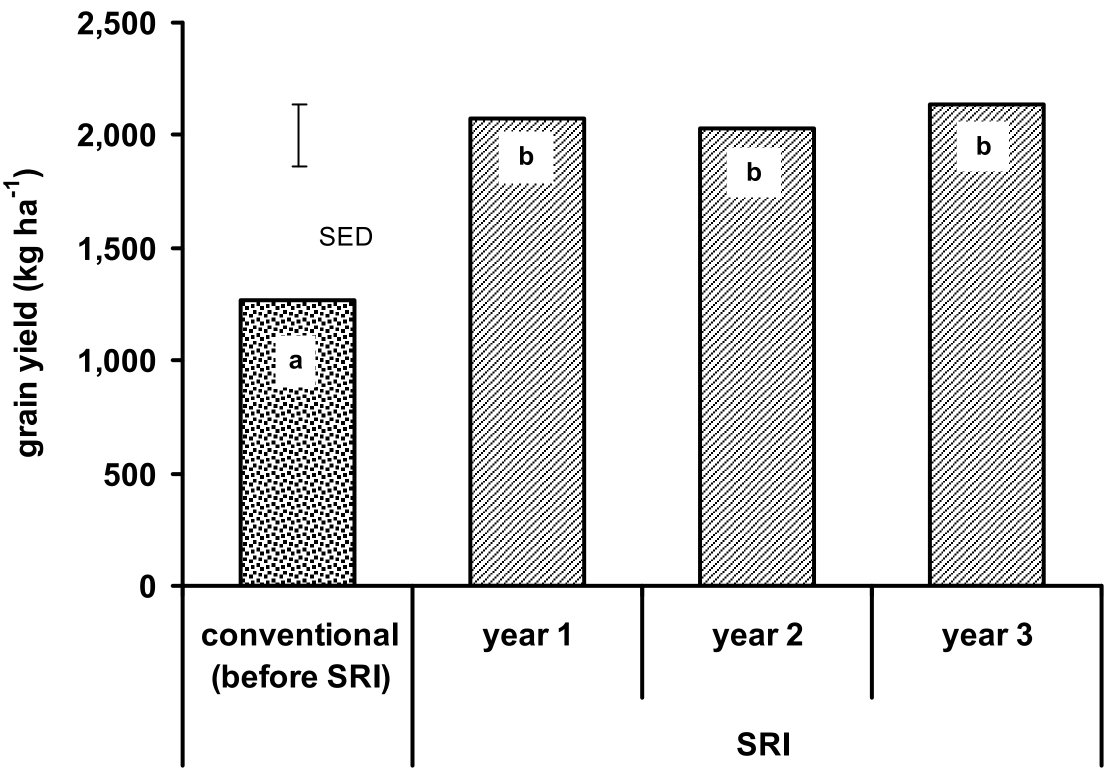

Figure 15 Rice grain yield with conventional practice (before SRI) and in the three succeeding years on the same fields when changing to SRI.

3.2 Labor demand and distribution

Labor is a very important production factor, especially for smallholder farmers, and needs to be included in any technology assessment. Most low external input technologies are very labor intensive and, despite promising agronomic results to increase yields, they largely fail to be adopted on a wider scale due to high opportunity costs for labor making them unattractive for farmers.

Different views on the labor demand for SRI exist. While SRI is thought to increase the labor demand in Madagascar (MOSER and BARRETT, 2003) the opposite is reported from Cambodia (CEDAC, 2002), at least for more experienced farmers. Group discussions with farmers during this study gave a very mixed picture without a clear trend. While many farmers mentioned the additional labor requirement caused by the increased weeding operations, lots of farmers expressed their appreciation about the labor saving effect during uprooting and transplanting. **A quantification of the overall labor demand for SRI showed that it is rather labor neutral with respect to family labor. However, it reduced the need for hired labor significantly, although at a fairly low level (Fig. 16).**

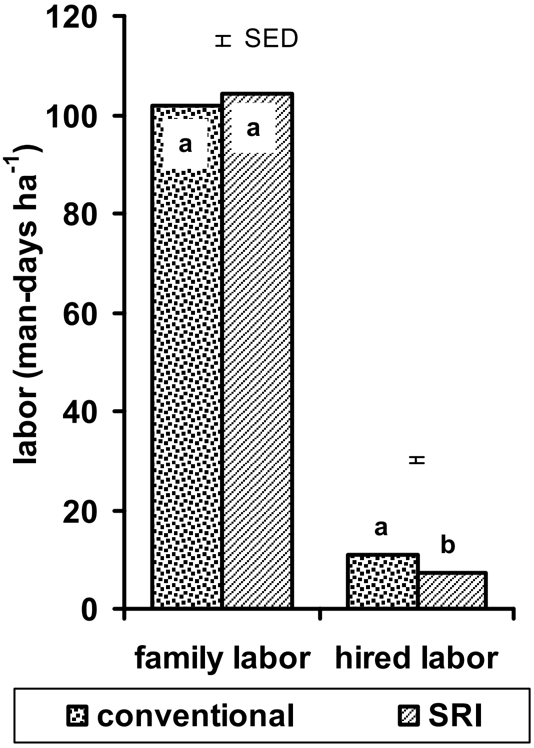

Figure 16. Total labor demand for conventional rice production and for SRI.

Taking a closer look at the individual cultivation activities of both conventional rice production and SRI, we can observe two major labor peaks: the first one for uprooting the rice seedlings and transplanting them to the field and a second peak for harvesting (Fig. 17). For most Cambodian farmers the second peak is of less relevance because it is at the end of the rice season and usually no further crop follows. The first peak, however, is a major labor bottleneck, which can severely affect the overall productivity of the whole farm. The reasons for the labor reducing effect of SRI during uprooting and transplanting is two-fold: (1) It is much easier to uproot the much younger seedlings and, (2) transport and transplanting of the much lower quantity of seedlings planted at wider spacing is time-saving. Unskilled farmers may require more time during the first year of SRI experimentation. Many farmers found it first difficult and time-consuming to select only the most vigorous seedlings and to carefully transplant the tiny young seedlings. Row planting is also sometimes found to be too time-consuming; however, there was a general agreement among farmers questioned during the group discussions that, with some experience, a substantial amount of time could be saved during the uprooting and transplanting activities. These statements were confirmed by stratifying the data set into SRI farmers practicing the novel practice for the first time and those farmers having more experience with SRI. While 35% of the first time experimenters claimed to need more time for uprooting and transplanting, only 21% of the more experienced farmers shared this opinion (Fig. **18**).

Obviously, with some experience SRI is able to cut down the most critical labor bottleneck by 10 man-days ha^{-1}, which is a reduction of 26%. Besides the reduction of inputs like seeds and fertilizers and the increase of yields, labor reduction during transplanting might be an important criterion for Cambodian farmers to adopt SRI.

SRI increases the labour demand for weeding (Fig. 17). Among the SRI farmers 93%, 26% and 7% of them weeded the SRI fields at least once, twice or tree times respectively, while only 40% of the same farmers weeded the same fields only once when using conventional practices. On average, weeding operations on SRI fields were performed 19, 30 and 44 days after transplanting. However, labor allocation between transplanting and harvesting is more frequently available except in cases when farmers leave their farm to look for other income opportunities. The latter case holds true for poorer farmers or for farmers whose major income derives from other sources. Such farmers might find it difficult or even unattractive to apply SRI due to high opportunity costs. **On the other hand, full-time farmers with sufficient labor forces available in their household should be able to manage the necessary weeding operations**.

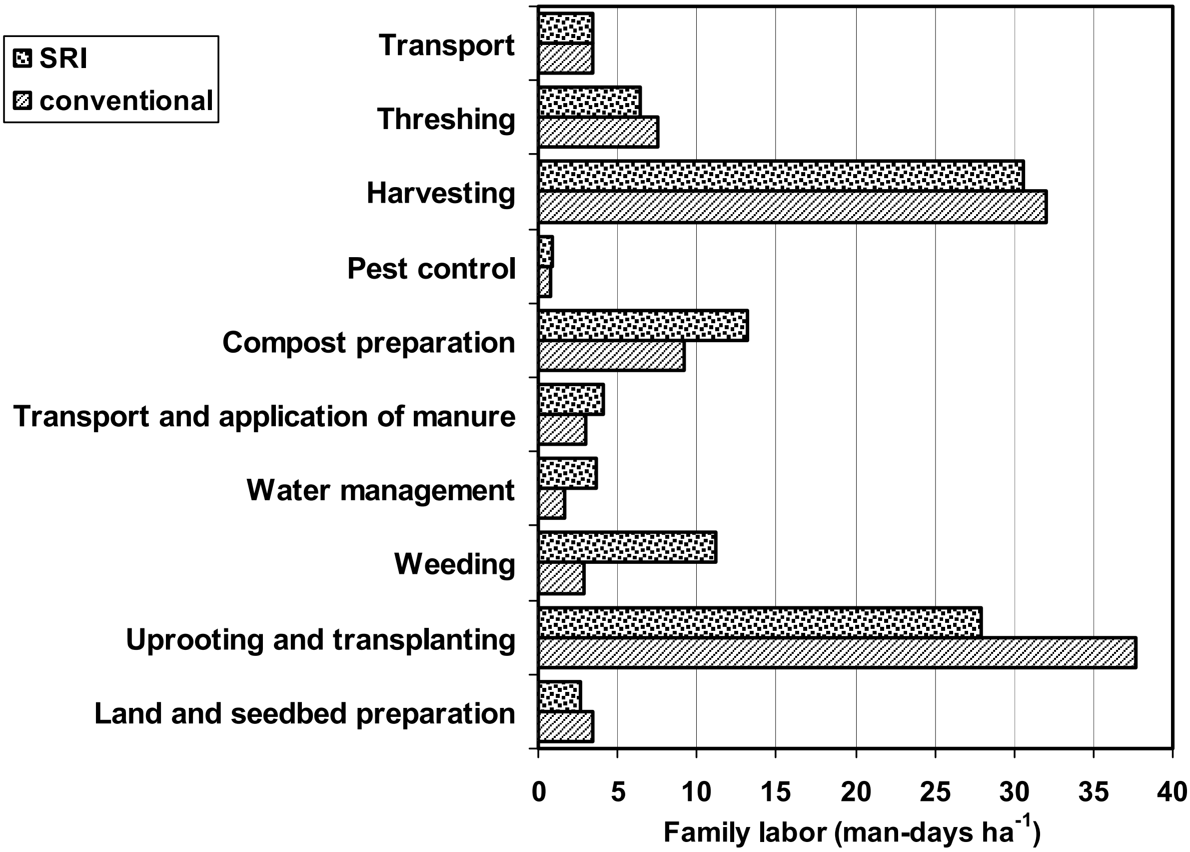

Figure 17. Family labor demand for individual rice management activities with common rice cultivation practices (before SRI) and with SRI (N = 176)

The household's decision to seek off-farm employment between transplanting and harvesting not only depends on the availability of suitable jobs but also depends on the location specific rainfall pattern and frequency of flooding and drought. In certain locations the rice fields frequently dry out and again become submerged after rainfall. In such environments, weeds establish much easier and weeding operations become a normal part of rice production. In other environments, where the fields are usually submerged throughout the rice season, weeding might not be perceived as necessary. Where weeds are more common, weeding operations are a normal part of rice cultivation as well, and farmers allocate their time accordingly. Where submerged rice fields largely suppress the weed flora, farmers are more likely to leave the farm to look for extra income. In Kampong Thom, for example, only 6% of the SRI farmers formerly weeded their fields, while in Takeo 83% of the farmers weed their conventional rice plots (Fig. **19**). Therefore, it can be assumed to face an adoption constraint due to weeding in Kampong Thom rather than in Takeo.

Compost making and its application also requires additional time when applying SRI, but the time requirement is rather well distributed throughout the season. For most farmers, compost preparation and its application was not mentioned as a major

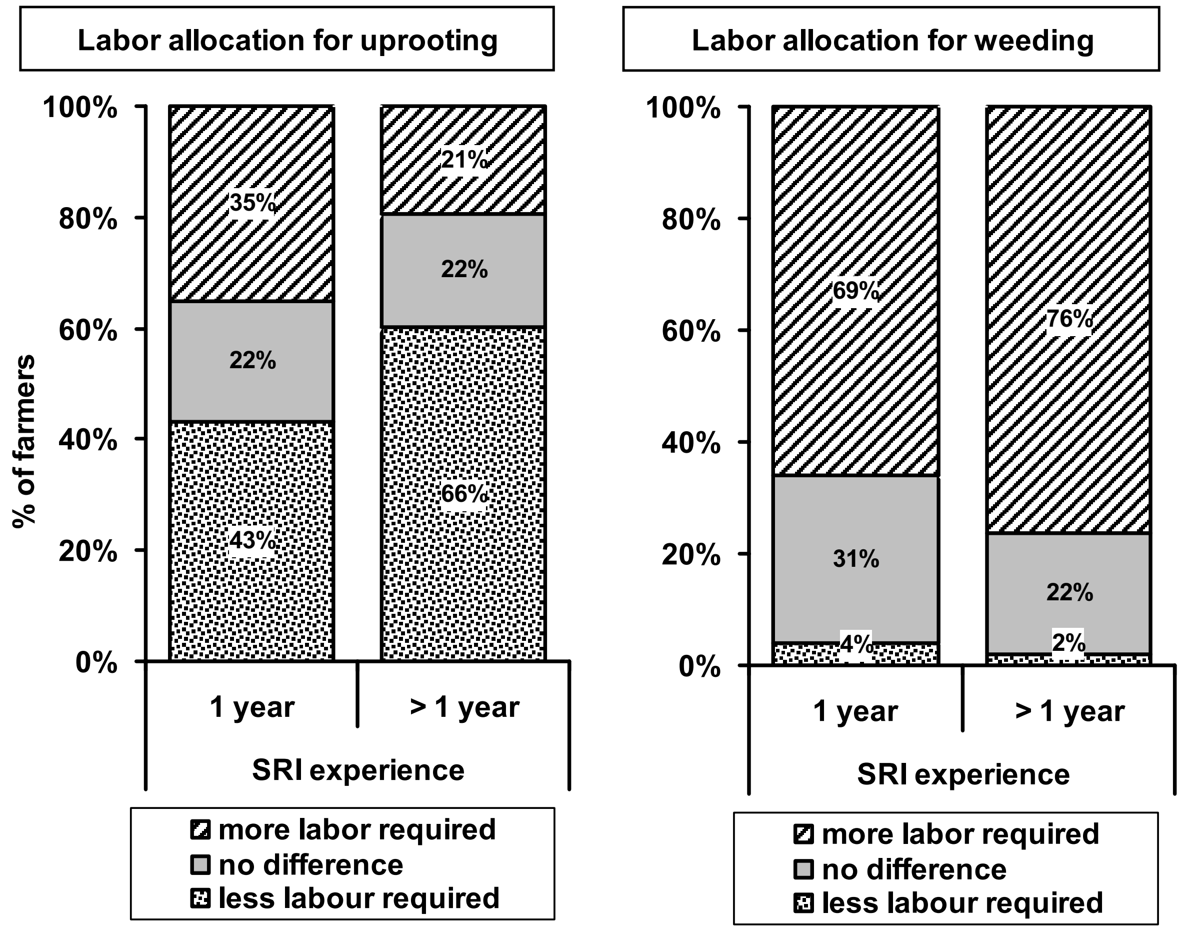

Figure 18 Qualitative assessment of labor demand for uprooting and transplanting (left) and of weeding (right) depending on the experience of farmers with SRI.

