Present Situation of SRI Farming in Sri Lanka

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FOREWORD

SRI (System of Rice Intensification) is an eco friendly way of rice cultivation introduced from Madagascar around 1980 to Sri Lanka. Even though literature proves that SRI method gives higher yields, Sri Lankan farmers have not been keen in adopting this method. This research study was undertaken by the HARTI to examine the current trends and factors influencing SRI farming.

The Study reveals that there is no significant yield variation between SRI method and conventional methods in Sri Lanka. In addition, the cost of Production of SRI farming with and without family labour is also higher than in the conventional method. SRI requires more labour for several agronomic practices such as transplanting and weeding. Some innovative and eco friendly farmers continue SRI farming with the help of several NGO's.

On the other hand the inorganic fertilizer requirement is less in SRI method because organic fertilizer is essential to increase the vigor of the paddy plants and it is one of the necessary agronomic practices of SRI farming. Therefore SRI method can be promoted for seed paddy production. Hence it is an environment friendly method and it can be used to maintain the environment sustainability of the farming environment.

This study will be useful for the policy makers to increase the quality of the paddy production in Sri Lanka.

Lalith Kantha Jayasekara
Director
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EXECUTIVE SUMMARY

Rice is the most important crop for human well-being across the world and it is the staple food in 33 countries around the world including Sri Lanka (Krupnik,2005). Therefore improvement of rice productivity has been one of the main objectives of agriculture and rural development programmes implemented by successive governments over the last few decades (Perera, J. *etal*, 2007). The Green revolution in late 1960s was introduced to the farmers for increasing the yield. The Green Revolution consisted of introduction of fertilizer-responsive, lodging and disease- resistant and high-yielding varieties; investments in irrigation infrastructure; increased use of chemical fertilizers, herbicides, insecticides and fungicides, and government support through extension and micro-credit provisions (Ellis, 1993). Due to long term usage of agricultural inputs the fertility of the soil get diminished. Therefore to maintain the sustainability of paddy fields it is required to practice environmentally friendly methods. The System of Rice Intensification (SRI) has evolved in Madagaskar during 1980's and it has been implemented in more than 28 countries. SRI method was introduced to Sri Lanka during the year 2000. This is not a new technological method, but it is a set of different cultivation practices. The main features of these practices; are use of younger seedlings (8-12 days old), wider spacing, (one seeding per hill with 25 cm x 25 cm), not providing water logging conditions (drying and wetting), adding organic fertilizer and support for healthy growth of root system. Therefore this system can be considered as an alternative method of preventing the environmental degradation. Literature has shown that by practicing this SRI farming the quality and the quantity of the rice production can be increased. Even though SRI farming is a very good and eco-friendly method the adoption rate of this method is very low. Therefore the study on the present situation of SRI farming in Sri Lanka is timely and relevant.

The main objective of this study is to investigate the present condition of the SRI farming in Sri Lanka. The specific objectives are (1). to study the Socio-Economic conditions of the SRI farmers in Sri Lanka, (02). to investigate farming practices adapted by SRI farmers (3). to workout cost of production of SRI farming. (4). to investigate the problems and constraints in expansion of SRI method in the country and (5). to provide necessary policy guidelines towards promoting SRI farming in Sri Lanka.

The research was conducted in three districts of Sri Lanka: Hambanthota, Anuradhapura and Kegalle. Study area was selected based on the existence of SRI farmers in these districts. From each districts 30 SRI farmers and 20 conventional farmers were selected randomly and altogether 150 farmers were selected for the study. The secondary data about SRI farmers were obtained from the SRI network which was maintained by the Oxfam Australia. The primary information needed for the study was collected from the questionnaire survey. The field survey of the study was undertaken in June to September in 2009.

The proportion of SRI farmers below 30 years of age was 7.8%. But in between 30-50 age groups, 44% of the farmers were practicing SRI in the sample population. Approximately 12 % of the farmers were more than 60 years of age. This indicates that majority of the SRI farmers belonged to young farmers groups. The study indicates that 45.6% of the SRI farmers had received education up to the secondary level (year 6 to G.C.E O/L). The average monthly household incomes were Rs.22,400.00, Rs.28,829.00, Rs.23,380.00 respectively in Kegalle, Anuradhapura and Hambantota districts. Most of the farmers received knowledge about SRI method from non-government organizations such as Oxfam, Gamidiriya, Jana Aruna Foundation, Mercy Crop and etc; it was 77.8% of the total sample.

This study reveals that the majority of SRI farmers (88.7%) transplanted seedlings between 7-12 days. In the conventional method the majority of farmers (66.7%) transplanted seedlings after 16 days of age. Transplanting and seedlings were the highest cost factor in SRI practices. In Kegalle district, Marking and transplanting cost per acre was about Rs.6,582.00, whereas, in Hambantota and Anuradhapura district costs were Rs.11,873.00 and Rs.8,632.00 respectively. The average number of tillers were around 23 in SRI method. But in the conventional method 05 tillers were observed as average tillers.

The average yield of SRI in the study area was 2,296 Kg/acre whereas in the conventional method it was 2,212 Kg/ acre. The T test proves that there was no significant yield variation between SRI and conventional method. The study also reveals that average cost of production both with and without family labour in SRI was higher than in the conventional method. This was mainly because the labour cost for several agronomical practices in SRI method was higher than the conventional method. There was a small price variation in the market between the SRI cultivated paddy and the normal paddy. The SRI cultivated paddy price was approximately Rs. 2/= higher than paddy cultivated under the normal conditions. The millers explained that SRI paddy yielded more rice and these were heavier than the normally cultivated paddy.

The SRI method was practiced by few innovative farmers in the country. Except some special cases the significant yield improvements could not be seen in this method. The SRI cost of production was also higher due to the huge amount of labour requirement. But with the environment concerns SRI method can be expanded to improve the soil quality, as continuous utilization of agro chemicals leads to deterioration of the soil quality. In order to maintain vigorous paddy plant population SRI method can be used for seed paddy production. The SRI method can be practiced to cultivate traditional paddy varieties. This paddy can be sold in the super markets at a better price. SRI method is a very good method for a sustainability of paddy farming in Sri Lanka.

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CHAPTER ONE

Introduction

1.1 Introduction

Rice is unquestionably the most important crop for human well-being across the world. It is the staple food in at least 33 countries of the world and consumed on a daily basis by at least one-half of the world's population, many of whom are in the Asian region (Krupnik, 2005). Rice is grown in at least 114 countries around the world. In Sri Lanka also rice is the staple food, and most of the rural farmers are engaged in rice cultivation. The number of farm families involved in rice cultivation in the year 2005 was 879,000 (http://en.wikipedia.org/wiki/Agriculture). Improvement of rice productivity has been one of the main objectives of agricultural and rural development programmes implemented by successive governments over the last few decades. (Perera, 2007). The concept of Green Revolution was implemented in late 1960's. The Green Revolution consisted of introduction of fertilizer-responsive, lodging and disease- resistant and high-yielding varieties; investments in irrigation infrastructure; increased use of chemical fertilizers, herbicides, insecticides and fungicides, and government support through extension and credit (Ellis,1993). As a result, under the Green Revolution the agricultural productivity increased over the years. Even though the production has increased significantly due to the usage of high inputs, the environmental degradation has taken place continuously. This "Green revolution" or conventional system of production intensification had negative social and environmental results. (Vandana, 1991, cited by www.scribd.com/doc/practice of SRI in Sri Lanka.08/25/2009). Due to the long-term application of high inputs to rice and other crops, the fertility of the soil had gradually diminished. Therefore new intensification processes went by different labels, such as low external-input sustainable agriculture, organic farming, ecological farming, intermittent irrigation, alternate wetting and drying, aerobic rice cultivation, etc. The system of rice intensification (SRI) shares one or more features with each of these methods of production. (Perera, J, *et.al*, 2007). Therefore SRI cultivation can be used to reduce the environmental degradation caused by the constant use of high inputs introduced during Green Revolution.