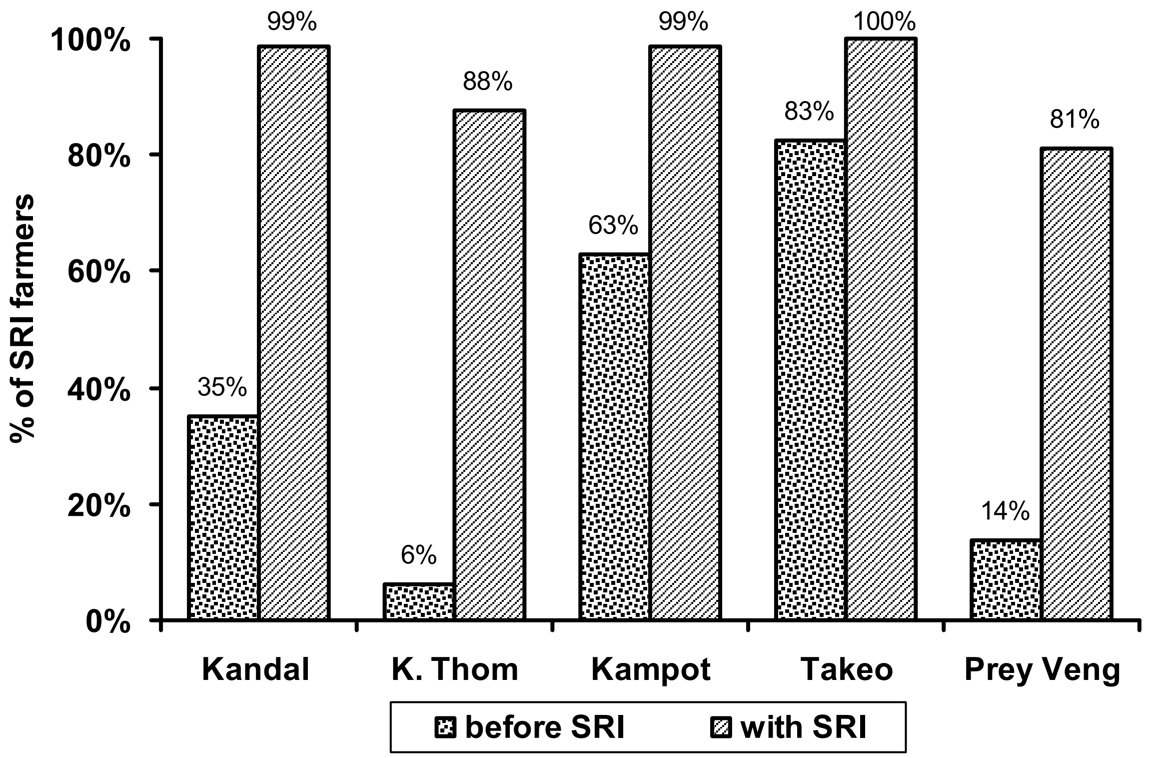

Figure 19 Percentage of farmers who weeded their rice crop at least once with common cultivation practices (before SRI) and with SRI.

labor constraint. However, farmers who intend to leave the farm part-time for additional income sources might find it difficult to allocate adequate time for compost preparation.

Despite these overall positive results of the effect of SRI on labor demand and distribution, a less obvious issue occurs for larger farms with a low labor force. Farmers often practice SRI only on parts of their rice fields and explain it with labor constraints during transplanting. Such an answer seems to make no sense given the labor-saving effect during transplanting as discussed above. The reason is the transplanting of very *young* seedlings. While the age of the seedling is less important in conventional rice cultivation, there is only a short period during which farmers can transplant young seedlings. The obvious solution to that problem seems to be staggered sowing of seeds so that young seedlings are available at any time during transplanting. However, depending on the farm size and the labor force available, transplanting for an extended period of time easily collides with weeding the seedlings transplanted first. Hence, the timing of these activities may limit the adoption potential for larger farm sizes.

Within farming households, there is often a significant specialization of agricultural tasks, and enterprises, among sex and age groups (SANDS, 1986). Such specializations can cause an unbalanced advantage/disadvantage for a certain gender group when the household applies a certain agricultural practice or technology.

To get an impression of whether the introduction of SRI leads to a shift of responsibilities of rice management activities, a qualitative assessment was conducted. The results showed no general changes in responsibilities for the different activities among women, men and children (Table **11**). However, the main actors during uprooting and transplanting are female household members. This was repeatedly confirmed during the group discussions with farmers. Therefore, **the reduced labor demand during transplanting particularly benefits the female household members**.

Table 11 Household member responsibilities for different rice management activities as affected by the rice technology (common practice vs. SRI)

Rice management activities	Common practice (before using SRI)			SRI		
	female	male	children	female	male	children
Ploughing	7.5	95.8	3.0	7.2	96.0	2.7
Leveling	13.2	94.3	3.3	13.2	95.0	3.7
Establish drainage channels	14.8	86.8	4.5	15.2	87.0	2.8
Sowing rice seeds in the nursery	84.0	47.6	8.7	84.0	47.1	8.0
Uprooting and transplanting	95.3	90.3	44.4	96.0	90.3	46.1
Weeding	57.1	57.3	16.8	67.9	78.5	25.3
Application of mineral fertilizer /compost/animal manure	63.3	78.5	14.5	64.5	78.3	14.0
Compost preparation	60.1	69.8	34.4	63.3	73.8	35.8
Water management	29.0	79.3	4.5	30.4	79.8	5.5
Application of pesticides/ pest control	5.2	34.2	5.5	5.2	30.4	2.2
Harvesting	93.5	91.5	37.9	94.0	90.5	40.1
Threshing	41.9	86.8	15.7	41.9	82.8	15.0
Transport	8.7	94.0	7.2	9.7	93.5	7.2

Values refer to percent of farming households using SRI

3.3 Economics

3.3.1. Gross margin calculation

Gross margin calculations revealed a clear advantage of SRI over conventional practices. On average, gross margins increased from 120 US \$ ha^{-1} to 209 US \$ ha^{-1}, an increase of 89 US \$ ha^{-1} (+74%) (Table **12**). The economic marginal difference is equivalent to 890 kg rice seeds ha^{-1}. Two factors contributed to the large difference. Farmers saved 23 US \$ ha^{-1} for variable costs like seeds and mineral fertilizers, and SRI substantially increased rice yields leading to an increased gross benefit by 66 US \$ ha^{-1}.

Gross margin calculations do not consider the timing effect. However, saving costs for inputs might be even more valuable to the farmers than increasing yields because costs for purchased inputs are saved at a time of year when financial resources in small-scale farming households are particularly scarce. Hence, the farmers presumably value the economic advantage even higher than it already appears. Moreover, saving monetary inputs reduces the economic risk of investing money for purchased inputs and losing everything in case of flooding or drought.

Table 12. Gross margin calculation for rice production on fields with common cultivation practices (before SRI) and for the succeeding year with SRI (in US $)

	Before SRI	With SRI	difference
Gross benefit	**161.33**	**226.89**	**+65.56**
Variable costs:			
Seeds	9.26	3.01	-6.25
Plant nutrition	21.43	6.61	-14.81
Plant protection	0.38	0.12	-0.26
Hired labor	9.45	6.60	-2.85
Threshing	0.86	1.72	+0.86
Sum variable costs	**41.37**	**18.06**	**-23.31**
Gross margin ha^{-1}	**119.96**	**208.83**	**+88.87**
Gross margin man-day^{-1}	**1.55**	**2.54**	**+0.99**

3.3.2 Economic risk

Economic risk assessment revealed a lower risk for SRI to achieve the same desired gross margin per hectare than with conventional practices. For example, the probability not to achieve a gross margin of 100 US $ ha^{-1} was 42% for common rice practices, while the probability not to achieve 100 US$ with SRI was only 17% (Fig. **20**). Moreover, the risk for SRI to be economically outperformed by other methods was only 12%, 16%, 13%, 2% and 12% in Kandal, Kampong Thom, Kampot, Takeo and Prey Veng, respectively.

The return to labor was much more variable than the return to land. Therefore, the slopes of the risk curves were gentler. Likewise to the return to land, the risk to fall below a defined gross margin man-day^{-1} was always lower (Fig. **21**).

It was concluded that **SRI is an economically very attractive methodology for rice cultivation with a lower economic risk compared to other cultivation practices**.

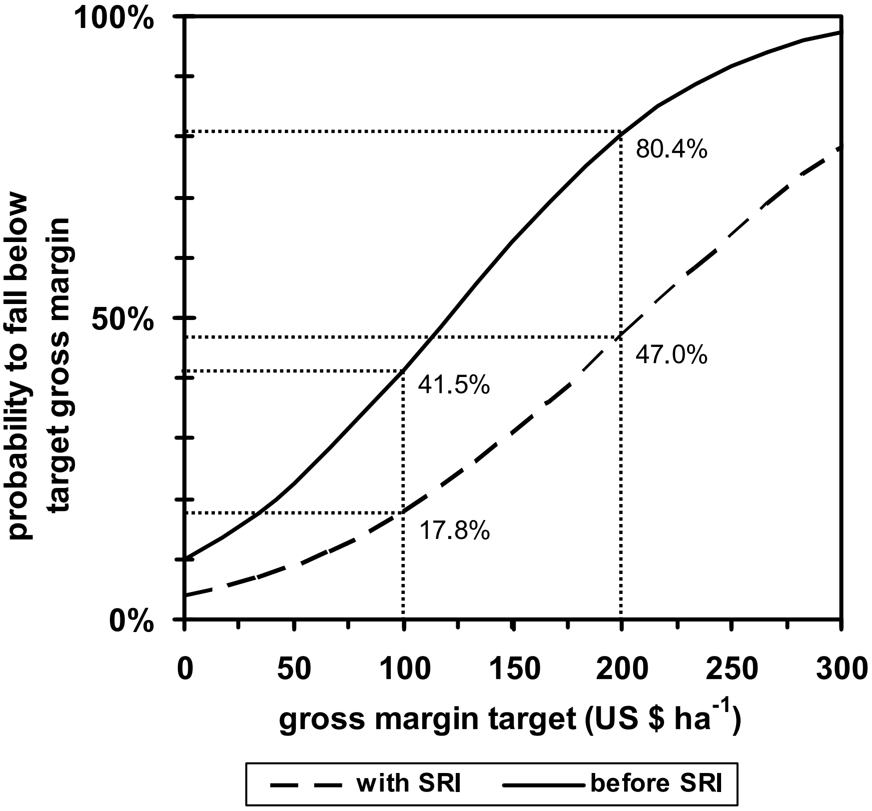

Figure 20. Risk (probability in %) for a randomly chosen farmer among the SRI farmers not to achieve a gross margin target per hectare before using SRI (conventional practice) and with SRI.

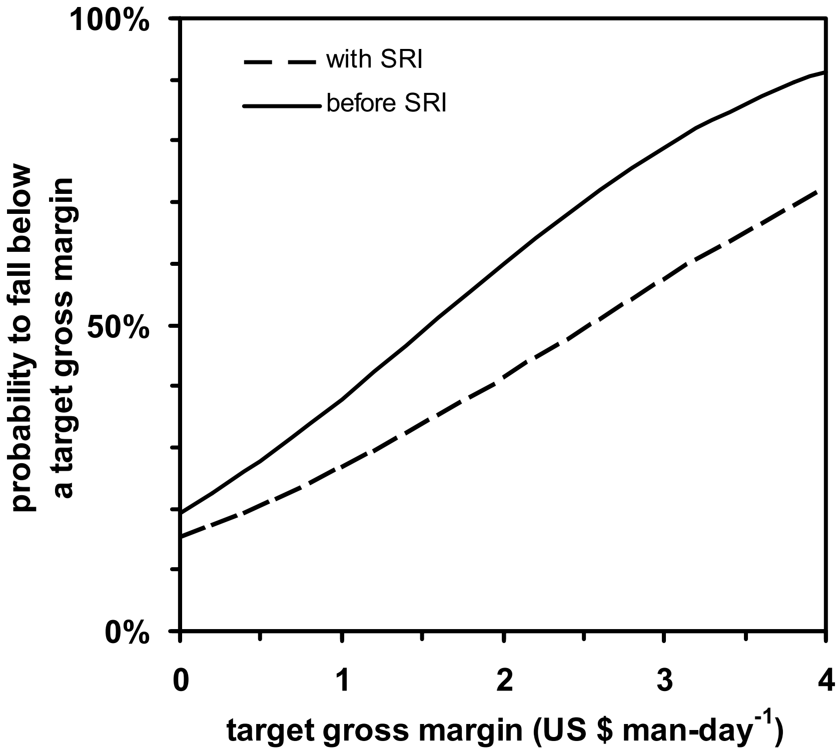

Figure 21. Risk (probability in %) for a randomly chosen farmer among the SRI farmers not to achieve a gross margin target per man-day before using SRI (conventional practice) and with SRI.

4 Impact at household and national level

Agricultural technologies are usually compared on a hectare basis. However, to have an effect at the farm household level, a sufficiently large proportion of the agricultural land must be converted to the practice.

4.1 Rice self sufficiency

In rural Cambodia, having enough rice and other foodstuffs to eat 12 months a year is synonymous with being not poor or food insecure (CSD, 2002). Those affected by chronic food insecurity include subsistence farmers, landless and marginal land holders, while transitory food insecurity is caused by natural disasters such as flooding or drought.

To assess the contribution of SRI to poverty reduction, the SRI practicing farmers were asked about the changes of rice sufficiency/insufficiency from the time before they practiced SRI (conventional practice) compared to afterwards when applying SRI at least on parts of their fields (Table **13**). **Since farmers started applying SRI, the proportion of farmers facing rice insecurity declined from 34 to 28%. At the same time, farmers being able to produce a surplus increased from 20 to 33%.**

Table 13 Changes in sufficiency of rice production when changing from conventional practice to SRI.

Rice technology	Not enough	Enough	Surplus
Conventional	138 (34%)	182 (45%)	80 (20%)
SRI	112 (28%)	157 (39%)	131 (33%)
Difference	-26 (-6%)	-25 (-6%)	+51 (+13%)

As anticipated, the **effect of SRI on rice sufficiency depends on the area where farmers apply the new practice.** There was no effect on food security in farming households where the area under SRI was lower than 30 are (Fig. **22**). Conversely, applied on 30 are and above, SRI significantly reduced the number of months deficient in rice supply. Therefore, to assess the impact of SRI on the household level, one must know the proportion of rice land converted to SRI management.

Farmers using SRI usually do not convert their whole rice fields to SRI, partly because it is a new and unknown practice to them. When applied for the first time, the area under SRI was 28 are, representing 21% of the total farm (Fig. **23**). Farmers with more experience with SRI applied SRI on 66 are or 42% of the total rice area. These results lead to two conclusions: (1) Farmers are generally satisfied with SRI and, therefore, increase the proportion of SRI on their farm, (2) About half of the rice area continues to be cultivated with conventional practices, indicating that there are certain constraints for farmers not to apply SRI on all of their farm land. Farmers' intentions for the next season confirm these findings: Averaged over all SRI farmers, 42 are (29%) were cultivated with SRI last year (2003). The same farmers expressed their intention to increase the area this year (2004) to 52 are (37%). The lower increase can be explained by farmers included in the analysis, who have already converted all of their suitable rice area to SRI. **As many as 17% of all SRI farmers had converted the total rice area to SRI. These figures alone document that SRI works well at least for a substantial part of farmers**.

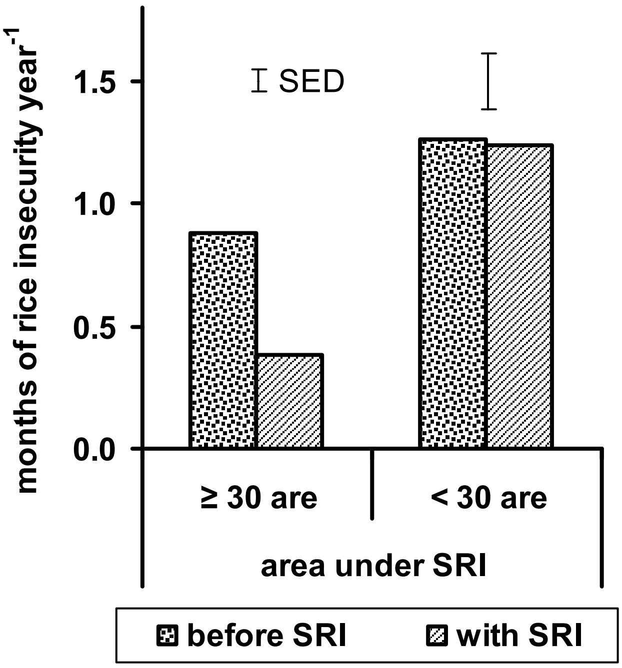

Figure 22 Months of rice insufficiency before applying SRI (common practices) and with SRI depending on the area under SRI

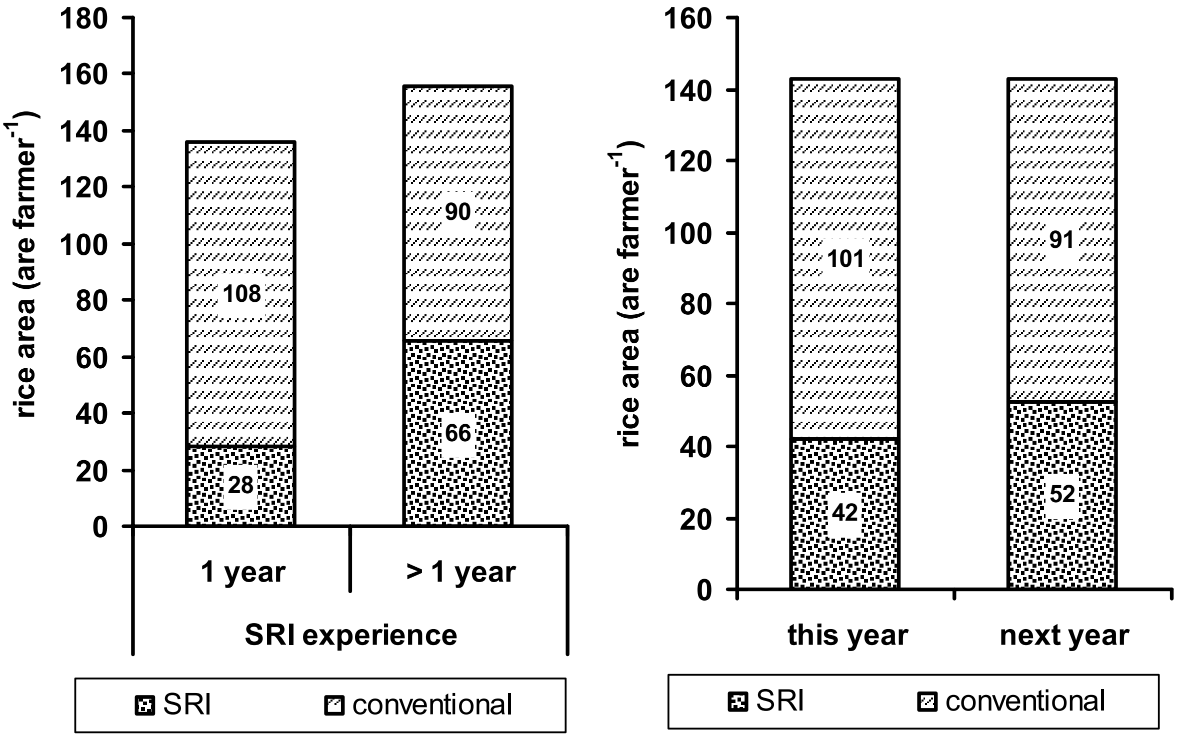

Figure 23 Proportion of rice area cultivated with SRI practices to rice area cultivated with conventional practices depending on the experience of the farmer with SRI (left) and proportion of farm land cultivated with SRI this year (2003) and intention for the following year

Using the proportions of rice area the farmers were applying SRI and conventional rice practices resulted in an average gross margin of 192 US $ household^{-1}, an increase of 26 US $ (+15%) for farmers using SRI the first time (Table **14**). The more experienced farmers with 42% of their rice area cultivated with SRI practices enjoyed an increase of the average gross margin household^{-1} by 52 US $ (+31%).

The average monthly rice consumption per household was 114 kg. That means that in **households using SRI for the first time, the surplus produced with SRI was equivalent to the household's rice needs for 2.2 months. For the more experienced farmers, the rice surplus from SRI was equivalent to the household's need for as much as 4.6 months. Hence, SRI significantly contributes to rice self sufficiency of farming households**.

Table 14. Economic impact of SRI at field level and at household level considering the experience of the farmer with SRI (difference to conventional practices in brackets)

	Field level		Farm level (1st year)*		Farm level (succeeding years)*	
Gross margin ha^{-1} (US $)	208.83	(+88.87)	138.39	(+18.43)	157.51	(+37.55)
Gross margin household (US $)	-		192.36	(+25.62)	218.94	(+52.19)
Gross margin man-day (US $)	2.54	(+0.99)	1.79	(+0.24)	1.98	(+0.43)

* experience with SRI

4.2 Labor – constraints at the household level

It was mentioned earlier that the time between uprooting/transplanting and the **requirement for early weeding after transplanting might pose a constraint for farmers to apply SRI on a large scale within the household**. On average, the SRI practicing households had an available labor force of 3.37 man-units (Table **15**). Therefore, the days required for uprooting and transplanting was 15.5 days for conventional practice and 11.5 days for SRI. Although transplanting takes 4 days longer for the conventional practice, no urgent activity follows. Even for households with a low labor force, prolonged transplanting is possible.

For SRI the situation is different. Not only do the seedlings have to be of a certain age (preferably 8-15 days) but early and frequent weeding is also recommended. On average it would be possible to weed after 11 days, which might still be early enough. However, single-headed households, households with elderly farmers without children and very large farms would not have the necessary labor force to weed early (Fig. **24**). If applied on all of their rice area, the weed competition would presumably wipe out the possible gains. In these cases, hired labor is required to practice SRI, but then SRI could no longer be considered a low external input technology.

Table 15. Required man-days for uprooting and transplanting, available man-units per household and required days for uprooting and transplanting

	man-days/ha	man-days/HH	man-units	days for transplanting
conventional	37.7	52.3	3.37	15.54
SRI	27.9	38.8	3.37	11.52

Based on the average sample rice growing area per household of 1.39 ha

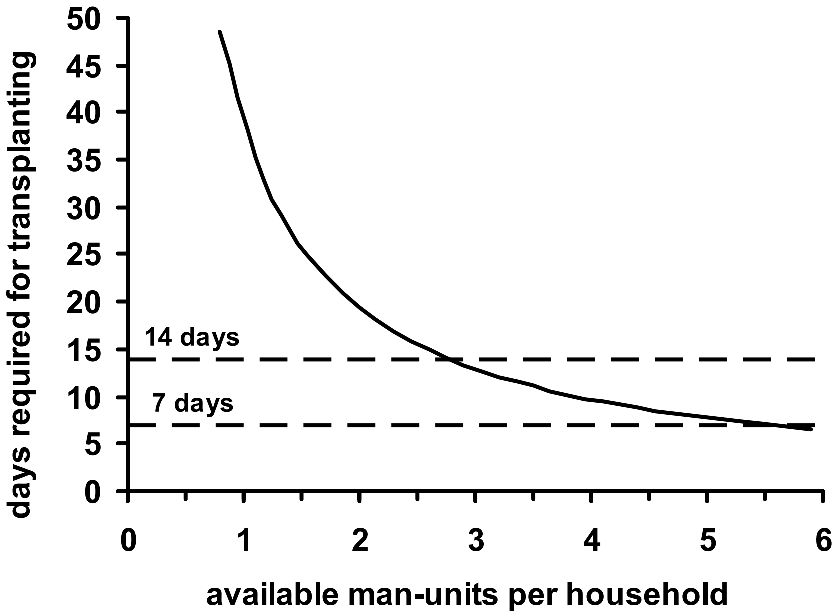

Figure 24. Relationship between available man-units per household and required days for uprooting and transplanting for a rice area of 1.39 ha (sample mean).

4.3 Adoption and potential economic benefit at national level

CEDAC was the first organization to introduce SRI to Cambodia. In 2000, the first farmers were trained on SRI principles and practices and implemented it in their rice fields. Since then, the number of SRI practicing farmers has increased continuously. Meanwhile, several government and non-governmental projects promote SRI in various provinces of the country. According to CEDAC, the number of SRI farmers reached more than 9,000 in 2003 and is expected to increase to 50,000 in 2004 (Table **16**). Whether these high numbers are realistic is difficult to say. Different projects have different methods of data collection and monitoring, and the numbers of SRI practicing farmers derive mainly from estimations by project managers, implementing field staff or farmer promoters/key farmers. Implementing staff and farmer promoters are expected to be biased towards higher figures as it is part of their duty to convince more farmers to experiment with SRI. Therefore, it was also not surprising that no data about dis-adopting farmers were available. However, given some of the problems associated with the use of SRI, it would be surprising not to have at least a certain proportion of experimenting farmers who reject the practice after some time. The number of farmers who reject SRI can be very high as surveys on SRI elsewhere (MOSER and BARRETT, 2003) and on other rice technologies in Cambodia have shown when using randomized sampling procedures (ANTHOFER, 2004).

Despite these uncertainties, a scenario with different adoption rates documents the economic potential of SRI at the national level (Fig. **25**). Assuming that farmers convert the same proportion of their rice area to SRI, even low adoption rates would lead to substantial economic benefits. For instance, **an adoption rate of 10% of experienced SRI farmers who apply SRI on 42% of their rice area would account for an annual benefit of 36 Mio. US $. Such benefits are high enough to justify additional costs for training in SRI within the agricultural extension system.**

Table 16 SRI farmers in 2003 estimated by CEDAC

No	NGO	Province	SR
CEDAC projects:			
1	CEDAC-ILFARM	Prey Veng	1000
2	CEDAC-EED	Ta Keo	563
3	CEDAC-ILFARM	Ta Keo	980
4	CEDAC-SCIP	Kg.Thom	180
5	CEDAC-NTFP	Ratanakiri	100
6	CEDAC-JFPR	Kg.Cham	100
7	CEDAC-JFPR	Prey Veng	38
8	CEDAC-FFI	Pursat	3
9	CEDAC-JFPR	Svay Rieng	45
10	Farmer to Farmer	5 Province	1029
		Subtotal	**4038**
NGOs funded by Oxfam GB with technical assistance of CEDAC			
1	Rural Development Association	Battambang	10
2	Krom Aphiwat Phum	Battambang	150
3	Aphiwat Strey	Battambang	81
4	National Prosperity Association	Kg.Speu	13
5	Nak Aphiwat Sahakum	Kg.Cham	75
6	Cham Roeun Cheat Khmer	Ta Keo	81
7	Chey Thor	Prey Veng	29
8	Wattanak Pheap	Pursat	15
9	Ponleu Ney Khdey Sangkhim	Prey Veng	43
		Subtotal	**497**
Other NGOs/projects			
1	PADEK	Prey Veng	17
2	PRASAC	Prey Veng	1700
3	PRASAC	Ta Keo	538
4	PRASAC	Kg.Speu	439
5	PADEK	Kg.Speu	30
6	GTZ-CBRDP	Kg.Thom	1274
7	GTZ-CBRDP	Kompot	530
8	CRS	Svay Rieng	4
9	ADRA	Siem Reap	60
		Subtotal	**4592**
		Total	**9127**

Data are based on estimations from project managers, implementing field staff and farmer promoters/key farmers but not from randomized sampling procedures.

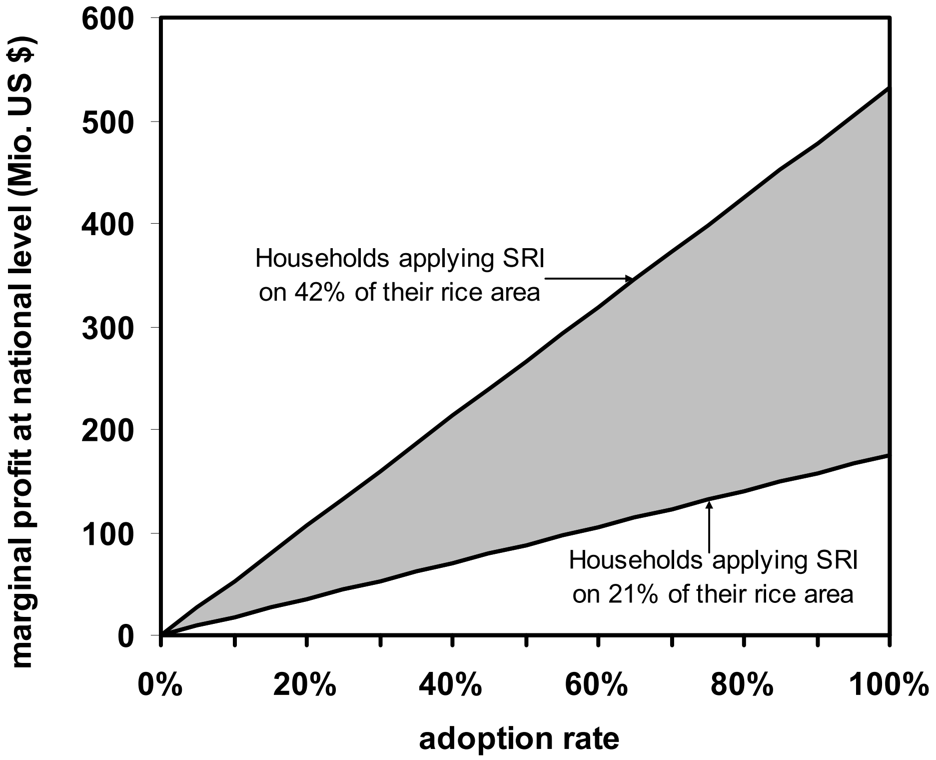

Figure 25. Scenarios for the economic benefit at national level using different adoption rates and moderate levels of SRI application within farming households as found in the current study.

Plate 3. Individual interview of a farmer in Kampong Thom province by an enumerator as part of the survey.

V Conclusions and Recommendations

1 Advantages and constraints of SRI

SRI applied under complete farmers' management proved to offer several ***advantages*** to farmers. On average, it considerably increased rice grain yields, and these yield levels could be maintained for at least three consecutive years. The overall demand for labor remains the same as compared to conventional practices, but SRI has the advantage to break the most important labor bottleneck in rice cultivation, namely uprooting and transplanting. Costs for inputs such as seeds and mineral fertilizers are reduced at a time of year when financial resources of the farming household are scarce. The reduction of input costs, together with an increased gross income through higher yields and an unchanged overall labor demand, leads to a higher land and labor productivity compared with conventional farming practices.

Constraints of SRI mainly refer to site specific factors. Under poor environmental or management conditions, the yield increase with SRI compared to other practices was rather low. Animal manure and other farm resources for plant nutrition to compensate for the reduction of fertilizer use are also often not sufficiently available. The weeding requirement in the SRI system might pose an adoption constraint for farmers who usually leave their farm after transplanting to seek additional income opportunities. Likewise, elderly households without children, single headed households and very large holdings might not have the required labor force to transplant young seedlings and weed in time afterwards. Such households might be able to apply SRI only on smaller portions of their farm. The most important constraint is the starting point. Due to its very unconventional practices of transplanting very young seedlings at wider spacing and alternation of flooding and drying of the soil, SRI requires much more training and follow-up than the propagation and dissemination of other rice technologies.