1.2 System of Rice Intensification (SRI)

The System of Rice Intensification (SRI) has been evolved in Madagascar during 1980's and it has been practiced in more than 28 countries. This is not a new technological method, but is a set of different cultivation practices. The main features of the SRI are using younger seedlings (8-12 days old), wider spacing, (one seeding per hill with 25 cm x 25 cm), absence of water logging conditions (drying and wetting), adding organic fertilizer and support for healthy growth of root system.

There are several advantages in the SRI farming. SRI farming increases the land productivity, which means obtaining higher yields from a lesser area of land. This method of cultivation can be practiced by the poor. Thus SRI farming is a tool for

sustainable livelihood options. The SRI is also an environmentally friendly or Eco-friendly method, more resistance to pests and deceases. The grain quality is also better compared to the conventional method. Experiments have proved that from SRI cultivation can result in greater profits.

1.3 Problem Statement

Even though the Literature proves that the SRI cultivation enhance the productivity and profitability, the majority of farmers in Sri Lanka have not adapted this cultivation method. The Department of Agriculture also had not promoted the SRI practices during the last decade. These farmers who practice SRI method had been encouraged and get benefits from the different Non-Government Organizations, which actively, participate in promoting SRI methods. Most of the experts express that the SRI method has not been much adopted by the farmers as it needed more labour. Even those who practice SRI it is done only in less than one acre of land. There are very limited studies about present progress and constraints in adopting SRI method in Sri Lanka Therefore a detailed investigation of present conditions of SRI farming in Sri Lanka is timely and relevant to take future decisions with regard to agricultural development in the country.

1.4 Objectives of the Study

The main objective of this study is to investigate the present condition of the SRI farming in Sri Lanka.

The specific objectives are,

1. To study the Socio-Economic conditions of the SRI farmers in Sri Lanka,
2. To investigate farming practices adapted by SRI farmers,
3. To workout cost of production of SRI farming
4. To investigate the problems and constraints in expansion of SRI method in the country,
5. To provide necessary policy guidelines towards promoting SRI farming in Sri Lanka.

As most of the experts have explained the SRI method requires higher usage of labour than in the conventional method. Therefore to test the usage of labour following hypothesis is tested H1- SRI practicing among farmers is less due to higher labour requirement and H_0 - SRI practicing among farmers is less not due to higher labour requirement.

1.5 Limitations of the Study

Absence of sufficient literature on the subject was one of the limitations of the study. Another limitation was that very often the SRI farmers were unable to provide accurate information. Most of the farmers did not keep records on paddy farming. In the proposal of this study it was planned to select SRI farmers to represent different ecological zones

in Sri Lanka. But in the actual situation the number of SRI farmers were limited. Therefore the zonal variation was not considered in this study.

1.6 Scope of the Study

The present study is an attempt to fill the gap in knowledge about SRI farming in Sri Lanka. Why the majority of the farmers did not adopt this method will be examined in the study. These findings would help mapping out effective policy directions in planning and developing the paddy sector in Sri Lanka.

CHAPTER TWO

Research Methodology

The following research methodology was applied to collect and analyze the data and other information.

2.1 Data Collection

In line with specific objectives of this study, the methods of data collection consisted of 3 major components including a comprehensive literature review, focus group and key informant-discussions and a questionnaire survey. The questionnaire survey was conducted to identify the present situation of SRI farming in the study area.

2.1.1 Literature Review

Literature review relied on collecting the existing published information on SRI farming in Sri Lanka. The information thus collected helped to select SRI farmers for the study. SRI net-work records have given a very clear picture of the SRI farming areas in selected districts and the distribution pattern of the farmers in different districts.

2.1.2 Key Informants Discussion

The officers in different NGO's which involved in SRI farming were identified as key informants. Officials in the SRI net-work were interviewed by using guidelines. Informal discussions were also held to gather necessary information about the SRI farming.

2.4 Questionnaire Survey

Farmers were selected randomly according to the availability of the number of SRI farmers in different districts in Sri Lanka for the questionnaire survey. The questionnaires were Pre-tested, and finalized with the help of experts. Structured questionnaires were prepared to collect detail information about the following aspects:

a. Socio-Economic background of both SRI and conventional farmers,
b. Basic information in SRI farming,
c. SRI farming practices,
d. Production cost of SRI farming and conventional farming.
e. Labour requirements,
f. Marketing,
g. Problems and constraints in promoting SRI farming,
h. Supports given to promote SRI farming by different institutions,

To obtain the data on cost of production of conventional method to compare with SRI method, questionnaire survey was administered to 60 conventional farmers. Those 60

farmers were selected randomly from these 3 districts and represent 20 farmers from each district.

2.5 Sampling Procedure

According to SRI network information 756 farmers practiced SRI in Sri Lanka with the help of different NGO's in 2008. But some farmers did not practice SRI in both seasons. Therefore selecting farmers for the study was somewhat difficult. Nevertheless SRI farmers and Conventional farmers in three different districts were subjected to questionnaire survey to gather information. Thirty SRI farmers and 20 Conventional farmers were selected randomly for the study. Altogether 90 SRI farmers and 60 non SRI farmers came under the questionnaire Survey. The table 2.1 elaborates the selected Agrarian Service Centers, GN divisions and interviewed SRI and non SRI farmers.

Table 2.1: SRI Farmers and Non Sri Farmers Interviewed in Three Districts

District	Agrarian Service Center	G.N. Division (APRA Division)	No. of Farmers	
			SRI	Non SRI
Kegalle	Ambepussa	Pahala Waligalla	09	02
		Ganegama	05	06
		Kukulpane	13	08
		Dodamdeniya	01	
		Harankahawa	02	04
Sub Total			**30**	**20**
Hambantota	Bandagiriya	Julgamuwa	14	10
		Yahangala-East	16	10
Sub Total			**30**	**20**
Anuradhapura	Thambuttegama	Makulawa	05	03
		Thammannawa	08	05
		Halabawa	01	01
	Nagampaha	Kuratiyawa	10	06
		Pahalagama	06	05
Sub Total			**30**	**20**
Total			**90**	**60**

2.6 Method of Analysis

Since the main objective of the study, was to find out the present conditions of the SRI farming, the following analytical methods were used to realize the objectives.

I. Hypothesis testing.
II. Comparison of cost-benefits of SRI farming and conventional farming.

2.7 Study Period

The field data collection of this study was carried out from July 2009 to September 2009.

2.8 The Study Locations

Study was conducted in Kegalle, Hambantota and Anuradhapura districts. Study area was selected on the availability of SRI farmers in each area. At the time of the field survey some farmers did not continue the SRI practices. The number of farmers who were resorting to SRI method in each area is listed in table 2.2.

Table 2.2: Area and the SRI Farmers

District	Organization	Acres	Total No. of Farmers	Interviewed SRI Farmers	Interviewed Non- SRI Farmers
Kegalle	Oxfam	14	46	30	20
Hambantota	Oxfam, Jana Aruna Foundation, Mercy Corp Gami Diriya	157	325	30	20
Anuradhapura	Oxfam	20	45	30	20
Total		**191**	**416**	**90**	**60**

Source: Sri Network, Oxfam Australia, 2007

CHAPTER THREE

Review of Literature

Review of literature, provides information regarding the previous work done in the area of SRI farming. The available literature relevant to the objectives of this study is reviewed and presented under the following headings.