Despite many open questions still to be investigated by researchers, **SRI has proven to be a worthwhile practice to be promoted and should be included in any rice intensification program**. Although some of the constraints limit its use on larger proportions within a farm and certain farming households might not be able or willing to apply it, its potential should not be missed.

2 Crop diversification

It is often argued that increased yield levels achievable with SRI can be used to diversify crop production. On a smaller proportion of farmland the same quantity of rice can be produced as before, and on the remaining land other crops with a higher economic value can be grown. Although that argument seems to be appealing, it faces several difficulties to put into practice. Many Cambodian farming households produce near subsistence level and are often not even self-sufficient in rice production. The current study has shown that SRI contributes to food security, but the households' production level is still far from being able to produce large amounts of surplus rice. Therefore, farmers are unlikely to grow crops other than rice if self-sufficiency in rice is still at risk. Rice produced with SRI practices faces the same risk of being seriously affected by drought or flooding than rice produced by conventional practices, and to shift to other crop enterprises would imply taking an unnecessary risk into account. Secondly, many farming environments are located in flood prone areas; hence, if not flooded, the area is at least submerged. There are simply no other crops which have the same adaptability to such harsh environmental conditions. While drought affects all crops including rice, rice is among the few crops, which can withstand submerged conditions and even survive complete flooding for a short time. Group discussions with farmers confirmed this point. They completely rejected the idea of growing crops other than rice. Farmland at higher elevations might have the potential to be used for other crops, but these are exactly the rare pieces of land farmers choose to apply SRI. Hence, **although not impossible, the potential to diversify crop production with increased yield levels should be viewed more realistically.**

3 Research-extension linkage

The underlying dynamics of SRI are still hardly understood. Unfortunately, researchers up to now have largely ignored the potential of SRI and remain very critical of SRI. However, the increasing number of farmers experimenting with and applying SRI documents the relevance of that system. On the other hand, practitioners have either used inadequate evaluation methods or presented the data in a strongly biased way. For instance, to extrapolate yield figures from mini-plots of a few square meters taken with crude measurements (hanging scales, no adjustment for moisture) and to calculate on that basis hectare yields is not acceptable. Likewise, to present maximum yield data obtained by a handful of farmers creates a misleading impression. If maximum values are presented so should be the minimum values. If maximum yields with SRI are presented so should be maximum yields for conventional practices. Yield data taken under farmers' management vary considerably. Therefore, it is still best only to present mean data and possibly a measure to capture the variability (e.g. standard deviation).

On the other hand, researchers often focus on so-called best practices. If applied exactly in the way researchers wish, such options might easily perform better than SRI, but this is not the point. Finally, what counts is how the farmer handles a certain technology or option and how it performs against competing options. **The fact that thousands of farmers have started to use SRI, with a considerable number applying SRI on all of their rice area, clearly documents that SRI works very well under the conditions small-scale farmers are facing in Cambodia**. SRI is already a reality in Cambodia. If researchers reject to get on the boat, it will depart without them. **Researchers should view SRI as a great opportunity to work on. There are many knowledge gaps, and researchers are urgently needed,** especially for the investigation of the long-term sustainability of such a system.

Unfortunately, discussions at the international level have become very tense. What is now needed is a discussion where one respects the other side's opinion. The recent workshop on SRI in Phnom Penh has shown that both sides can learn from each other if people are open enough and do not perceive their point of view as a dogma. The **existing task force on SRI**, a loose meeting group of the implementing projects of CEDAC, GTZ and PADEK that discusses issues concerned with SRI, **should be broadened** and include government institutions like MAFF and CARDI and major donor agencies involved in agriculture. Such a forum should identify a common approach of technology development, modification and dissemination with regard to SRI. Research needs have to be identified and suitable trials can be carried out. While the implementing agencies have better knowledge about the biophysical and socio-economic conditions of many of the farmer locations, researchers might be able to identify the appropriate research and evaluation tools, which can meet internationally agreed standards.

4 Implication for the extension approach

So far, SRI has been introduced and promoted by a participatory farmer group approach. This approach developed by CEDAC has proven to be a useful instrument in disseminating SRI. In Kandal, the first province in Cambodia where CEDAC introduced SRI, farmers now act almost independently without much assistance by the project. Key farmers disseminate SRI to other farmers, facilitate group meetings and conduct training. Besides SRI, other technological options are now being tested and promoted. Although during the initial stages much training, coaching and follow-up is necessary, enabling farmers to play a more active role in their own development is presumably much more sustainable in the long term than approaches where farmers have few choices other than to accept or reject a technology developed elsewhere.

The question is whether the approach of technology development and dissemination has much to do with SRI. Is SRI not a technology like any other technological option that can also be taught in a top-down system? Most likely not! SRI itself should not be perceived as a technology but as a set of practices. To apply these practices in a flexible manner goes beyond teaching. During the training and evaluation process, farmers learn how to identify practices most useful to them and modify others according to their own needs and circumstances. One of the great advantages of SRI is its ability to compete very well against any other conventional option. The fact that farmers experience yield increases with practices so uncommon and against old inherited customs builds up trust in the projects promoting SRI. Hence, **SRI is particularly useful to serve as an important entry point for any further development intervention intended by a project. This chance should not be missed and the focus should go beyond just SRI.** What implications does such an approach have for the existing extension service? In various projects so far, extension workers have set up demonstration plots to 'demonstrate' an improved technology. SRI is also demonstrated to other farmers but in a different manner. No doubt, it is very important that farmers get exposed to a new technology, see for themselves how it performs and possibly interact directly with a farmer hosting the demonstration. However, **it is important that farmers have the feeling that they have ownership over the demonstration in question. Heavily subsidized demonstrations do not fulfil this requirement.** Within the SRI training, farmers visit other farmers who apply SRI, but these plots are meant not only to demonstrate something for the project. They are just normal fields the farmers cultivate.

In a first step, **extension workers need to be trained in participatory approaches and tools. The technological aspect of SRI needs to be transferred to the extension workers as well**. It is strongly recommended that CEDAC gets involved in government staff training because they already have several years experience on the topic. However, even CEDAC have to learn and adjust their teaching program. They have a very strong focus on the environmental aspects and largely reject the use of mineral fertilizers. Some of their views are questionable or are too strict by largely generalizing adverse effects of certain fertilizer types used in particular situations. Hence, **especially the technical aspects of SRI should be discussed with research institutions like CARDI and, where found necessary, be modified according to new insights. SRI should not be perceived as organic agriculture per se.** This would counteract its initial idea of handling its components flexibly.

Beyond the field level, networking will become increasingly important to streamline activities and to avoid wasting resources by investigating the same research questions elsewhere. It is important for MAFF to have both subject matter specialists for the technical side of SRI and for the participatory approach of disseminating the practices in place. They themselves need a continuous feedback from the various provinces and districts as well as from the research site to work most efficiently.

In conclusion, SRI is a worthwhile rice management practice to be promoted with a substantial demand for financial and human resources. However, **the possible long-term gains achievable through SRI and a more farmer-centred extension approach easily justify the costs involved**.

Plate 4. Transplanting of young rice seedlings with one seedling per hill

Plate 5. Increased tillering of single transplanted rice seedlings under aerobic conditions

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Appendices:

1. **Group discussions**
2. **Questionnaire**
3. **Schedule of survey team**
4. **Terms of Reference**

Group discussion in Trapaing Raing, Mokak commune, Angsnoul district in Kandal province; 23.02.04

- Participants:
  a. all consultants (3) and enumerators (6), one CEDAC staff,
  b. representatives of farmer associations for community development who are also key farmers for SRI dissemination: 12 (4 female, 8 male):
     i. from Traipaing Raing: 7 farmers;
     ii. from Traipaing smatch: 2 farmers;
     iii. from Trapaing tey: 1 farmer;
     iv. from Srekandol: 1 farmer;
     v. from Taprap: 1 farmer.

Discussion with farmers:

- General problems in farming:
  c. availability of water, sometimes drought;
  d. diseases
- History of SRI introduction and dissemination:
  e. SRI was introduced by CEDAC in 2000 trough training by project staff;
  f. Low initial interest: only 8 farmers tried it out;
  g. Yields increased from formerly 1.5 t ha^{-1} to 2-3 t ha^{-1};
  h. Meanwhile, about 200 farmers in 15 villages apply SRI components;
  i. After experiencing positive results, farmers often increase the area under SRI; example of one farmer: He applied SRI on a small piece of land in the year 2000 and increased the area to 0.5 ha in 2001 and to 1 ha in 2002
- Positive effects observed by farmers using SRI:
  j. No problems with pests/diseases;
  k. Less water required;
  l. Rice grows well even when the field is dry;
  m. More drought resistant;
  n. Overall labor requirement is reduced: less for sowing seeds, initially more labor for transplanting but with experience only one third of the time required for transplanting with the common practice is needed with SRI.
  o. Before: urea for fertilizing the crops: expensive, can be harmful for the soil; now: no need for mineral fertilizer, saves money for external inputs;
  p. Before: rice production does not even meet the need for home consumption; after SRI: even a surplus of rice is achieved;

q. Saves also money through lower seed requirement: only 25% of the seeds are needed with SRI;

- ❑ Possible problems associated with SRI:

r. Not enough water for SRI water management

Most plots cultivated with SRI practices are located **close to the homestead** (200 - 300 m), indicating that the labor requirement especially for the water management is a possible bottleneck. Several farmers mentioned that almost every day they check the water level of the SRI fields (some farmers may go to see the rice fields more often because they want to observe how rice grows with this new technique).

A difficulty in applying SRI components is the **availability of animal manure** to produce sufficient compost. The possibility to **diversify crop production** with increasing rice fields was assessed to be not possible as the area is prone to flooding. Any other crops beside rice would imply an unacceptable high risk for small farmers. Especially during the wet season the rice fields are frequently flooded.

- ❑ Dissemination tools of SRI and strengthening of farmers' self capacity:

s. Tools for dissemination of SRI
   i. Training;
   ii. Cross visits (leaflets most promising tool according to key farmers)
   iii. Monthly farmer magazine from CEDAC

t. CEDAC trained farmers to make compost;

u. Farmer associations organize cross visits; CEDAC provides lunch/snack for key farmers also other expenses for traveling and accommodation if necessary;

v. Initially CEDAC staff visited once a month the village for follow-up, now only every second month to the key farmers only;

w. Formation of farmer associations: farmers with cattle help others to level the field;

x. More group discussion now; before the introduction of SRI there were not even discussions between individual farmers on rice cultivation practices.

- ❑ Estimated adoption rates:

y. Initially 8 farmers using SRI following a training conducted by CEDAC staff;

z. Innovative farmers became 'key farmers' to train other farmers in SRI components;

aa. 200 SRI farmers in the second year

bb. farmers from 15 villages now use SRI: 70% SRI farmers, 30% non-SRI farmers;

- ❑ external inputs:

cc. not interested in improved varieties because they think that improved varieties only perform well with other external inputs like mineral fertilizer (experience of one key farmer);

dd. Pest control is done with plant extracts (traditional method)

Stakeholder discussion (CEDAC)

SRI training:

- The concept of SRI was first explained to the village chief who invited farmers for a general meeting open to all villagers;
- The first time CEDAC conducted the training (3-4 hours) with own staff;
- Farmers interested after the training implemented SRI in parts of their fields;
- The following year the farmers selected key farmers among those who practiced SRI already according to certain criteria defined by the farmers themselves.
- The key farmers are now the main actors of the training: After theoretical lessons, including photographs for visualization, cross visits may be conducted depending on the financial means available. Usually, the attending farmers of the training visit the key farmer's SRI plot with subsequent deeper discussions among farmers;
- According to CEDAC, all participating farmers adopt certain SRI components sooner or later. Some of them wait for another season to first see the results of more innovative farmers;
- Ideally, the training should not be too long in advance of the planting season which otherwise negatively affects the adoption rate;

The key farmers not only promote SRI but also the concept of MPF (multi purpose farm) aiming at diversification of farm enterprises. However, SRI often serves as an entry point for further development activities.

Group discussion Chambak village, Stoung Saen District, Kampong Thom Province

Date: 10.03.04; participants: 16 SRI farmers/2 non-SRI farmers; 5 female/11 male farmers.

The village Chambak is often affected by annual flooding. Only wet season rice is grown while dry season rice does not occur. SRI was first introduced in 2002 by the DOT/CBRDP through discussion with farmers. Initially, most farmers did not believe in the success of that practice. The village chief appointed one farmer to host a demonstration plot with the SRI practices. Improved rice seeds were provided to host the demonstration on a subsidized basis (40% subsidy, 60% to be paid back to the commune).

- 2003: 160 kg seeds of improved rice varieties for association for organic farming (SRI plots);
- Training was conducted for three days in 2003 to learn the different steps in SRI;

- Practices are generally not perceived as difficult but the water management appears to be largely impossible to apply. In flooded fields, SRI cannot be applied. SRI was generally perceived as a riskier technology in flood prone areas.
- Additional labor for weeding is necessary, but the labor demand for uprooting and transplanting reduced to 30% of the labor for transplanting in the common cultivation method;
- The labor demand for land preparation was controversially discussed. Some farmers stated they need more labor with SRI while others stated they save labor with SRI. Overall it was perceived that applying SRI saves labor.
- Yields after applying SRI were much higher than before.
- Farmers use own farm resources like cattle, pig or poultry manure to fertilize their rice crop or to produce higher quality compost. Straw is usually removed from the field to feed their animals. During the dry season, the fields often get burned either accidentally by children or intentionally for hunting wild animals. Farmers would use mineral fertilizers but are prohibited in doing so by the high costs involved. The amount of animal manure is perceived as not sufficient but farmers do not expect a yield decline in the longer run but rather expect a stabilization of the yields at a higher level than before using SRI.
- **There is an unfortunate link between improved seeds and SRI. Farmers stated not being able to expand the area under SRI to all of their rice fields due to lack of improved seeds! Likewise, other farmers expressed their interest in applying SRI but stated to be inhibited due to a lack of improved rice seeds.**
- As a consequence, self-sufficiency in rice has not changed after applying SRI. Despite large yield increases, the small areas dedicated to SRI were insufficient to have a major impact on the farm household economy. Again, insufficient improved rice seeds were mentioned as the reason.
- SRI was perceived as a rice management technology suitable to all types of farmers, regardless whether they are rich or poor.
- SRI was also closely linked to organic farming. Most SRI farmers are members of an organic farmer association. They conduct regular meetings and have trainings before the start of the rainy season. Meetings are also a forum to solve/discuss general agricultural problems.

Village meeting Panhachhy, Stoung Saen District, Kampong Thom Province

Date: 10.03.04; participants: 12 female and 6 male farmers; all farmers apply SRI.

Only wet season rice is grown in the village as a major crop. Vegetables are cultivated in home gardens and water melon is sometimes cultivated early in the rainy season preceding the cultivation of rice.

Major problems in farming are adverse weather conditions with either flooding or drought. Mineral fertilizers are either not available or high costs prevent farmers from using them. Irrigation schemes do not exist. The harvested rice fields are often burned by children during the dry season.