3.1 What is SRI Farming ?

The System of Rice Intensification (SRI) technology is an innovative and cost-saving approach to boost rice yields. SRI is also called as Madagascar Technology (www.hindu.com). The system was developed in 1983 by the late Fr. Henri de Laulanie, who observed a strong increase in tillers and yield after an accidental early transplanting. (ILEIA News letter, 1999).The SRI system itself is very simple, but it changes practices of farmers had done for thousands of years (http://news.cornell.edu). The method is now adopted by farmers in 24 countries. It requires less water and fertilizer and fewer seeds, but increases yield by 50% to 100% or more (http://news.cornell.edu/). SRI involves the use of certain management practices which provide better growing conditions for plants, particularly in the root zone, than for plants grown under traditional practices. SRI methods have at least doubled the yields of any variety of rice. No external inputs are necessary for a farmer to benefit from SRI (www.echotch.org). The SRI method is not a matter of theory but a beneficial practice. (http://ciifad.cornell.edu). In 2003, a study had been conducted on Prospects for Adopting System of Rice Intensification in Sri Lanka. According to that study, there are many definitions and descriptions of SRI. All of these definitions underline the importance of conceptualizing SRI as a system rather than as a technology because it is not a fixed set of practices. Therefore, SRI is not a package of fixed technical specifications. It is rather a system of production formulated on certain core principles of soil chemistry and biology, rice physiology and genetics and the principles of sustainability with the possibility of adjusting the exact technical components based on the prevailing biophysical and socioeconomic realities of an area. This definition calls for research and adoption of the system to specific conditions of an area rather than trying to impose practices relevant to one location on the other injudiciously. (Namara *et al*. 2003).

3.2 Present Context of SRI Farming of Sri Lanka

SRI farming has been introduced to Sri Lanka during the year 2000. But it has not been adopted sufficiently by paddy farmers. Even though government did not promote this method, different non-governmental organizations made efforts to promote it. All these SRI promoting NGO's got together and formed a network called SRI network. That network is operative in several districts of Sri Lanka.

The number of SRI farmers and the supporting organizations have been presented in the table 3.1. As shown in the table, according to the SRI net work total numbers of SRI practicing farmers in year 2009 in Sri Lanka are 756 and the areas covered by SRI cultivation is around 383 acres. These SRI practices are highly concentrated in the dry zone. World Vision and the Oxfam organizations are the leading institutes promoting this method. The districts such as Hambantota., Puttlam, Kurunegala, Anuradhapura and Kegalle are the most important Sri practicing areas.

Table 3.1: Distribution of SRI Farmers in Sri Lanka

District	Organization	Acres	No. of Farmers
Kegalle	Oxfam	14	46
Matara	Oxfam Gami Diriya	5 10.5	31
Kandy	Dept. of Agriculture	8	60
Gampaha	Other Organizations	14	24
Colombo	Cooperative Environmental Foundation	06	08
Anuradhapura	Oxfam	20	45
Polonnaruwa	Oxfam	21	34
Ampara	Oxfam, Sewa Lanka	3.75	07
Hambantota	Oxfam, Jana Aruna Foundation Mercy Corp, Gami Diriya	157	325
Moneragala	World Vision/Vikalpani Women.Org.	9.5	20
Trincomalee	Vikalpani W.O.	01	02
Puttalam	World Vision, Sewa Lanka	68	97
Kurunegala	Other Organizations	46	60
Total		**383.75**	**756**

Source: SRI Net Work, Oxfam Australia, 2008

Even though the SRI promoting NGO's point out that this method gives higher yields; according to Abesiriwardena 2009, SRI was not capable of giving high grain yield or at least a significantly higher grain yield than that of properly managed conventional methods. However, its grain yield level on seed basis was comparatively very high owing to its low seed rates

3.3 SRI Practices in Sri Lanka

SRI method was introduced in Sri Lanka by Professor Norman Uphoff, Director of CIIFAD, at a meeting of farmers in Gal Oya in September 1998. After this, communications commenced and information was shared with the Ministry of Agriculture and Lands (Perera *et al.* 2007). In Sri Lanka, rice is grown under conditions of sub-optimal water and land availability. Thus, innovations such as the system of rice intensification (SRI) that can increase productivity and save resources are needed (http://www.scribd.com).

The Ecological Farming Center at Mellawalana operated by a farmer named H.M. Premarathna, the Mihidiya Foundation for Research and Development, and several NGO's and farmer groups supported by a small team of officers in the ministry of Agriculture continued to disseminate information on SRI. The first systematic testing to evaluate SRI was undertaken in 1999 at the Ambepussa Agricultural Training Center in the Western province. SRI evaluation has also been undertaken by Rice Research and Development Institute of the Department of Agriculture at Batalagoda.

In year 2005 more than 3,000 farmers in 18 districts were estimated to be practicing SRI in small plots of about 0.2ha. On average SRI practice is most prominent in Kurunegala district where the Deputy Director of the Agricultural Development Authority collects information on SRI practice and continues observations. In other districts, officers from different agencies give leadership in disseminating information among farmers. There is no formal directive from the Ministry's extension service to undertake SRI promotion, extension or supervision.

SRI method is practiced in all three locally defined Agro Ecological Zones (AEZ), such as dry zone, the wet zone and the intermediate zone. Farmers have practiced both improved varieties and traditional varieties under SRI. The highest yield recorded during the last three years came from the improved variety of BG – 403, a four month variety (15.8mt/ha) and from Rathhel, a traditional variety (9.6mt/ha) (http://ciifad.cornell.edu/sri/). According to Ahamed *et al.* (2007), for almost 30 years Oxfam Australia (OAUS) has been working to alleviate poverty among very poor families in Sri Lanka through participatory community- based development. OAUS teamed up with Mr. H.M. Premarathna, a SRI farmer, to evaluate and promote SRI techniques in various parts of the country, primarily through OAUS' Community-Based Organization (CBO) partners. The SRI approach is currently being promoted by OAUS through partner organizations in Anuradhapura, Kegalle, Polonnaruwa, Hambantota, Matara and Ampara districts.

The main differences and similarities between the SRI and conventional methods are given in Table 3.2. But SRI is promoted as a system rather than a technology.

Table 3.2: Comparison of Conventional Farming and SRI Practices

Conventional Practice	SRI Practice
1. Transplant seedlings at 3-4 weeks of age.	1. Transplant seedlings at 8-12 days old.
2. Transplant 3-4 seedlings per mound.	2. Transplant one seedling per mound.
3. Transplant seedlings into an anoxic aquatic environment.	3. Transplant seedlings into a moist, but not flooded field.
4. Transplant seedlings by plunging directly into soil.	4. Transplant seedlings with care, keeping the seed coat attached at the base of the tillers.
5. Dense seeding rate of 50-100 kg/ha (10-15cm² spacing)	5. Sparse seeding rate of 5-10 kg/ha(20-30cm² spacing)
6. Flood consistently throughout the growing cycle (to a depth of about 6cm)	6. Maintain soil moisture throughout growing cycle (anoxic conditions are to be avoided)
7. Maintain flooding through panicle initiation.	7. Maintain flooding through panicle initiation.
8. Control weeds by flood, hand and/or by herbicides.	8. Control weeds by hand or with rotary hoe.
9. Maintain fertility with inorganic f fertilizers (at the rate of about 100-150 kg/ha/season)	9. Maintain fertility by generous compost applications each season prior to planting.
10.Control pests with pesticides / insecticides applications.	10.Control pests naturally, with traditional organic techniques.

Source: Randriamiharisoa and uphoff (2004), cited in Krupnic (2005)

The main components of SRI can be listed as; planting method, soil fertility management, weed control and water management. Local verification trials should be conducted for all three components to verify the suitability for the local conditions. And SRI practices are still evolving as concerns shift to improving productivity of land, labor, water and nutrients and harnessing the potential of soil biology for pushing up the yield plateau of rice further (Perera *et.al*, 2003). Farmers in Sri Lanka adapted SRI after modifying its all four elements of SRI planting method, soil fertility management, weed control, and water (irrigation) management.