- SRI was introduced by CEDAC in 2001 by implementing one demonstration plot. Afterwards, four trainings on different SRI steps were conducted and the first farmers applied SRI in 2002.
- Weeding was perceived as the most difficult aspect of SRI and contributed to additional labor required while time requirement for uprooting and transplanting was reduced. Weeding was not seen as a serious hindrance to using SRI although it can be a problem for poor farmers. For them, the labor for weeding may not be available since they need the time to earn extra money through off-farm activities like construction work.
- Gender aspect of labor distribution: SRI drastically reduces the labor requirement for uprooting and transplanting which is usually done by female household members
- SRI generally yielded higher but it was recognized that the performance was highly site-specific. Leveled fields in valleys achieve higher yield increases while in unleveled fields and in sloppy land also prone to erosion lower increases were observed.
- To apply SRI smaller field sizes are necessary to achieve leveled surfaces.
- About 20% of the farmers who were trained in SRI have not applied the new practices. However, now that they have seen the positive yield performance they are also interested in applying SRI. It was generally agreed that more farmers are expected to adopt SRI practices. Up to now, almost all farmers in the village transplant only 2-3 seedlings per hill. Farmers rejecting SRI practices after trying them out have not been observed, yet.
- Farmer-to-farmer dissemination also occurs. Other farmers interested in SRI copy the practices and buy improved rice varieties from the organic farmer association.
- SRI was perceived as a flexible set of practices and applicable for all types of farmers.
- The average area size of SRI applied by SRI farmers was 30 are, representing about 30% of the total farm size.
- Positive effects of SRI practices: reduced seed requirement, increased drought tolerance, reduced incidence of pests, increased tolerance to flooding because the plants grow quickly and higher, none or fewer mineral fertilizers needed, higher straw production.
- Organic farmer association: almost all SRI farmers are members of the association; 60% are female farmers, the elected head of the association is also a female farmer, 180 members.
- SRI often generates an internal family conflict. After 2-3 weeks, when the SRI rice starts to perform better than the common rice, the situation changes. Since some of the practices require certain skills, the first year is slightly difficult but afterwards the practice is rather easy to apply.

Stakeholder discussion (CBRDP, Kampong Thom)

Date: 10.03.04; discussion partners: Mr. Ritivuth Sem, Agricultural Officer, GTZ and Mr. Buntha Em, PDAFF

History of SRI introduction and dissemination: In 2000, CEDAC conducted the first training on SRI for PDAFF staff. This was part of a contract between CEDAC and the former PDP in Kampong Thom. Twelve extension workers were trained and 23 farmer promoters. The farmer promoters were selected by the DOT according to certain criteria. The contract with CEDAC comprised intensive training activities for the farmer promoters for one year. Each farmer promoter was supposed to extend the SRI practices to three neighbouring villages. In the same year, several field days and cross visits were conducted.

In 2001, only the farmer promoters implemented SRI practices in their demonstration plots. Organized cross visits were not conducted, only more or less spontaneous visits by neighbouring farmers. Due to the termination of the PDP project and the initiation of CBRDP with a different project setup, the contract with CBRDP for training ended in the same year. However, CEDAC continued to monitor the activities of the farmer promoters.

In 2002, 36 farmers were selected by the project to implement SRI according to specified criteria. They participated in a special SRI training and received rice seeds of improved varieties. In addition, they were trained in compost making.

- Theoretical framework of the farmer promoter approach: The farmer promoter organizes a group of 12 to 15 farmers and conducts one or several raining sessions with them on SRI. The farmer promoter trains several key farmers (specialist in one subject) who are supposed to extend the SRI message to other farmers. The farmer promoters should meet the following key criteria: basic technical knowledge, good facilitation skills, implementation of a demonstration plot and extending the message to other farmers.
- At the institutional level 20 DOTs received training on SRI in 2002 by Mr. Ritivuth and 3 PTST. The PTST is responsible for the SRI demonstration plots, for the planning of training on SRI for extension workers (DOTs) and for the follow-up of the demonstration plots.
- Major budget costs are for training material, seeds, leaflets and refreshments during the trainings.

Group discussion with farmer in Sre Cheng village, Sre Cheng commune, Chumkiri district, Kampot Province, 12.03.2004.

Participations: 45 peoples

- 34 villagers(6 SRI and 28 non- SRI)
- 3 GTZ staff
- co-consultant
- 1 key farmer
- 6 members of farmer organic rice association

General problems happened in the village-

- Poor soil (sandy soil and upland)
- No water source
- Not enough animal manure

- ❑ Insect (Brown hopper, weed, rice bug)

In this village they mainly obtained this information from CEDAC/ GTZ staff

(1) Suitable tools for SRI dissemination: training, cross visit.

(2) SRI information promotions: SRI came to the village in 2003 and only 6 villagers used SRI after they attended the training. They expected more farmers would use SRI based on the results they obtained from the first year. They are satisfied with SRI because the yields increase 3 times compared to normal practice, used less inputs etc.

(3) Crop calendar: Generally villagers plant the rice from June-January. SRI can be applied in the dry season if water is available.

(4) Seed and yield: Most of them used improved seed in the SRI and normal field, but the yield of SRI increased by triple compared to the normal rice.

(5) Labor: Labor is mainly required for land leveling up to transplanting and weeding.

(6) Most of the farmers said that SRI is suitable for all farmer categories.

(7) Gender contribution: female labor decreases, additional time is used to make compost, for weed control and for small business. For the men, additional time is used for collecting wood from the mountain, growing vegetables (cucumber, watermelon) and animal raising.

(8) Associations in the village: rice bank association, credit, organic rice, village bank.

(9) Future: More farmers plan to apply SRI during the next season.

(10) SRI practice: there are more than 12 components of SRI, but the farmers can not follow up all activities, only a few points like leveling, transplanting, vigorous seedling, wide spacing etc.

(11) Non-SRI farmers: Reasons for not applying SRI: not enough manure, scared of SRI, don't know SRI technique.

(12) Advantages: less seed, high yields, less labor, less time.

(13) Disadvantages: difficult the first time, more weeds, need time for leveling, pulling the seedling (careful uprooting), need more compost during the growing stage (15 days after transplanting).

(14) Some comments from villagers: conduct more training courses on SRI and field demonstrations; organic fertilizer: rate of application, quantity and stage of application etc. With SRI one has to plough many times and early weeding is necessary. During fertilizer application, some water should be available in the field.

(15) Suggestions: need some crop varieties-for cover crop and compost making, identifying rice markets

Village discussion in Trapaing Andong village, Sat Pong commune, Chhouk district, Kampot Province, 11.03.04

Participants: 39 persons

- ❑ 1 PTST

- 1 GTZ staff
- 1 DOT
- 1 Commune chief
- 3 Village committee
- 1 Village chief
- 31 villagers (25 SRI and 6 non-SRI)

General problems in the village: No water source for irrigation, not enough animal manure and some insects (header stem borer). In this village they grow rice only during the wet season.

Introduction of SRI: In 2001 only 2 villagers started using SRI after they got some information from a student who finished university in Germany. He came to the village to visit his relatives and explained the SRI technique to them. Later on they became interested. During harvest time the neighbors saw that the yield was higher than with normal practice and decided to try SRI as well. The following year more farmers used SRI based on the results of these villagers. In 2002 CEDAC and GTZ staff came to this village and conducted the training course on SRI theory and field demonstrations. Most of the villagers have participated in the training on SRI since 2002. Additional information was provided to them through cross visits and training. SRI can be applied in the dry season if they have enough water.

Rice varieties/other crops: Most of the farmers use local seeds and few farmers use improved seed. They are not satisfied with the improved seed because the rice is ‘soft’. Most labor is required for fertilizer application, weeding and harvesting. No other crops are grown in the village beside rice.

Farmer category: The villagers said that SRI is more suitable for the middle income families because poor farmers who have only a small plot will lose everything when they face a problem such as drought or disease.

Farmer associations: There are some organizations working in the village such as IPM, CEDAC/GTZ, and health promoters. The farmers have organized an organic rice association by themselves after they participated in the compost making training course. Now all villagers prepare the compost at their respective homes. Some farmers use green manure and cover crops. When they have a problem, they solve it through the association, except for agriculture techniques when they call for help from the DOT or GTZ staff. They are very satisfied with SRI and expect that in the future more farmers will use SRI.

Labor: Labor decreased with SRI (less seedlings, faster transplanting). The time gained is used for small businesses and compost saving.

Reasons of farmers not to apply SRI: Non-SRI farmers do not apply SRI because they do not have draft animals, are scared of SRI technique and don't have enough animal manure(not sufficient livestock).

Advantages of SRI are:

- need less seed compared to the normal practices.
- high yield
- less time (only family labor required)

- ❑ less input (mineral fertilizers)
- ❑ easy uprooting and transplanting of seedlings

Disadvantages of SRI are:

- ❑ Difficult the first time(they are scared to try because they fear crop failure))
- ❑ Conflict in some families
- ❑ More time for transplanting and weeding stage
- ❑ More time for land leveling
- ❑ Water management

Perception of DOT staff: SRI is very popular among the villagers (use less seed, less labor, use of compost). Presently, most of the farmers don't use inorganic fertilizer. About 157 farmers are members of the farmer organic rice association and this number is expected to increase in the future.

Comment from the Commune council member: He is very happy with SRI, 50 % of the farmers in his village use SRI, he will support everything what farmers need. He suggested that some seeds such as soybean and cover crop seeds may be provided to the farmers.

Stakeholder discussion: CEDAC/Prey Veng (17/03/04)

(Mr. Huor Sreng and Mr. Yem Soksophuos)

(1) General problems farmers are facing in the CEDAC target areas in Prey Veng according to CEDAC staff:

- ❑ Flooding – happened for three consecutive years, 1999 – 2001,
- ❑ Drought,
- ❑ Lack of irrigation system,
- ❑ Pest problems – Brown leaf hopper and stem borer; pesticide use has now become the norm in the area,
- ❑ Rice production is low in terms of quality and quantity,
- ❑ CEDAC used to provide seeds to farmers in Prey Veng after consecutive flooding (1999/2001), but this practice is no longer in use by CEDAC.

(2) CEDAC staff has been trained since 1999 in SRI. The system was introduced to farmers in Prey Veng in 2000 and 2001.

- ❑ Identified interested farmers and invited them to attend an exchange visit to see SRI applied in farmers' fields.
- ❑ Group training took place later in order to remind them or to add additional information than what they observed and learned from the exchange visit.
- ❑ CEDAC organized a field demonstration and/or a field day or a harvest day so as to recall them the SRI principles.
- ❑ Follow-up activities.

(3) SRI is now being applied in Prey Veng and the number of farmers using SRI on their paddy fields is about 1,000-1,200. However, around 233 farmers adopted SRI in the CEDAC target areas, and 216 are key farmers who play an important role in promoting the new technology to other farmers in the community.

Remarkably, roughly 30-60% of the SRI principles were followed by the farmers, depending on the weather and soil condition of the area (agro-ecosystem of the paddy field). Generally the following principles were practiced by the farmers in Prey Veng:

- Land preparation
- Seed selection
- Seedling selection
- Transplanting young seedlings and planting in row.

(4) SRI is suitable for all types of farmers (poor, middle income, and rich farmers), and it depends on their usual cropping practices whether they strictly follow the SRI principles. SRI was introduced to farmers because of:

- Increased rice yield (at least two times compared to normal practice);
- Less seeds are required;
- No improved or even imported rice varieties are required to raise yields;
- Reduction of external inputs like pesticides and chemical fertilizers by using farm own resources like compost, green manures, cow manure, etc.;
- Technology based on principles observed from nature;
- Improves the soil condition in terms of natural protection and use of all existing resources.
- Helps to improve the habits of the farmers; helps to improve people's living conditions in terms of food security.

(5) The main problems observed when applying SRI are crabs which can seriously damage the young seedlings. CEDAC organized a meeting to discuss about the problem. As a result, extracts from neem tree leaves and seeds were introduced to farmers by CEDAC to protect the rice from crabs while pesticide use was not recommended.

(6) When SRI was introduced, farmers were not very interested. They didn’t believe that by transplanting only 1-2 seedlings, yields can be increased. They also found the practice too risky. However, 15 days after transplanting they saw the positive effects and were satisfied with SRI.

Farmers now have a better understanding of SRI. They know that with SRI high yields are possible and the soil condition improves through the use of compost and other natural sources for fertilizing their rice crop which exist in their community. CEDAC has learned that SRI really contributes a lot to improving food security for rural people. However, it requires more patience, and participating farmers must be those who are interested and willing to do it as well as manage their farms well.

(7) Networking:

So far, CEDAC in Prey Veng established its network with certain organizations and associations, specifically CARE, CO (Christian Outrage), CRS, GRET, Chitthor, GTZ, VSF (Veterinaires Sans Frontieres), PADEK, etc. The network was established through exchange visits, group training and workshops. The exchange visits were made between provinces and also within project sites. Generally, most of the organizations hired CEDAC staff to train farmers in their target areas.

Open village discussion: Baphnom district, Prey Veng, 16.03.04

(27 farmers from two different villages, namely Angkahn and Trappings Sala villages of Cheur Kach commune. Out of the amount, 8 are non-SRI, and 8 are key farmers)

(1) General problems in farming practice:

- Flooding (2000-2002)
- Drought
- Pests (Brown Hopper)
- Lack of irrigation system

(2) Besides rice, villagers can also grow other cash crops such as cucumber, cassava, etc. but for family consumption only because of a lack of irrigation system and poor soils .

(3) SRI introduction in the villages

- First introduction in 2001 by CEDAC through an exchange visit and training. Training normally took place once a week.
- Villagers felt reluctant to apply SRI, and were not very interested. Neighbors of the first SRI farmers laughed at them when they saw them transplanting one or two young seedlings.
- Now the villagers are happy with SRI and more farmers will apply it in the next season.
- Suitable technology for farmers, specifically for those who own small plot of land.

(4) The most helpful and easy tools for farmers to get to understand the SRI:

- Exchange visit – they can see the real practice, experiences and production of rice by applying SRI technology.
- Training – they get more theoretical background about SRI.
- Field demonstration.

(5) Farmers' point of view on the SRI:

- Suitable and easy technology.
- Just plant only one or two seedlings per hill and easy for weeding and water management.
- More labor is needed during the transplanting and weeding stages compared to the normal practice.
- Only compost is used.
- Less seeds are used compared to normal practice.

(6) Gender contribution: There is no change in responsibilities for different rice management practices after the introduction of SRI, however female labor is required mainly for sowing, uprooting and transplanting of rice seedlings.

(7) Generally the yield for SRI Rice is higher than the normal one. It can be 2-3 times, and before the improved variety was used, but at the moment local variety is strongly encouraged by the project staff, and it is also more resistant to the pest.

(8) The rice generally start planting in June until January, and also the period is dependent on the type of rice – long-term rice, middle-term rice and short-term rice.

(9) Advantages and disadvantages of SRI

- ❑ Advantages:
- ❑ High yield.
- ❑ Suitable for small lot of land.
- ❑ Less seed is needed.
- ❑ No external input like chemical fertilizers or pesticides.
- ❑ Used existing natural resources such as compost, green manure, cow manure.
- ❑ Disadvantages:
- ❑ More technology
- ❑ More labor
- ❑ More times
- ❑ Less and tough straw for cow

(10) Villagers were not so sure about the number of farmers who will apply SRI in the next season because there were only 28 out of 180 households in the two villages who adopted SRI last season.

(11) SRI can also be applied in the dry season, but at the moment it is not possible due to a lack of irrigation system. Villagers now understand more about SRI and they are satisfied with it.

The reasons why some farmers (non-SRI farmers) did not follow the SRI principles are:

- ❑ They do not have enough labor
- ❑ They just learned from their neighbors
- ❑ Not enough draft power such as cows.

Stakeholder discussion with PADEK, Prey Veng Province

Background and staff:

- ❑ PADEK: Partnership for Development in Kampuchea, founded in 1986 by a Group of different OXfams to coordinate their efforts in Cambodia;
- ❑ 6 staff members comprising the following areas: rural economy, agriculture, veterinary, fishery, self-help groups, water
- ❑ internationally founded, follows an integrated community approach

In 2002 staff was trained in SRI by PRASAC and CEDAC. Afterwards, expert farmers (= key farmers) were trained in SRI. If interested, the expert farmers were exposed to SRI by exchange visits/cross visits to SRI farmers of CEDAC/PRASAC (60-70% of the expert farmers). Usually, two expert farmers (one male, one female) work in each target village.

Criteria for expert farmers:

- interested
- educated (literate)
- accepted in the village
- active in farming, full time farmer
- not discriminating others

Expert farmers are mainly rich and middle income farmers (20% rich, 70% middle income, 10% poor). According to the staff, poor farmers are difficult to work with: they are less educated, do not listen to advice. Exchange visits are thought to be very important for poor farmers.

So far most SRI farmers apply the following SRI components:

- land preparation,
- the use of young seedlings,
- transplanting of two seedlings,
- wider planting distance (25-30 cm),
- and the use of compost instead of mineral fertilizers.

The main problems farmers are facing, which also affect the application of SRI, are flooding and drought.

Advantages as seen by project staff:

- higher yields
- less seeds required
- reduced fertilizer inputs
- saving time during uprooting

Problems of farmers using SRI identified by staff:

- SRI bears higher risks for the farmers. Consequently, they apply it only on parts of their farm land. While drought affects SRI and conventional practices in the same way, flooding affects SRI more severely;
- Not enough time for weeding: Some farmers work as laborers, driver of motorbike taxis;
- Not possible if not enough water;
- Less resistant to drought;
- Less tolerant to flooding;
- SRI is less useful on infertile soil

Statements on yield increases depending on the soil conditions could not be made because there are many influencing factors. The collection of yield data is based on questionnaires. Nearby plots of the same farmer are usually chosen as control plots.

The opinion on the quantity of farm animals needed is mixed. While some of the staff believes that the quantity is sufficient for compost preparation, others believe it is not. There is the opinion, that the lacking quantity of manure can be compensated by adding plant material.

SRI survey 2004

ឈ្មោះអ្នកសំភាសន៏/Enumerator: ___________________ ថ្ងៃខែឆ្នាំសំភាសន៍/Date: ___________

លេខកូដ/Code number: _________ កសិករបង្គោល/Key farmer: ☐ បាទ ឬ ចាស/yes ☐ ទេ/no

1. ឈ្មោះកសិករ/Respondent's name

កសិករ/Farmer	ឈ្មោះ/Given name	នាមត្រកូល/Surname

2. កន្លែងស្នាក់នៅ/Location

	ខេត្ត/Province	ស្រុក/District	ឃុំ/Commune	ភូមិ/Village
English				
Khmer				

3. ពតិមានទូទៅរបស់កសិករ/Characteristics of the houehold

ឈ្មោះ Name	គ្រួសារ H/H	ភេទ Sex	អាយុ Age	ការអប់រំ/ Educa-tion	ឆ្នាំចូលសាលា years attending school	ពាក់ព័ន្ធការងារកសិកម្ម Involved in farming
	☐					
	-					
	-					
	-					
	-					
	-					
	-					
	-					

- តើអ្នកត្រូវការស្រូវប៉ុនានគីឡូក្រាមក្នុងមួយខែ?/How much rice does your family (household) need every month?________kg
- តើអ្នកជាសមាជិកនៃក្រុមសកិករដែលប្រើជីធម្មជាតិឬ?/Are you registered as an organic rice farmer? ☐ បាទឬចាស/yes….☐ទេ/no
- តើអ្នកជាសមាជិកសមាគមកសិករឬ?/Are you member of a (farmer association)? ☐ បាទ ឬចាស/yes….☐ទេ, អត់ជួលទេ/no

ប្រសិនបើបាទ, សូមបញ្ជាក់;/If yes, please specify:

____

____

____

- តើអ្នកមានផ្ទៃដីសំរាប់ធ្វើស្រែប៉ុន្មានអា?/What is the total farm size you own? _________are
  - ផ្ទៃដីសំរាប់ធ្វើស្រែវស្សា/Wet season rice: _______អា /are
  - ផ្ទៃដីសំរាប់ធ្វើស្រែប្រាំង/Dry season rice: ________ អា /are
- តើអ្នកមានជួលដីបន្ថែមទេ?/Do you rent additional land? ☐ បាទ, ជួល/Yes….☐ទេ, អត់ជួលទេ/No
  - បើជួល, តើមានទំហំប៉ុន្មានអារ?/If yes, what is the size of the rented land?________are
  - បើជួល, តើការរៀបចំពេលវេលាការជួលយ៉ាងដូចម្តេច?/If yes, what is the tenancy arrangement for renting the land?

- ☐ តំលៃជួលជាប្រចាំ/Fixed rent: ___________Riel, រយះពេលជួល/Renting period: _____
- ☐ លក្ខខណ្ឌចែករំលែកផលិតផល/Share cropping:
    - លក្ខខ័ណ/condition: ☐ ១ភាគ៣នៃលិតផល/One third for land owner
      ☐ ផ្សេងៗទៀត /Others:_____________________
- ☐ ផ្សេងទៀត/Others: ____

- តើអ្នកមានជួលកំលាំងពលកម្មបន្ថែមមកពីក្រៅដែរឬទេ?/Do you hire casual labor?

☐ បាទ, ជួល/Yes….☐ទេ, អត់ជួលទេ/No

សកមភាព/Activity	ចំនួនកំលាំងគិតជាថ្ងៃ/Man-days	តំលៃនៃកំលាំងពលកម្ម(រៀល)/Riel/man-day

ប្រភពចំនូល/Sources of income

ប្រភពចំនូល/Sources of income	ខែ/season

4. វគ្គបណ្តុះបណ្តាលស្តីពី ប,វ,ស និង ការងារផ្សព្វផ្សាយ/SRI training and extension

- តើអ្នកមានដែលធ្លាប់ចូលរៀនក្នុង វគ្គបណ្តុះបណ្តាលស្តីពី SRI ដែរឬទេ? /Have you attended a training on SRI?
    - ☐បាទ/yes ☐ទេ/no
    - បើមាន, តើអង្គការណា?/If yes, who was organizing the training?
      ____
    - ប្រសិនបាទ, តើនៅពេលណា?/if yes, when have you attended the training?
      _________________(Month/year)
    - Who was facilitating the training? នណាជាអ្នកសំរបសំរួលកងវគបណ្តុះបណ្តាល?
        - ☐ បុគ្គលិកកម្មវិធី /Project staff ☐ កសិករបង្គោល /Farmer promoter / key farmer
- តើអ្នកធ្លាប់ចូលរៀនប៉ុន្មានដង?/How often have you attended a training? ___________

- តើអ្នកពេញចិត្តវគ្គបណ្តុះបណ្តាលនោះបែបណា? /How satisfied were you with the training?
    - ☐ ពេញចិត្តខ្លាំង/Very satisfied
    - ☐ ពេញចិត្ត/Satisfied
    - ☐ ធម្មតា/Indifferent
    - ☐ មិនពេញចិត្ត/Unsatisfied
    - ☐ មិនពេញចិតជាខ្លាំង/Very unsatisfied
    - ប្រសិនមិនពេញចិត្ត, សូមបញ្ជាក់/If unsatisfied, please specify:

      ____
      ____
      ____

ក្នុងគោលការណ៍ ប.វ.ស តើគោលការណ៍មួយណាដែលអ្នកបានចាំ និង មួយណាដែលអ្នកបានយកមកអនុវត្តតាម?/Which SRI practices do you remember and which of those did you implement in the field?

ការអនុវត្ត ប.វ.ស / SRI practices	តាមការចាំ/ remembers	បានអនុវត្ត/ applied
កាត់បន្ថយការប្រើពូជ/Reduced rice seed	☐	☐
ការរៀបចំថ្នាលសំណាប/Seed bed preparation	☐	☐
ការពង្រាបស្រែ/Flat rice field (leveling if necessary)	☐	☐
ការជ្រើសរើសតែកូនសំណាបណាដែលថ្លោស និង មានសុខភាពល្អ/Select only vigorous seedlings for transplanting	☐	☐
ស្ទូងតែ ១ ឬ ២ កូនសំណាបក្នុងមួយគុម្ព/ Transplanting of 1-2 seedlings per hill	☐	☐
ស្ទូងតែកូនសំណាបដែលនៅក្មេងមានអាយុតិចជាង១៥ថ្ងៃ/Transplanting young seedlings (<15 days)	☐	☐
ប្រើរយៈពេលខ្លីគិតចាប់ពីពេលដកសន្ទូងរហូតដល់ពេលស្ទូងដោយដកកូនសំណាបដោយប្រុងប្រយ័ត្ន និង ស្ទូងថ្មៗ/ Short time gap between careful uprooting seedlings from the nursery and transplanting (same day)	☐	☐
ស្ទូងជាជួរ/Planting in rows	☐	☐
ស្ទូងចន្លោះពី ២៥-៥០/Wider spacing (25 – 50 cm)	☐	☐
ស្ទូងរាក់/Shallow planting	☐	☐
បញ្ចូលទឹក និង សម្ងួតស្រែសំរាប់រយៈពេលសមស្រម/Flood and dry the field for alternative periods	☐	☐
ការសំអាតស្មៅនៅដំណាក់កាលដំបូង និង ធ្វើអោយបានច្រើនដង់/Early and frequent weeding	☐	☐
បង្កើនជីជាតិក្នុងដីដោយដាក់ជីសរីរាង្គ និង កាត់បន្ថយការប្រើប្រាស់ជីគីមី/Add nutrients to the soil, preferably in organic form; Reduce chemical fertilizer inputs	☐	☐

- តើមានអ្នកមានដែលឃើញមន្ត្រីផ្សព្វផ្សាយ ឬ មន្ត្រីកម្មវិធីនមកត្រួតពិនិត្យពេលអ្នកអនុវត្ត ប.វ.ស ឬទេ?/Did your extension worker/program officer/farmer promoter visit you when you implemented SRI practices?
    - ☐បាទ/Yes ☐ ទេ/no
    - ប្រសិនបើមាន, តើមានប៉ុន្មានដង?/if yes, how frequently does he visit you? _______times per season
- តើមន្ត្រីផ្សព្វផ្សាយអាចដោះស្រាយបញ្ហា ឬ ជួយពន្យល់នូវបញ្ហាកើតឡើងដល់អ្នកនៅពេលដែលអ្នកអនុវត្ត SRI/Could the extension worker solve/explain any of the problems you were facing by implementing SRI?
    - ☐បាទ, បានទាំងអស់/Yes, all ☐បាទ, បានមួយចំនួន/Partly....☐គ្មានអ្វីទាំងអស់/No, none of them

- តើប្រភពពត័មានខាងក្រោម, មួយណាដែលអ្នកយល់ថាមានប្រយោជន៍បំផុតសំរាប់អ្នក?/Which source of information was the most beneficial for you?
    - ☐ វគ្គបណ្តុះបណ្តាល/Training
    - ☐ ស្រែបង្ហាញ/Field demonstration
    - ☐ ទស្សនកិច្ច/Cross visit
    - ☐ ទស្សនកិច្ចដោយមន្ត្រីផ្សព្វផ្សាយ/Individual visit by extension/project worker
    - ☐ ព្រឹត្តប័ត្រ រឺ ទស្សនាវដ្តីកសិកម្ម/Leaflet/magazine
    - ☐ កសិករផ្សព្វផ្សាយ/Farmer promoter/key farmer
    - ☐ ទស្សនកិច្ចដោយកសិករផ្សេងទៀត/Individually from another farmer
- ? តើអ្នកចាប់ផ្តើមអនុវត្តចាប់តាំងពីពេលណា? /Since when are you practicing SRI______________________________

5. ការអនុវត្តការគ្រប់គ្រងដំណាំស្រូវ/Rice management practices

- តើអ្នកធ្វើស្រែដោយព្រួស ឬ ដោយស្ទូង?,Are you broadcasting the seeds or are you transplanting seedlings?
    - តាមទំលាប់/Normal practice: ☐ ព្រួស/broadcasting ☐ ស្ទូង/Transplanting
    - តាមប,វ,ស/SRI practice: ☐ ព្រួស/broadcasting ☐ ស្ទូង/Transplanting
- តើអ្នកប្រើប្រាស់អស់ពូជប៉ុន្មាន?/How much seed do you use in your practices?
    - តាមទំលាប់/Normal practice: _______________Kg
    - តាមប,វ,ស/SRI practice: _______________Kg
- តើអ្នកស្ទូងសំណាបប៉ុន្មានដើមក្នុងមួយគុម្ព?/How many seedlings per hill do you transplant?
    - តាមទំលាប់/Normal practice:_______________
    - ប,វ,ស/SRI : _______________
- តើសំណាបនៅអាយុប៉ុន្មានពេលដែលអ្នកដកយកទៅដាំ ?/How old are the seedlings when you transplant them?
    - តាមទំលាប់/Normal practice:________days
    - ប,វ,ស/SRI : ________days
- តើអ្នកជ្រើសរើសសំណាបបែបណាសំរាប់ស្ទូង ?/How do you select the seedlings for transplanting?
    - តាមទំលាប់/Normal prac-tice:____
    - ប,វ,ស/SRI ____
- តើអ្នកស្ទូងសំណាបក្នុងជំរៅប៉ុន្មាន ?/How deep do you plant the seedlings?
    - តាមទំលាប់/Normal practice:______ cm
    - ប,វ,ស/SRI: ______ cm
- តើអ្នកស្ទូងចន្លោះពីគុម្ពមួយទៅគុម្ពក្នុងចំងាយប៉ុន្មាន ?/What is the planting distance?
    - តាមទំលាប់/Normal practice: __________
    - ប,វ,ស/SRI: __________

- តើអ្នកស្ទូងដូចម្តេច ?/What is the planting arrangement?
  - តាមទំលាប់/Normal Practice: ☐ តាមធម្មតា/At random ☐ ជាជួរ/In rows
  - ប.វ.ស/SRI: ☐ តាមធម្មតា/At random ☐ ជាជួរ/In rows

តើអ្នកប្រើអស់រយៈពេលប៉ុន្មាន/How long does it take between ពីដក ដល់ពេលស្ទូង uprooting young seedlings in the nursery and transplanting them in the field?

  - តាមទំលាប់/Normal practice: ___________ នាទី, ម៉ោង,ថ្ងៃ /Min/hours/days
  - ប.វ.ស/SRI: ___________ នាទី, ម៉ោង,ថ្ងៃ /Min/hours/days

តើទឹកមានកំរិតណានៅពេលពេលអ្នកស្ទូង ?/What is the water level during transplanting?

  - តាមទំលាប់/Normal practice: ពន្លិចស្រែ/flooded ☐ គ្រាន់តែ/just moist ☐ សើម
  - ប.វ.ស/SRI: ពន្លិច/flooded ☐ ស្រែគ្រាន់តែ/just moist ☐ សើម

- តើអ្នកគ្រប់គ្រងទឹកយ៉ាងដូចម្តេចក្នុងដំណាក់កាលស្រូវចេញគ្រាប់ ?/
  How do you manage the water supply during the vegetative stage?
  - តាមទំលាប់/Normal practice: ☐ ពន្លិចស្រែជាប្រចាំ/Permanently flooded
    ☐ ពន្លិច និងស្រែ/Alternating flooding/drying ទុកអោយស្ងួត
  - ប.វ.ស/SRI: ☐ ពន្លិចស្រែជាប្រចាំ/Permanently flooded
    ☐ ពន្លិច និងស្រែ/Alternating flooding/drying ទុកអោយស្ងួត

- តើពេលណាដែលអ្នកសំអាតស្មៅ ហើយធ្វើដូចម្តេច ?/When and how do you weed?
  - តាមទំលាប់/Normal practice:

វិធីសាស្ត្រ Method	ដំណាក់កាលដំណាំ/Growth stage	បរិមាណ Quantity	តំលៃ ក្នុងមួយមុខ Cost/unit

  - ប.វ.ស/SRI:

វិធីសាស្ត្រ/Method	ដំណាក់កាលដំណាំ/Growth stage	បរិមាណ/Quantity	តំលៃក្នុងមួយមុខ /Cost/unit

- តើអ្នកប្រើប្រាស់ជីយ៉ាងដូចម្តេចទៅលើដំណាំស្រូវ?How do you fertilize your rice crop?
  - តាមទំលាប់,Normal practice:

ប្រភេទ Type	ដំណាក់កាលដំណាំ/Growth stage (DAT)	បរិមាណ Quan- tity	តំលៃ ក្នុងមួយមុខ Cost/unit

- ប.វ.ស/SRI:

ប្រភេទ Type	ដំណាក់កាលលូតលាស់/Growth stage (DAT)	បរិមាណ Quan-tity	តម្លៃលើឯកតាមួយ Cost/unit

- តើអ្នកមានចិញ្ចឹមសត្វសំរាប់យកលាមកធ្វើជីដែរឬទេ/Do you have animals for manure production?