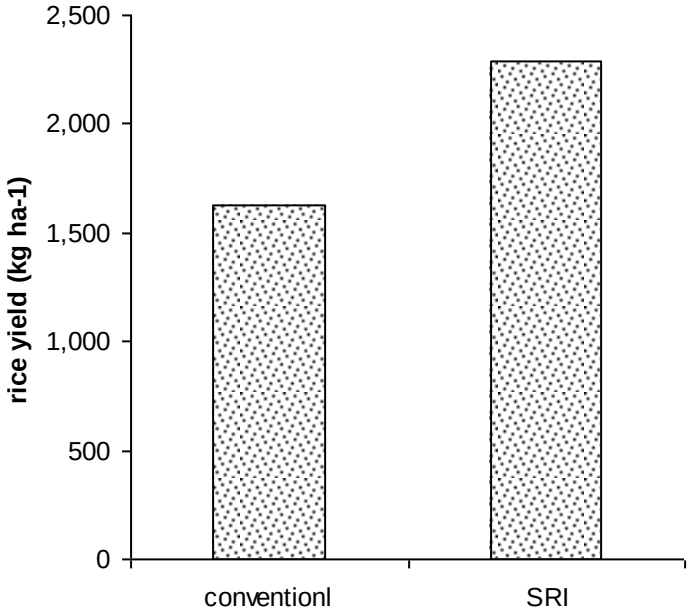
In Kurunegala, SRI farmers were dispersed over substantial areas of the district. On SRI farms, irrigation was reduced by 24%, seeding rates were reduced by 85%, and plant spacing was increased by 60%. Total inputs of nitrogen, phosphorus and potassium were similar across SRI and conventional plots, but the source of nutrients was different. SRI farmers had reduced herbicide usage by 95%. Yields varied, but significantly higher on SRI farms, soil available potassium and phosphorus were increased, and SRI plants exhibited better tolerance to low moisture stress. SRI as practice, and not just as recommended, was found to provide many of the potential benefits as claimed, including lower requirements for external inputs without negative impacts on yield. The SRI resulted in more effective tillers per unit area and saved about 0.1 ton seed per hectare,

the latter potentially significant household food security benefits. It was observed that in severe drought SRI fields exhibited more tolerance to low moisture stress than the conventional fields with consequent implications for both rain-fed and irrigated rice production systems (Namara *et al.,* 2008).

3.4 Yield of SRI Farming

Rice yields increase from 1,629 to 2,289 Kg Ha^{-1} when the farmer changed his practice from conventional cultivation to SRI in the following year on the same plot. (*Anthofer,* 2004).

Figure 3.1: Rice Yields with Conventional Practices and with SRI



Source: (Jourgen Anthofer, 2004)

SRI paddy cultivation requires less water and less expenditure but give more yield, for small and marginal farmers (http://www.ikisan.com/links/ap).SRI can achieve average yield about double the present average of 3.8 t/ha, When the methods are applied well and improved the soil, yields can reach 15 – 20 t/ha. (Rice Today, 2004). SRI methods have worked with practically all rice varieties, traditional ones and improved/modern (commonly high inputs) varieties and hybrids, but some varieties within both categories respond better than others. While the highest yields (> 15 t/ha) have been achieved with high yielding varieties on hybrids, local "unimproved" varieties can be more profitable as in Sri Lanka where yields of 6 -12 t/ha have been achieved (PANAP Rice Sheet, 2007). But according to this study SRI and Conventional yield is not significantly difference. In some plots the conventional yield is higher than the SRI yield.

Productivity of system of Rice Intensification (SRI method was evaluated with conventional rice farming systems in Sri Lanka. An experiment was carried out in the dry zone region during 2002 (Oct)/ 2003 (March) *Maha* season and a popular rice variety B.G.358 (3½ months duration) was used. Four treatments namely; SRI (T1; one plant per hill with 25cmx 25cm spacing), conventional transplanting (T2; three plants per hill with 15cm x 15cm spacing), conventional broadcasting (T3; 100kg seeds/ha) and density broadcasting (T4; 300kg seeds/ha) were arranged in randomized complete block design with four replication. Growth parameters and dry matter distribution in every two weeks intervals and yield components and grain yield at maturity were measured. Dry weights of stems, leaves and roots and the total dry weights, leaf area and total root length per hill during the growing period and the tiller number per plant at heading were significantly higher in SRI. Grain yield was 7.6 t/ha in the SRI and it was 9%, 20% and 12% greater than the conventional transplanting (T2), and normal (T3) high density (T4) broadcasting (Sarath, P.N.; Bandara, T.; 2004).

NGOs in the Philippines (CDSMC and BIND) and Cambodia (CEDAC) working with small farmers have recorded that yields have more than doubled, to 5 and 6 t/ha respectively, in their first year of using SRI methods. Farmers in Philippines are very keen to continue with SRI because of the way the plants grow, with resistance to pest and diseases. Farmers in Bangladesh working with CARE and the Department of Agriculture have got 6.5 – 7.5 t/ha, and in Sri Lanka, farmer yields have averaged over 8 t/ha reaching as high as 16 t/ha. The first yields reported from Cuba using SRI methods were both over 9 t/ha, and trials in 2000 at the National Agricultural Research Center at Sapu in the Gambia in west Africa ranged from 5.4 to 8.4 t/ha (http://ciifad.cornell.edu/SRI/quanda). SRI doesn't require the purchase of new seeds or the use of new high-yielding varieties. Although the highest yields with SRI have been obtained from improved varieties (http://ciifad.cornell.edu/sri/).

As shown in the table 3.2 in Anuradhapura, Puttlam, Kegalle and Matara districts average rice yield increased approximately two times with SRI compared to the situation on before the SRI situation.

Table 3.3: Average Yield of Anuradhapura, Polonnaruwa, Puttalam, Kegalle and Matara Districts

	Average Yield	Low	High
Before SRI	3.1	0.9	4.1
With SRI	7.6	4.1	11.4

Source: Agriculture Division, Department of census and Statistics, (2001)
(http://ciifad.cornell.edu/sri)

3.5 Farming Practices

There are six basic ideas/practices in SRI method.

1. **Use young seedlings to preserve growth potential.**

Paddy seedlings are transplanted when only the first two leaves have emerged from the initial tiller or stalk, usually when they are between 8 and 15 days old. Seedlings should be grown in a nursery in which the soil is kept moist but not flooded (www.echotech.org).

2. **Avoid trauma to the roots**
   When transplanting seedlings, carefully remove them from the nursery bed with the seed, soil and keep them moist. The seed sack (the remains of the germinated seed) should be kept attached to the infant root, because it is an important energy source for the young seedling (www.echotech.org).

3. **Seedling should be transplanted as soon as possible after being removed from the nursery, within half an hour and preferably within 15 minutes.**
   When placing seedlings in the field carefully lay the sideways in the soil with a horizontal motion, so that the root's tip is not inadvertently left pointing upward (this happens when seedlings are plunged straight downward in to the soil). The root tip needs to be able to grow downward. Careful transplanting of seedlings when they are very young reduces shock and increases the plants' ability, to produce numerous tillers and roots during their vegetative growth stage. Grains of rice are eventually produced on the panicles. More tillers result in more panicles and with SRI methods, more grains are produced on each panicle (www.echotech.org).

4. **Give plant wide spacing**
   Rather than in tight rows, seedlings are planted in square pattern with plenty of space between them in all directions. Usually they are spaced at least 25cm x 25 cm. To space the plants carefully (which makes weeding easier), sticks can be placedat appropriate intervals, along the edge of the field, then stretch strings between them. Leaving wide spaces between each plant ensures that roots have adequate room for growth and the plants will be exposed to more sunlight, air and nutrients. The result is more root growth (and thus better nutrient uptake) and more tillering (www.echotech.org).

5. **Keep paddy soil moist but un flooded**
   Rice has traditionally been grown submerged in water. Clearly rice is able to tolerate standing water. However standing creates hypoxic soil conditions (lacking of oxygen) for the roots. Rice roots have been shown to degenerate under flooded conditions. SRI, farmers use less than half of the water they would use if they kept their paddies constantly flooded. Soil is kept but not saturated during the vegetative growth period, ensuring that more oxygen is available in the soil for the roots. Occasionally (perhaps once a week) the soil should be allowed to dry to the point of cracking. This will allow oxygen to enter the soil and will also induce the roots to grow and "search" for water. After all, when the soil is flooded, there is no need for roots to grow and spread and they lack enough oxygen to grow vigorously. Water is best applied in the evening and any water remaining on the surface drained in the morning (www.echotech.org).

6. **Actively aerate the soil**
   Unflooded conditions combined with aerate soil and with mechanical weeding, result in more air in the soil and greater root growth means that the rest of the plant will have access to more nutrients (www.echotech.org).

7. **Organic Fertilizer**
   SRI was developed initially with chemical fertilizers to increase yield on very poor soils of Madagascar. Compost can be made from any biomass (e.g. rice straw, plant trimmings and plant material) with some animal manure added if available. Banana leaves can add more potassium, cutting from leguminous shrubs add more nitrogen and other plants such as Tithonia and Afromomum angustifolium, may be high in phosphorous (www.echotech.org). Under drained soil conditions a symbiosis between rice roots and aerobic soil micro-organisms such as N-fixing bacteria, azospirillum and/or mycorrhyzae, becomes likely and particularly so in relatively rich soils and when organic fertilizers such as compost are used. While chemical fertilizer and agrochemicals can be applied with SRI, their use is not required as organic materials can give good or even better results t low cost (http://ciifad.cornell.edu).

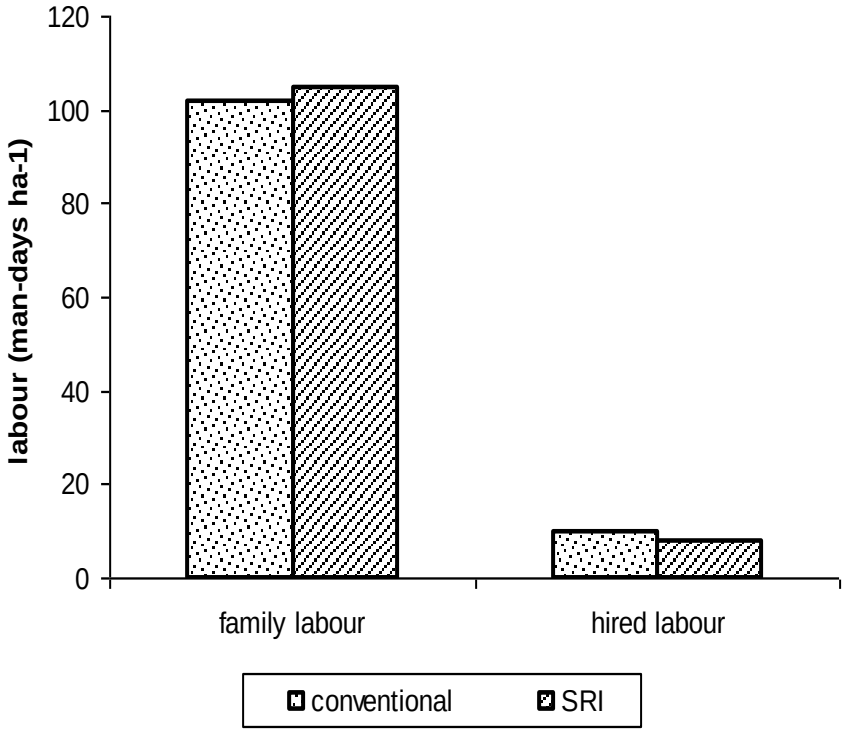
3.6 Inputs Usage in SRI Farming

3.6.1 Labour

Labour 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 labour intensive and, despite promising agronomic results for increasing yields, they largely fail to be adopted on a wider scale due to high opportunity costs for labour marking them unattractive or farmers.

Different views on the labour demand for SRI exist. SRI is thought to increase labour demands 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 labour requirement caused by the increased weeding operations, lots of farmers expressed their appreciation about the labour saving effect during uprooting and transplanting. A quantification of the overall labour demand for SRI has shown that it is rather labour neutral with respect to family labour. However, it has reduced the need for hired labour significantly, although at a family low level. *(*Anthofer, 2004)

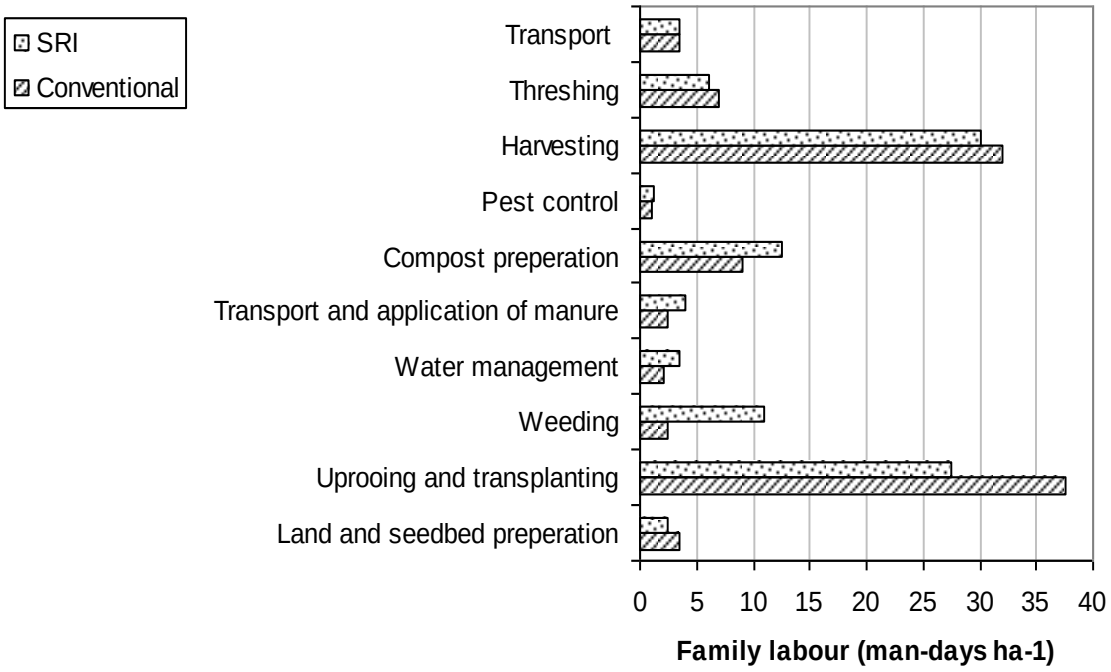
Figure 3.2: Total Labour Demand for Conventional Rice Production and for SRI



Source: Anthofer, 2004

Taking a closer look at the individual calculation activities of both conventional rice production and SRI, we can observe two major labour peaks: the first one for uprooting the rice seedlings and transplanting them to the field and a second peak for harvesting. (Anthofer, 2004)

Figure 3.3: Family Labour Demand for Individual Rice Management Activities with Common Rice Cultivation Practices (before SRI) and SRI (N =176)



Source: Anthofer, 2004

The reasons for the labour reducing effects of SRI during uprooting and transplanting is two-fold: (1) it is much easier to uproot much younger seedlings and, (2) 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. SRI increases the labour demand for weeding. Compost making and its application also requires additional time when applying SRI, but the time requirement is rather well distributed throughout the season. Compost preparation and its application was not mentioned as a major labour constraint by most farmers. Despite these overall positive results of the effect of SRI on labour demand and distribution, a less obvious issue is therefore larger farms with a low labour force. Farmers often practice SRI only on a part of their rice fields.