☐ ចាស/បាទ/Yes ... ☐ ទេ/No

បើមាន សូមបញ្ជាក់/if yes, please specify

ប្រភេទសត្វ Type of animals	បរិមាណ Quantity	ជីលាមកសសត្វសំរាប់ធ្វើកំប៉ុស្តិ៍ . ប្រើទៅលើស្រែ/Manure used for compost/ direct application in rice fields
		☐ ចាស/បាទ/Yes ☐ ទេ/No
		☐ ចាស/បាទ/Yes ☐ ទេ/No
		☐ ចាស/បាទ/Yes ☐ ទេ/No
		☐ ចាស/បាទ/Yes ☐ ទេ/No

- តើអ្នកធ្វើយ៉ាងដូចម្តេចចំពោះចំបើង/What are you doing with the rice straw?

☐ ទុកចោលក្នុងស្រែ/left in the field ☐ ប្រមូលទុកធ្វើជីកំប៉ុស្តិ៍/removed from the field and used for compost

☐ ដុតក្នុងស្រែ/burned in the field ☐ ប្រមូលទុកសំរាប់ប្រើប្រាស់ផ្សេងៗទៀត/removed from the field and not further utilized

☐ ផ្សេងៗ/others:

____

- តើអ្នកមានប្រើប្រាស់ថ្នាំកសិកម្ម/Do you use pesticides/fungicides?

- តាមទំលាប់/Normal practice:

ប្រភេទ Type	ប្រភេទកត្តាចង្រៃ Target	ចំនួន Quantity	តម្លៃលើឯកតាមួយ Cost/unit

- ប.វ.ស/SRI:

ប្រភេទ Type	ប្រភេទកត្តាចង្រៃ Target	ចំនួន Quantity	តម្លៃលើឯកតាមួយ Cost/unit

6. ផលប៉ះពាល់នៃការអនុវត្ត ប.វ.ស/Impact of SRI practices

- ត ្រ ម ូ វ ក ា រ ក ំ លា ំ /Labor demand for rice production ក ា រ ផ លិត ដ ំ ណា ំ ្រ ស ូ វ

ទំហំស្រែ /Plot size:___________	តាមប.វ.ស ឥឡូវ /SRI (now)		តា មទ ំលា ប ់ /Normal prac-tice (before)	
ស ក ម្ម/Activity ភា ព	កំលាំងពលកម្មក្នុងគ្រួសារ (ម៉ោង) family labor (hours x persons)	កំលាំងពលកម្មដែលជួល (ម៉ោង) hired labor (hours x persons)	កំលាំងពលកម្មក្នុងគ្រួសារ (ម៉ោង) family labor (hours x persons)	កំលាំងពលកម្មដែលជួល (ម៉ោង) hired labor (hours x persons
រៀបចំស្រែ និង ថ្នាលសំណាប/ Land and seedbed preparation				
ក ា រ ដ ក ស ំ /Uprooting and ង ក ា រ ស ្ ូ ង transplanting				
ការសំ អាត/Weeding				
ក ា រ ្រ /Water management				
ការដឹកជីទៅស្រែនិងការបាចជី/Transport of mineral fertilizer/compost/animal manure and application				
រៀបចំកំប៉ុស្តិ៍/Compost preparation				
ក ា រ ្រ ត ួ /Pest control ត ្យ ក ត ្ ា ច ៃ ្រ ង				
ការប្រមូលផល Harvest				
ក ា រ /Threshing ៃ ប ន				
ការដឹកជញ្ជូន/Transport				

- កា រច ំណា យប នៃ ្មលើរៀប ច ំស្រែ ានរិង្រាកីប្រ រពេ ស ់ម៉ាប ់ទេ ្ន) Variable costs for land preparation and treshing (use of machines not owned by the farmer):
  - ប.វ.ស/SRI:
    - ការចំណាយបន្ថែមលើរៀបចំស្រែ/land preparation:______________Riel
    - ក ា រ /threshing: ៃ ប ន ______________Riel
  - តាមទំលាប់/normal practice:
    - ការចំណាយបន្ថែមលើរៀបចំស្រែ/land preparation: _________Riel
    - ក ា រ /threshing: ៃ ប ន _________Riel
- សូមធ្វើការប៉ាន់ស្មានអំពីទិន្នផលស្រូវ (មុន និង ក្រោយ) កា រអនុ វ ត្ត /Estimate your rice yields before and after applying SRI:

បច្ចេកទេស/Technology	ពូជ/Variety	ឆ្នាំ year	ៃ ផ ្ទដី ់គ ិតជ ា Area (are)	អាទិន្នផល ់តៅ ់ / Yield (basket/plot)
ម ុ ន ព េ ល /Before ្រ ប ិ ប . វ . ស SRI				
ៃ ្រ ក ា យ /After SRI ប . វ . ស				
ៃ ្រ ក ា យ /After SRI ប . វ . ស				
ៃ ្រ ក ា យ /After SRI ប . វ . ស				
ៃ ្រ ក ា យ /After SRI ប . វ . ស				

- ស ូ ម អ ្ ន ក ម េ ត ្ ត ា ប ្ រ ា ប ់ ព ី ទ ំ ហ ំ ដ ី ស ្ រ ែ ច ំ ង ា យ ព ី ផ ្ ទ ះ និង ទិន្នផលស្រូវ តាមទំ/Estimate your plot sizes and distances from the homestead and rice yield following SRI/normal practices?,

បច្ចេកទេស តាមប.រ.ស និង តាមទំលាប់ Technology (SRI/ normal farmer's practice)	ចំងាយពីផ្ទះទៅស្រែ Distance from homestead (m)	ពូជ Variety	ផ្ទៃដី Area (are)	គុណភាពដី Soil quality

- ត ើ ផ ្ ទ ៃ ដ ី ប ៉ ុ ន ្ ម ា ន ដ ែ ល អ ្ ន ក ន ឹ ង ប ្ រ ើ ប ្ រ ា ស ់ ស ៊ ី ស ្ រ ា ប ់ ដ ំ
  On how many are do you intend to use SRI the next season? ________are
- តំរូវការនៃផលិតផលស្រូវ/Self sufficiency of rice production
  - មុន ប.រ.ស ់ តាមទំលាប់/Before SRI (normal practice)

    ☐ ផលិតផលស្រូវលើស ./Surplus in rice; មាន

    ☐ គ្រប់គ្រាន់សំរាប់គ្រួសារ/just enough to feed my family

    ☐ មិន គ្រាន់/Not enough;

    - មិន គ្រប់/Not self sufficient for ______ ខែ/months
  - ប.រ.ស/With SRI

    ☐ ផលិតផលស្រូវ លើសមាន. តើមានចំនួនប៉ុន្មាន?/Surplus in rice; if applicable how much surplus:

    ___________kg/year

    ☐ គ្រប់គ្រាន់សំរាប់គ្រួសារ/Just enough to feed my family

    ☐ មិន គ្រប់គ្រាន់/Not enough;

    - មិន គ្រប់/Not self sufficient for ______ ខែ/months
- ការរួមរូមចំណែករបស់ស្ត្រីក្នុងការងារជាំដុះដំណាំស្រូវតាមប.រ.ស/Gender distribution of activities in rice cultivation (SRI plots):

សកម្មភាព/Activity	ប.រ.ស/SRI			តាមទំលាប់.Normal practice		
	Female ស្រី	Male ប្រុស	Children ក្មេង	Female ស្រី	Male ប្រុស	Children ក្មេង
ការភ្ជួរ/Ploughing	☐	☐	☐	☐	☐	☐
ការពង្រាបដី /Leveling	☐	☐	☐	☐	☐	☐
ការធ្វើគង្លង/Establish drainage channel	☐	☐	☐	☐	☐	☐
ការសាបព្រោះ/Sowing rice seed in nursery	☐	☐	☐	☐	☐	☐
ការស្ទូង/Transplanting	☐	☐	☐	☐	☐	☐

សកម្មភាព/Activity	ប.វ.ស/SRI			តាមទំលាប់,Normal practice		
	Female ស្រី	Male ប្រុស	Children ក្មេង	Female ស្រី	Male ប្រុស	Children ក្មេង
ការសំអាតស្មៅ/Weeding	☐	☐	☐	☐	☐	☐
ការប្រើប្រាស់ជីគីមី/Application of mineral fertilizer/compost/animal manure	☐	☐	☐	☐	☐	☐
ការរៀបចំជីកំប៉ុស្ត៍/Compost preparation	☐	☐	☐	☐	☐	☐
ការគ្រប់គ្រងទឹក/Water management	☐	☐	☐	☐	☐	☐
ការប្រើប្រាស់ថ្នាំកំចាត់សត្វល្អិត/Application of pesticides/pest control	☐	☐	☐	☐	☐	☐
ការប្រមូលផល/Harvesting	☐	☐	☐	☐	☐	☐
បោកបែន/Threshing	☐	☐	☐	☐	☐	☐
ដឹកជញ្ជូន/Transport	☐	☐	☐	☐	☐	☐

7. ការយល់ដឹងរបស់កសិករទៅលើប.វ.ស/Farmer's perception on SRI

Activity សកម្មភាព	Disagree មិនឯកភាព	Indifferent មិនខ្វល់	Agree ឯក-ភាព
ប.វ.ស ជួយបង្កើនទិន្នផលស្រូវ/SRI increases rice yields.	☐	☐	☐
ប.វ.ស ត្រូវការគ្រាប់ពូជតិច/SRI requires less seeds for planting.	☐	☐	☐
ប.វ.ស កាត់បន្ថយការចំណាយខាងក្រៅដូចជា ជីគីមី, ថ្នាំ/ SRI requires less external inputs (mineral fertilizer, pesticides, herbicides).	☐	☐	☐
ប.វ.ស ត្រូវការកម្លាំងពលកម្មច្រើន/SRI requires more labor.	☐	☐	☐
ប.វ.ស បង្កអោយមានបញ្ហាស្មៅ/SRI increases weed problems.	☐	☐	☐
ប.វ.សបង្កអោយមានបញ្ហាសត្វល្អិតចង្រៃ និង ជំងឺឡើយ /SRI increases the pressure of pests and diseases.	☐	☐	☐
ការប្រើប.វ.ស មានការប្រថុយប្រថានខ្ពស់ដោយសារទឹកជំនន់ឬរាំងស្ងួត/SRI increases the risk of crop failure due to flooding or drought.	☐	☐	☐
ទោះស្ទូងសំណាប ១រឺ២ដើមនាំអោយប្រថុយប្រថានផលិតកម្ម Transplanting one/two young seedlings bears more risk of crop failure.	☐	☐	☐
ការដកសំណាបហើយស្ទូងភ្លាមដោយមិនទុក/To uproot the seedlings in the nursery and transplant them without delay is feasible for me.	☐	☐	☐
ខ្ញុំអាចដាំជាជួរដោយងាយស្រួល/I can easily manage to plant seedlings in rows.	☐	☐	☐
ការគ្រប់គ្រងទឹកតាម ប.វ.ស (ទោះមានទឹក ឬ អត់ទឹក) ងាយស្រួលសំរាប់ខ្ញុំ /The water management under SRI (alternating flooding and drying) is feasible for me.	☐	☐	☐
ប.វ.ស ជួយបង្កើនដីមានជីជាតិដី/The soil quality improves when applying SRI	☐	☐	☐
ពេលវេលាសំរាប់/The time requirement for com-	☐	☐	☐

post making is feasible for me.			
Activity ស ក ម្ ភ ា ព	Disagree មិនឯកភាព	Indifferent មិនខ្វល់	Agree ឯក-ភាព
មានជីលាមកសត្វ និង ជីកំប៉ុសគ្រប់គ្រាន់សំរាប់ប្រើប្រាស់លើដំណាំ / Enough animal manure and compost is available to fertilize my rice crop.	☐	☐	☐
ប.វ.ស បង្កើនទិន្នផលស្រូវសំរាប់តំរូការក្នុងគ្រួសារ SRI has increased my self sufficiency in rice	☐	☐	☐
ប . វ . ស ជា ប ច េ ក េ / SRI is also suitable for poor farmers.	☐	☐	☐

8. Cross-check questions

- ក្រោយពេលអនុវត្ត ប.វ.ស How is your rice yield after using SRI components compared to before (normal practice)?
  - ☐ កើនខ្លាំង /Much higher
  - ☐ កើន /A little higher
  - ☐ ដូចពីមុន /The same as before
  - ☐ តិចជាងមុន/A little less
  - ☐ តិចជាងមុន /Much less
- តើជាទូទៅ អ្នកពេញ /Are you overall satisfied with SRI? ☐ បាទ, ពេញចិត្ត/Yes….☐ ទេ/No
- បើពេញចិត្ត, ហេតុអ្វីបានជាអ្នកមិនប្រើលើដចស់របស់អ្នក?/If yes, why don't you apply it on all of your fields?

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- តើ អ្វី ជាបំផុតសំរាប់ការធ្វើ ប.វ.ស?/Which are the major problems/difficulties for using SRI?