Farmers use more labour days in certain operations with SRI, mainly in transplanting and weeding at the beginning of their adoption. However, they use less labour with SRI once they get experience with these operations. Transplanting fewer seedlings even carefully, can take less time than in standard transplanting practice once farmers gained skill and confidence in SRI techniques. One farmer who tried both systems recorded his experience during *yala* 2001 in Sri Lanka as follows. (Table 2.4) (http://ciifad.cornell.edu/sri) – Table 3.4

Table 3.4 Comparison of Labour Requirement

	Conventional System		SRI	
	Labour (days)	Cost (Rs.)	Labour (days)	Cost (Rs.)
Raising bunds and plastering	05	1000	-	-
Transplanting	15	2250	15	2250
Weeding	15	2250	16	3200
Total	35	5500	31	5450

Source: (http://ciifad.cornell.edu/sri.

If one counts the saving of labour from not having to spray agrochemicals (as many as four sprayings a season when following recommended practice), the difference becomes greater. His returns to labour become much greater with SRI. With the conventional system, his production was 2,205 kg of paddy, valued at Rs 28,665. Whereas his production with SRI was 3750 kg, valued at Rs 49,140. The increased labour cost for the main SRI operations was 14% but the total return from SRI was 71% higher than in conventional practice (http://ciifad.cornell.edu/sri).

SRI requires more labour per hectare than traditional methods of growing rice, when farmers are not familiar and comfortable with transplanting tiny seedlings with fairly exact spacing and depth of planting. This operation can initially take twice as long. But once farmers are comfortable and skilled with the technique, transplanting takes less time, because there are fewer plants to put in.

At first, SRI can take 50-100% more labour (and more skilled and exacting labor), but over time, this amount is reduced. Experienced SRI farmers say it can even require les labour once techniques are mastered and confidence is gained (www.echotech.org).One big difference in labour requirement between SRI and conventional rice production can be for harvesting because yields are so much higher. When any new method of production is taken up, some time is required for learning how to use the method correctly and quickly. Some of the increased labour needed for SRI is thus simply a matter of time required for learning. This is the investment that should be repaid within the first season (http://ciifad.cornell.edu/sri/cuntries/zambia).

3.6.2 Water Usage

Water use with SRI is quite less and most farmers report it to be less than 50% in the conventional system. A group of farmers in Monaragala District reported that the experimented SRI plot needed only 13 irrigation turns of water while the farmers using conventional practices needed 26 turns of water (http://ciifad.cornell.edu/sri).

Instead of keeping rice fields flooded throughout the growing season as has been considered necessary to get best yields, fields are kept moist but never flooded during the vegetative growth phase with SRI. During the ensuring reproductive phase, a thin layer of

water (1-2cm) is kept on the field. These recommendations are purely empirical (http://ciifad.cornell.edu/SRI/quanda).

3.6.3 Fertilizer usage

SRI was first developed in the 1980s using chemical fertilizer. But after the price of fertilizer skyrocketed in the early 1990s, Fr. De Laulanie began experimenting with compost. He used cattle manure when it was available, but mostly any sort of decomposed biomass, including rice straw. Cuttings from leguminous plants and shrubs proved particularly beneficial. He found that using organic sources of nutrients could help achieve levels of production that could not be obtained using conventional practices. In the north of Madagascar, a private company conducted trials to determine the best levels of chemical fertilizer for rice. It reported achieving average yields of 6.2 tons with modern methods and seeds. At the same time 27 farmers using SRI in the same area averaged 10.2 tons/ha. (ILEIA News letter, 1999). So far, all rice varieties have responded positively to SRI practices, while chemical fertilizer can be used with good effect, the best results have been obtained with compost biomass (http://ciifad.cornell.edu/SRI/quanda).

Farmers use fertilizer on their land ostensibly to increase yield. However each chemical and organic fertilizer has certain distinct advantages over one another (Perera *et al*. 2007). Although SRI method can work well with chemical fertilizers, the best yield responses have been achieved with organic fertilization-compost, manure, mulch, etc. This confirms the advice given by organic farming proponents for many years, i.e. instead of feeding the plant, feed the soil and the soil will feed the plant. SRI practices enhance soil fertility because they include addition of organic matter to the soil as much as possible- and because the large root systems that they include contribute more organic mater to the soil through root exudation (PANAP Rice Sheet, 2007).

The nutrient management in paddy under SRI and traditional method of cultivation has been described by Wijebandara in 2007. The objectives of the study was to compare the growth and yield of rice under SRI and traditional methods of cultivation as influenced by nutrient level and bio-fertilizers and to study the nutrient concentration and nutrient uptake of paddy under SRI and traditional methods of cultivation as influenced by nutrient levels and bio-fertilizers. The results had shown that significantly better stand, higher number of tillers and dry matter production were noticed in SRI method of cultivation at all the growth stages of crop, and SRI method of cultivation recorded significantly higher grain yield and yield attributes. (Wijebandara, 2007)

3.6.4 Seed Requirement

Productivity of SRI is improved from several perspectives. The SRI practice of planting singly and with wide spacing reduces seed costs dramatically because the typical seed requirement with SRI is only 5 – 10 kg/hectare, compared to 40 kg/hectare or more under conventional transplanting practices. Direct seeding requirements can go as high as 100 kg of seed hectares (http://rverzola.files..wordpress.com/). Rather than young seedlings, farmer broadcasts germinated seed onto a muddied field, with a seedling rate 25 kg/ha. While this is more than the 5 -7 kg/ha used with SRI transplanting, it is much less than normally used in Sri Lanka when establishing rice by the broadcasting of seed. (http://ciifad.cornell.edu/sri/)

3.6.5 Weeding and Controlling of Pests

With SRI, it is necessary to do several weedings, at least 2 and preferably as many as 4 before panicle initiation. This is best (most quickly and beneficially) done with a simple, inexpensive mechanical hand push-weeder (rotating hoe), that was developed at IRRI in the 1960s and that churns up the soil with small, toothed wheels. No nutrients are lost to weeds as they are returned to the soil to decompose. This weeding method has the advantage apparently of aerating the soil to encourage greater root and canopy growth (http://ciifad.cornell.edu/SRI/quanda). The first weeding should be done ten to twelve days after transplanting and the second weeding within fourteen days. At least two or three weedings are recommended, but another one or two can significantly increase the yield, adding one or two tons per hectare. Weeding is labour intensive, it may take up to 25 days of labour to weed one hectare but the increase in yield means that the work will more than pay for itself (www.echotech.org).

Pest and disease problems appear to be lass with SRI methods, perhaps because the fields are kept less humid. Wider spacing also inhibits the growth and spread of certain pests and diseases. It is known that healthier, more vigorous plants are more resistant to pest and disease attacks. Farmers in Bangladesh, Cambodia, the Philippines, Myanmar and Sri Lanka, as well as Madagascar, have reported fewer pest and disease problems with this method, making use of agrochemical protection not necessarily or economical (http://ciifad.cornell.edu/sri/countries/zambia/).

Of especial significance are the frequent reports by farmers in many countries that their rice crops grown with SRI methods have less damage from pests and diseases. Evidence on this has been mostly anecdotal or fragmentary. But when the National IPM (Integrated Pest Management) program in Vietnam conducted on- farm trials across eight provinces in 2005-2006, in spring and summer seasons, these trials had shown the incidence of major pests and diseases to be 40-80% lower in SRI Fields. The reasons for this have not been fully investigated, but the stronger, tougher tillers and leaves, probably due to silicon uptake when soils are kept saturated, could be one factor. The greater abundance of insects that control pests and crop predators could also be another reason (PANAP Rice Sheet, 2007).

3.7 Cost of Production of SRI Farming

In Sri Lanka, the average cost of production of a kilogram of paddy in 2000 has been calculated as Rs. 10.58 with conventional inorganic fertilizers and agrochemicals. SRI farmers have reported that their cost of production was usually less than Rs. 5 per kilo. Some of the savings came from lesser requirement of seed paddy (10 kg/ha, instead of 100 to 250 kg/ha with conventional practices), non plastering of bunds to retain water (a saving of Rs.4,200/ha), and non-application of biocides, either weedicides or insecticides, which was a very costly operation. Their extra cost of hired labour for SRI was compensated by these cost savings.

In 2000-2001, a group of farmers at Namalthalawa in the rice growing area of the eastern province did measurements and calculations comparing their observed SRI performance with those of alternative cultivation methods. Their cost of production per kilogram of rice was calculated to be Rs.6 for conventional method, Rs. 5.65 with the government assistance package, and Rs. 3.00 with SRI. A farmer in Kurunegala district compared his costs of production and found that with SRI cost was Rs. 4.35/kg, while it was Rs. 9.36/kg with the conventional systems. Since the quality of paddy under SRI grown without biocides was considered higher, using much less chemical fertilizer and with a higher filled-grain ration, farmers have reported that they can sell their paddy as seeds which fetches a higher price (http://ciifad.cornell.edu/sri).

The system of Rice Intensification (SRI) is an unusual innovation in several ways. It can improve the productivity of the land, utilize less labour, water and capital. There are costs involved in SRI adoption, particularly due to increased labour during their initial learning phase. There are also some calculations where the method is inappropriate or impractical, e.g., where there is little water control and flooding creates anaerobic soil conditions. But with skill and confidence as well as innovation, SRI can become labour saving over time, saving water (by 25-50%) and seed (by 80-90%), reducing costs (by 10-20%), and raising paddy output at least 25-50% and often 50-100% and sometimes even more. (http://www.future_agricultures.org/)

The SRI practice of planting singly and with wide spacing reduces seed costs dramatically because the typical seed requirement with SRI is only 5-10 kg/ha, compared to 40 kg/ha or more under conventional transplanting practices. Direct seeding requirements can go as 100 kg of seed per hectare in conventional farming. Further SRI reduces external input costs by encouraging the farmer to use readily available organic materials like leaves, straw and animal manure for compost instead of expensive inorganic fertilizers. (http://rverzola.files..wordpress.com/)
Table 3.5 compares profits (RS / Acre) with SRI and non SRI cultivation with different varieties of rice in Kerala India.

Table 3.5: Comparison of Profit between SRI and Non SRI Cultivation Methods with Different Rice Varieties in Kerala

	Profit Rs/Acre			
Variety	**SRI**	**Non SRI**	**Difference**	**% Increase**
Kanchana	14,376	6,455	7,921	112.7
Sunadari	10,245	2,987	7,258	243.0
Kanchana	11,804	6,776	5,028	74.2
G.Shala	9,000	7,900	1,100	13.9

Source: RASTA, 2003
(http://wassan.org/sri/documents/India/).

In October 2002, a group of professionals from the Indira Gandhi Institute of Development Research in Mumbai, India (formerly on the agricultural economics staff of IRRI) visited Sri Lanka to evaluate SRI to conduct interviews with farmers who were practicing these methods. Data from 30 farmers was calculated and it indicated that yield had increased 88% (8.0 VS 4.5 t/ha), with 15% higher return from the rice harvested (1500 vs 1300 rupees/kg). It was indicated that total costs (excluding family labour) had reduced by 18%. Gross returns/ha were 120,000 rupees with SRI vs conventional methods and net returns were 102,000 rupees vs 36,500 rupees. In addition, family labour earnings were higher per day of work and water savings were 50-40%.

In 2003, staff of the International Water Management institute did an evaluation of SRI in Sri Lanka, studying the experience of SRI and non-SRI farmers at random in two-districts [N=60 for both samples]. It revealed that Cost of production (rupees/kg) was reduced by 17-27% counting all labour inputs at prevailing market wages, and by 111-209%. Economic risks were reduced by SRI, as non-SRI farmers experienced net economic losses in 28% of their seasons, while SRI Farmer had losses in only 4% of seasons, such considerations will make SRI ever more popular in Sri Lanka (http://ciifad.cornell.edu/SRI/countries/).

Following details illustrate the economic calculations of costs, receipts and income of rice production in the Gaundam and Dire circle of Timbuktu. Estimates on costing include the costs for seeds, diesel to run the motor pump, amortization of the motor pump, fertilizer costs, transportation costs for manure and labour costs. Currently these costs reach 214,300 FCFA/ha. When practicing SRI, a reduction in water use (25-50%), the non-use of fertilizer, a reduction of seeds by 80%, and some additional transport costs for manure can be expected. For the scenario of 25% water savings, the costs would be reduced to 149,550 CFA/ha (or 70% of conventional costs). If water requirements are reduced by 50%, the costs would diminish to 115,970 FCFA/ha (or only 5% of the conventional costs). (http://www.erikasyger.com/SRI). (Table 3.6)

Note- 400 FCFA= I USD

Table 3.6: Costs (FCFA/ha for Conventional Rice Cropping and SRI with Reduction of 25% of Water use , and a Reduction of 50% of Water use

1USD= 440FCFA

	Conventional CFA/ha	SRI 25 CFA/ha	SRI 50 CFA/ha
Seeds	14,000	2,800	2,800
Diesel	84,300	63,250	42,170
Amortization	50,000	37,500	25,000
Fertilizer	36,000		
Transport manure		16,000	16,000
Labour	30,000	30,000	30,000
Total costs	214,300	149,550	115,970
%	100	70	54

Source: Erika Styger and Ed Baxter, 2008

Calculations (1 USD =440 FCFA): Seeds: Conventional: 40 kg at 350 CFA/kg improved seeds; SRI: 8kg at 350 CFA/kg; Diesel: Conventional: 23 barrels at 110,000 CFA=2,530,000 FCFA/30 ha; Yearly amortization of motor pump: Conventional 1,500,000 /ha; Fertilizer: 100 kg/ha Urea; Transport of manure: 80 bags at 200 CFA; Labour: 30 days at 1000 CFA/day (Based on GFSI project M & E data and secondary information) (http://www.erikasyger.com/SRI).

Gross margin calculations in Cambodia has revealed a clear advantage of SRI over conventional practices. On average, gross margin had 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 rice seeds ha^{-1}. Two factors had contributed to the large difference. Farmers had saved 23 US $ ha^{-1} for variable costs like seeds and mineral fertilizers, and SRI substantially had increased rice yields leading to an increased gross benefit by 66 US $ ha^{-1}. However, saving costs for inputs might be even more important 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 monitory inputs reduces the economic risk of investing money for purchased inputs and losing everything in case of flooding or drought. Table 3.6.

Table 3.7: 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 labour	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 $man\text{-}day^{-1}$	1.55	2.54	+ 0.99

Source: Jurgen Anthofer, 2004

(Anthofer, 2004.)

3.8 Problems of SRI in Sri Lanka

1. The SRI system has been categorized as highly labour-intensive in comparison with conventional practices (Perera *et al*. 2007). SRI requires skillful management of the factors of production and at least initially more labour, particularly for careful transplanting and for weeding (http://ciifad.cornell.edu/sri/). Households with elders' children, single headed households and households with very large holdings might not have the required labour 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 (http://www.earthinstitute.columbia.edu/cgsd/).

2. Farmers who cultivate in major irrigation schemes have inadequate time for land preparation and to raise seedlings due to the short notice they are given on issuing of water from the irrigation system (http://ciifad.cornell.edu/sri).

3. Some farmers who cultivate under rain fed conditions experienced difficulties in following the required water management practices. They tend to use as much water as possible when it is available, feeling uncertain about future availability of water .Therefore in such situations it is difficult to manage proper wetting and drying of SRI fields. (http://ciifad.cornell.edu/sri).