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Schedule of survey activities

Date	Jürgen Anthofer	Location	Vanny Suon	Location	Kosal Oum	Location
14.02.04	Departure from Germany					
15.02.04	Arrival in Phnom Penh	Phnom Penh		Phnom Penh		Phnom Penh
16.02.04	Coordinate with Team leader of FSNPSP and RDP and Co-Consultants	Phnom Penh	Coordinate with Team leader of FSNPSP and RDP and Co-Consultants		Coordinate with Team leader of FSNPSP and RDP and Co-Consultants	
17.02.04	Develop research hypothesis for the survey; update schedule	Phnom Penh	Obtain relevant data and documents from CARDI	Phnom Penh	Obtain relevant documents with regard to extension from MAFF	Phnom Penh
18.02.04	Obtain and review relevant documents available from CEDAC	Phnom Penh	Obtain and review relevant documents available from CEDAC	Phnom Penh	Obtain and review relevant documents available from CEDAC	Phnom Penh
19.02.04	Obtain and review relevant documents available from PADEK	Phnom Penh	Obtain and review relevant documents available from PADEK	Phnom Penh	Obtain and review relevant documents available from PADEK	Phnom Penh
20.02.04	Coordinate with all involved partners (FSNPSP, RDP, CEDAC, PADEK) to develop a frame for the questionnaire and interview quidelines	Phnom Penh	Coordinate with all involved partners (FSNPSP, RDP, CEDAC, PADEK) to develop a frame for the questionnaire	Phnom Penh	Coordinate with all involved partners (FSNPSP, RDP, CEDAC, PADEK) to develop a frame for the questionnaire	Phnom Penh
21.02.04	Meeting with all involved partners (FSNPSP, RDP, CEDAC, PADEK) to develop a frame for the questionnaire	Phnom Penh	Meeting with all involved partners (FSNPSP, RDP, CEDAC, PADEK) to develop a frame for the questionnaire	Phnom Penh	Meeting with all involved partners (FSNPSP, RDP, CEDAC, PADEK) to develop a frame for the questionnaire	Phnom Penh
22.02.04	-					

Date	Jürgen Anthofer	Location	Vanny Suon	Location	Kosal Oum	Location
23.02.04	Travel to Kandal and introduction with project staff	Kandal	Travel to Kandal and introduction with project staff	Kandal	Travel to Kandal and introduction with project staff	Kandal
24.02.04	Finalize questionnaire/interview guidelines and feed back to taskforce	Phnom Penh	Finalize questionnaire/interview guidelines and feed back to taskforce	Phnom Penh	Finalize questionnaire/interview guidelines and feed back to taskforce	Phnom Penh
25.02.04	Translation of questionnaire, Discuss questionnaire with enumerators; training on data collection	Phnom Penh	Translation of questionnaire Discuss questionnaire with enumerators; training on data collection	Phnom Penh	Translation of questionnaire Discuss questionnaire with enumerators; training on data collection	Phnom Penh
26.02.04	Pre-test questionnaire in the field	Kandal	Pre-test questionnaire in the field	Kandal	Pre-test questionnaire in the field	Kandal
27.02.04	Modify questionnaire according to needs	Phnom Penh	Modify questionnaire according to needs	Phnom Penh	Modify questionnaire according to needs	Phnom Penh
28.02.04		Phnom Penh		Phnom Penh		Phnom Penh
29.02.04	-					
01.03.04	group discussion with farmers	Kandal	group discussion with farmers	Kandal	group discussion with farmers	Kandal
02.03.04	Develop data base	Phnom Penh	Data collection and supervision	Kandal	Data collection and supervision	Kandal
03.03.04	Develop data entry form	Phnom Penh	Data collection and supervision	Kandal	Data collection and supervision	Kandal
04.03.04	Develop data entry form/ Discussion with resource persons	Phnom Penh/ Kandal	Discussion with resource persons	Kandal	Discussion with resource persons	Kandal
05.03.04	Develop data entry form/ Group discussion with farmers	Phnom Penh/ Kandal	Group discussion with farmers	Kandal	Group discussion with farmers	Kandal
06.03.04	Train co-consultants and enumerators to use the data-entry form	Phnom Penh	Training on data entry	Phnom Penh	Training on data entry	Phnom Penh

Date	Jürgen Anthofer	Location	Vanny Suon	Location	Kosal Oum	Location
07.03.04	-					
08.03.04	Travel to Kampong Thom	Kampong Thom	Travel to Kampot	Kampot	Travel to Kampong Thom	Kampong Thom
09.03.04	Supervision of data collection; discussion with resource persons	Kampong Thom	Supervision of data collection	Kampot	Supervision of data collection; discussion with resource persons	Kampong Thom
10.03.04	Group discussion with farmers	Kampong Thom	Supervision of data collection	Kampot	Supervision of data collection; group discussion with farmers	Kampong Thom
11.03.04	Travel Kampong Thom to Kampot	Kampot	Supervision of data collection	Kampot	Supervision of data collection,	Kampong Thom
12.03.04	Group discussion with farmers	Kampot	Data collection and supervision; Group discussion with farmers	Kampot	Data collection and supervision	Kampong Thom
13.03.04	Discussion with resource persons	Kampot	Data collection and supervision	Kampot	Data collection and supervision	Kampong Thom
14.03.04						
15.03.04	Group discussion with farmers	Kampot	Data collection and supervision; group discussion with farmers	Kampot	Data collection and supervision	Kampong Thom
16.03.04		Kampot	Data entry Kampot	Kampot	Data entry Kampong Thom	Kampong Thom
17.03.04	Travel to Takeo, discussion with resource persons	Takeo	Travel to Takeo, discussion with resource persons	Takeo	Travel to Prey Veng	Prey Veng
18.03.04	Supervision of data collection; group discussion with farmers	Takeo	Supervision of data collection; group discussion with farmers	Takeo	Data collection and supervision	Prey Veng
19.03.04		Takeo	Supervision of data collection,	Takeo	Data collection and supervision	Prey Veng
20.03.04	Travel to Prey Veng	Prey Veng	Supervision of data collection,	Takeo	Data collection and supervision,	Prey Veng

Date	Jürgen Anthofer	Location	Vanny Suon	Location	Kosal Oum	Location
21.03.04						
22.03.04	Travel to Prey Veng, group discussion with farmers (PADEK)	Prey Veng	Data collection and supervision	Takeo	Data collection and supervision, Group discussion with farmers	Prey Veng (PADEK)
23.03.04	Supervision of data collection, discussion with resource persons (PADEK)	Prey Veng	Data collection and supervision	Takeo	Data collection and supervision, discussion with resource persons (PADEK)	Prey Veng
24.03.04	Supervision of data collection, group discussion with farmers (CEDAC)	Prey Veng	Data collection and supervision	Takeo	Data collection and supervision, group discussion with farmers (CEDAC)	Prey Veng
25.03.04	Discussion with resource persons (CEDAC)	Prey Veng	Return to Phnom Penh	Phnom Penh	Discussion with resource persons (CEDAC)	Prey Veng
26.03.04	Return to Phnom Penh	Phnom Penh	Data entry Takeo	Phnom Penh	Return to Phnom Penh	Phnom Penh
27.03.04	Final discussion with enumerators	Phnom Penh	Final discussion with enumerators	Phnom Penh	Final discussion with enumerators	Phnom Penh
28.03.04	-					
29.03.04	Analysis of survey and secondary data	Phnom Penh	Data entry and analysis of survey and secondary data	Phnom Penh	Data entry and analysis of survey and secondary data	Phnom Penh
30.03.04	Analysis of survey and secondary data	Phnom Penh	Remaining data entry and analysis of survey and secondary data	Phnom Penh	Remaining data entry and analysis of survey and secondary data	Phnom Penh
31.03.04	Analysis of survey and secondary data	Phnom Penh	Remaining data entry and analysis of survey and secondary data	Phnom Penh	Remaining data entry and analysis of survey and secondary data	Phnom Penh
01.04.04	Analysis of survey and secondary data	Phnom Penh	Analysis of survey and secondary data	Phnom Penh	Analysis of survey and secondary data	Phnom Penh
02.04.04	Analysis of survey and secondary data	Phnom Penh	Analysis of survey and secondary data	Phnom Penh	Analysis of survey and secondary data	Phnom Penh
03.04.04	Task force meeting, discussion of survey results	Phnom Penh	Task force meeting, discussion of survey results	Phnom Penh	Task force meeting, discussion of survey results	Phnom Penh

Date	Jürgen Anthofer	Location	Vanny Suon	Location	Kosal Oum	Location
04.04.04	-					
05.04.04	Task force meeting, discussion of survey results	Phnom Penh	Task force meeting, discussion of survey results	Phnom Penh	Task force meeting, discussion of survey results	Phnom Penh
06.04.04	Preparation of workshop	Phnom Penh	Preparation of workshop	Phnom Penh	Preparation of workshop	Phnom Penh
07.04.04	Preparation of workshop	Phnom Penh	Preparation of workshop	Phnom Penh	Preparation of workshop	Phnom Penh
08.04.04	National SRI workshop	Phnom Penh	National SRI workshop	Phnom Penh	National SRI workshop	Phnom Penh
09.04.04	Compiling information from the workshop	Phnom Penh	Compiling information from the workshop	Phnom Penh	Compiling information from the workshop	Phnom Penh
10.04.04.	Departure to Germany	Phnom Penh				
11.04.04	Arrival in Germany					
18.04.04	Report writing (7 days)	Germany				

Terms of Reference:

Assessment of dissemination and benefit of System of Rice Intensification in Cambodia

1 Background

Rice is the main staple food and rice farming provides income and employment opportunity for around 65% of Cambodia's population[1]. Officially, the national average yield of rice is estimated to be between 1.65 and 1.80 tons per hectare in the wet season (MAFF 1995-2000, and FAO/WFP 1999). This is relatively low compared with other countries in the region.

Improvement of rice productivity is one of the main objectives of any agriculture and rural development program in Cambodia. In the last decades the Royal Government of Cambodia, NGOs and IOs have implemented agriculture productivity improvement programs with different approaches and strategies to increase rice yields of small farmers, which are expected to improve food security, increase rural incomes, and reduce the vulnerability of rural households. Fertilizer split application and the introduction of improved high-yielding varieties, as well as integrated pest management (IPM), were promoted on a large scale. However, the environmental sustainability and the economic viabilities of high input approaches for poor farmers are still questionable, especially taking into consideration that the production system has not yet been able to increase the yield beyond the 2 tons per ha mark.

The **System of Rice Intensification (SRI)** was originally developed in Madagascar. It has been shown to be a set of sustainable rice farming technologies that can help small farmers to increase significantly their rice yields up to 7 tons and more per hectares without depending on hybrid seeds, chemical fertilizers and pesticides. Although some of the techniques and principles of SRI have been already known to Cambodian farmers, there were no experiences in growing rice by systematically combining or integrating the crop cultivation techniques described with SRI. It is important, that SRI is to be seen as a set of low input technologies, which can be flexibly applied, rather than as one technology package.

Since 2000 with the assistance of CEDAC, Oxfam GB and Oxfam America, GTZ-RDP in Kampot and Kampong Thom, PRASAC in Kampong Chhnang, Takeo, Kampong Speu, Prey Veng and Svay Rieng Provinces, and several NGOs (Aphiwat Satrey, RDA, Krom Aphiwat Phum, CCK, Chethor, NAS) have implemented the SRI approach on a pilot level to investigate how these techniques work under different agro-climatic and soil conditions as well as to further develop SRI methods in the Cambodian context. In 2002, approximately 2600 farmers were working with SRI elements on various scales. In 2003, an estimated 10,000 farmers were using elements of SRI methods.

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1 About 85% of Cambodia's 12 million people live in rural areas, and about two-thirds of this rural population depend mainly on rice farming.

First results of the pilots with SRI have shown it to be a promising approach toward environmental-friendly intensification of rice production in Cambodia, which may be a valuable alternative for small farmers with limited land endowment and little capital to invest in agricultural inputs. In comparison with conventional practices, the average yield with SRI methods is about 150% higher, since the average yield that farmers have been getting with conventional practices is less than 2 tons per ha[2]. However the specific enabling and constraining factors for achieving these impacts, the economic net returns, and the feasibility of implementing this strategy for poor farmers on a broad scale in order to reduce household vulnerabilities and increasing food security are not well known. Although piloting SRI elements have been supported by relevant line ministries at the provincial level, at national level the approach is little known and has not found its way into policy documents and strategies.

In order to facilitate the systematic analysis of experiences with SRI in Cambodia, GTZ/FSNPSP in cooperation with CEDAC and GTZ/RDP is organizing a consultancy mission in early 2004. The Council of Agriculture and Rural Development (CARD), a coordination structure for agriculture and rural development in Cambodia within the Council of Ministers, has welcomed this evaluation research and is interested to discuss the outcome of the mission within the National Food Security Forum (FSF) that is organized through CARD. The FSF will be briefed on SRI prior to the evaluation through a presentation (by CEDAC) during its meeting in February 2004. The findings should also find their way into discussions at MAFF, CARDI and MRD respectively.

1 Overall objective of the study

- **The potential of SRI methods are systematically assessed and analyzed with regard to the economic and social feasibility as a sustainable strategy for poverty reduction among rural Cambodian farming households.**
- **Policy and decision makers at national level are aware of the potential of the SRI approach for poverty reduction of rural Cambodian farmers, and the SRI approach is adequately reflected in respective national strategies, as well as scaling up strategies for widespread implementation.**

2 Specific objectives and method of the study

- Experiences/documents with SRI in the sub-region are reviewed;
- An inventory with regard to SRI practices in Cambodia, analyzing success and failure in implementing SRI with special consideration of socio-economic and agro-geological factors is available;

[2] CEDAC, Report on Farmer Experimentation with System of Rice Intensification (SRI): Results in Wet Season 2000.

- The socio-economic feasibility/viability for implementing SRI elements in Cambodian context for different types of farm households is assessed;
- Recommendations on the suitability of different SRI elements considering its impacts on rural livelihoods and improved food security are analyzed;
- Recommendations on the feasibility of SRI elements under different agro-ecological conditions (soils, climate, etc.) are available;
- "Best practices and lessons learned" with regard to disseminating SRI concepts to the stakeholders at the national level, as well as to farmers, are analyzed.

1 Tasks of the consultant

- Contact relevant international and in-country agencies involved in SRI and review/ inventorize existing guidelines, research, documents and quantitative data (secondary data).
- Develop primary data collection instruments for an SRI. adoptation/impact study, conduct interviews and group discussion with SRI-farmers and non-SRI-farmers in 5 Provinces, Kandal (CEDAC and OXFAM Internatinal), Kampot and Kampong Thom (GTZ-RDP), Prey Veng and Takeo (CEDAC, PRASAC and PADEK), with particular focus on why the farmers are applying SRI elements and from where they received the information on it.
- Develop and elaborate survey design and sampling frame in coordination with partners (CEDAC, GTZ/RDP, PADEK, GTZ/FSNPSP).
- Analyze the data with regard to enabling and constraining factors (economic, social as well as management aspects of rice cultivation in Cambodia context e.g. labor requirements, farm and water management etc.).
- Carry out gross-margin calculations for different types of farm households (resource endowments) and soil types, and assess the role (contributions) of SRI elements on rural livelihoods and food security.
- Propose dissemination strategies for SRI elements with special reference to extension systems and diversification potentials of farming systems.
- Provide recommendations on how to improve the SRI approach, its strategies and management in a sustainable manner including a suggestion on how to better coordinate, monitor and evaluate SRI-activities in Cambodia.
- Based on the outcome of the study, provide recommendations on the integration of SRI approach into national agricultural development strategies.
- Present and discuss conclusions and recommendations of the study during national workshop on SRI in Cambodia later in 2004.
- Prepare a consolidated report on the findings and recommendations

These tasks are to be carried out in close collaboration with GTZ (FSNPSP, RDP-Kampot and Kampong Thom), MAFF, CARD and CEDAC, Oxfam International and other stakeholders of the advisory taskforce.

2 Expected outputs/products of the consultancy

- A summary draft of the findings and recommendations and a visualized presentation for the national workshop on SRI.
- Facilitation of a debriefing workshop conducted at national level with CARD, GTZ, MAFF, CEDAC, OXFAM International and other stakeholders at the end of the consultancy.
- A consolidated report on the findings (SRI impact assessment) and recommendations on further dissemination of SRI at macro, meso and micro levels, taking into account the discussions during the national workshop

3 Consultancy Mission

A team of consultants will carry out the consultancy mission.

The consultancy team consists of one international expert and two local co-consultants including 6 enumerators for primary data collection.

4 Reporting

A final report including the documentations of the national workshop has to be submitted to GTZ/FSNPSP and GTZ/RDP latest one week after end of the consultancy mission in hard and soft copy.

The consultant team has to report regularly the progress of the research to the taskforce[3] to supervise the research.

5 Timelines

The consultancy period is totally 8 weeks (Total 55 working days including days for traveling from and to Germany), beginning on 21st of February 2004 and finished on 17th of April 2004.

[3] Composition: Mr. Edwin de Korte (GTZ-RDP Kampot),Mr. Georg Deichert (GTZ/RDP-Kampot), Mr. Peter Kaufmann and Mr.Vann Kiet (GTZ-FSNPSP), Mr. Sem Rithyvuth (GTZ/RDP-Kthom), Mr. Yang Saing Koma (CEDAC), Luy Pisey Rith (PADEK), Huot Chhun (OXFAM GB), Mr. Rath Virak (CARD), Mr. Kean Sophea (SPFS-FAO), Mr. Mak Soeun (WIN-FAO) and CARDI. GTZ-FSNPSP is coordinator body of the taskforce.