4. Many families are constrained by the amount of available labour either within the household or for hire. If someone doesn't have enough labour to plant the seedlings in the whole field using SRI method, he or she can cultivate just part of the land to get higher returns for both labour and land (www.echtech.org).

5. 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 (http://www.earthinstitute.columbia.edu/cgsd/).

6. Animal manure and other farm resources for plant nutrition to compensate for the reduction of fertilizer use are also often not sufficiently available. (http://www.earthinstitute.columbia.edu/cgsd/)

3.9 Success of SRI in Sri Lanka

To identify the proper position of SRI as a method of stand establishment in the range of stand establishment methods in rice, a study was undertaken at the Rice Research and Development Institute, Batalegoda, Sri Lanka under the tropical environment.

Two field experiments were conducted over two consecutive years at the rice Research and Development Institute, Batalegoda, under the tropical environment. The first experiment was a two factor factorial experiment factors being method of stand establishment and standard broadcasting and varieties with two levels namely variety with 3 months maturity duration (Bg 300) and variety with 4 months maturity duration (BG 403)

The second experiment was also two factor factorial experiment factors being method of stand establishment with two levels namely SRI and standard transplanting and soil condition with two levels namely rich and poor soils.

Grain yield as expressed in terms of t/ha and 50kg/t of seeds used for cultivation, total biomass/m^2, number of panicles/m^2, number of spikelets/panicle and filled grain percentage of Bg 300 and Bg 403 under different stand establishment methods including SRI in the first experiment are presented in table 3.8.

Table 3.8: Grain yield as expressed in terms of t/ha and 50kg/t of seeds used for cultivation, total biomass/m², Number of panicles/m², number of spikelets/panicle and filled grain percentage of BG 300 and BG 403 under different stand establishment method

Characteristic	System of rice intensification (SRI) (seed rate- 10kg of seeds/ha)			Standard transplanting (seed rate- 50kg of seeds/ha)			Standard broadcasting (seed rate- 100kg of seeds/ha)		
	BG300	BG403	Mean	BG300	BG403	Mean	BG300	BG403	Mean
Grain yield t/ha	6.90	5.98	6.44	6.82	6.54	6.68	6.95	6.50	6.72
t/50kg of seeds Used for cultivation	34.50	29.90	32.20	6.82	6.54	6.68	3.47	3.25	3.36
Total biomass (g/m²)	700	760	73.	750	890	820	620	740	680
No. of panicles/m²	135	180	157	175	245	210	190	300	245
No. of spikelets/panicle	147	110	128	112	94	103	88	72	80
Filled grain (%)	83	70	76	85	82	83	88	85	86

Source: Rice Research and Development Institute, Batalegoda, Sri Lanka, 2009

Grain yields of BG357 as expressed in terms of t/ha and t/50kg of seeds used for cultivation under different stand establishment methods including SRI and under rich and poor soil conditions in the second experiment in Table 3.9.

Table 3.9: **Grain yield of BG 357 as expressed in terms of t/ha and t/50kg of seeds used for cultivation under different stand establishment methods in rich and poor soils**

Method of Yield Expression	SRI (Seed rate-10kg of seeds/ha)			Standard Transplanting (Seed rate-50kg of seeds/ha)		
	Poor Soil	Rich Soil	Mean	Poor Soil	Rich Soil	Mean
t/ha	5.20	8.20	6.75	6.00	8.70	7.35
t/50kg of seeds used for cultivation	26.50	41.00	33.75	6.00	8.70	7.35

According to the results, when the grain yield of rice was expressed in terms of t/ha in the first experiment, grain yield among SRI, standard broadcasting and standard transplanting was found to be the same. Therefore, SRI cannot be considered as a system of rice cultivation that can give extraordinary high yield as reported under the tropical environment. However, SRI gave five and ten times higher yields than that of standard

transplanting and broadcasting, respectively, when the grain yield was expressed in terms of t/50kg of seeds used for cultivation.

When yield of Bg 357 was expressed in terms of t/50kg of seeds used, SRI gave times higher yield than that of standard transplanting on the average (Table 2.10). Yield of standard transplanting was higher than that of SRI in poor soil whereas both standard transplanting and SRI gave comparable yields in rich soil indicating that SRI was more sensitive to changing soil environment than standard transplanting.

The number of panicles/m² was still lower, but number of spike lets/panicle was higher in transplanting than that of broadcasting. According to the final conclusion of this study, SRI was not capable of giving extraordinary high grain yield or at least a significantly higher grain yield than that of properly managed conventional methods on area basis. However, its grain yield on seed basis was comparatively very high owing to its low seed rate and SRI could be considered as one of the two extreme ends in the range of stand establishment methods in rice (Abeysisiriwardena *et.al*, 2009). Therefore this experiment shows that the SRI method is useless in Sri Lanka.

CHAPTER FOUR

Results and Discussion

4.1 Socio-Economic Background of the Sample Households

4.1.1 Introduction

This section describes the socio-economic characteristics of both SRI and non-SRI farmers in the sample population. This include population compositions, educational qualifications, age distribution, land and land tenure, income distribution from on farm, off farm and non farm sources, main occupation, such as agriculture, animal husbandry, government, private and self employment. The data was collected through sample survey, and were utilized to understand the demographic characteristics of SRI farmers.

4.1.2 The Profile of SRI Farmers

4.1.2.1 Age and Sex-wise Distribution of SRI Farmers

The sample population consisted of 65 male farmers and 25 female farmers. The age categories are shown in the table 4.1. The proportion of SRI farmers below 30 years of age was 7.8%. In between 30-50 age groups, 44% of the farmers were practicing SRI in the sample population. Approximately 12 % of the farmers were more than 60 years of age. This indicates that majority of the SRI farmers were between 30-50 age groups.

Table 4.1: Age and Sex Distribution of SRI Farmers

Age Group	No. of Males (%)	No. of Females (%)	Total
< = 30	5 (7.7)	02 (8.0)	7 (7.8)
30 < = 40	12 (18.5)	07 (28.0)	19 (21.1)
41< = 50	17 (26.2)	08 (32.0)	25 (27.8)
51 < = 60	20 (30.8)	07 (28.0)	27 (30.0)
61 < = 70	10 (15.4)	01 (4.0)	11 (12.2)
above 70	01 (1.5)	0 (0.0)	01 (1.1)
Total	**65 (100.0)**	**25 (100.0)**	**90 (100.0)**

Source: HARTI Survey Data, 2009
Note- The percentages were shown wit in brackets.

4.1.2.2 Level of Education of SRI Farmers

The educational attainment of the SRI farmers as shown in table 4.2 indicates that 45.6% had received education up to the secondary level (year 6 to G.C.E O/L), 26.7% had passed the G.C.E./ O/L, (General Certificate of Education - Ordinary Level) and 4.4% of the total population had passed the G.C.E. A/L (General Certificate of Education-Advanced Level) and four SRI farmers had not obtained school education at all.

Table 4.2: Level of Education of SRI Farmers by Sex

Level of Education	Males		Females		Total	
	No.	%	No.	%	No.	%
No schooling	01	1.5	03	12.0	04	4.4
Primary education	13	20.0	04	16.0	17	18.9
Secondary Education	30	46.2	11	44.0	41	45.6
Passed G.C.E. (O/L)	17	26.2	07	28.0	24	26.7
Passed G.C.E. (A/L)	04	6.2	0	0	04	4.4
Graduates		0		0		0
Total	**65**	**100.0**	**25**	**100.0**	**90**	**100.0**

Source: HARTI Survey Data, 2009

4.1.2.3 Family Size

Thirty percent of SRI farmers had 4 members in their households (Table 4.3). The average household size was 4.3 in the sample population; it shows that 16.7% of the sample had 6 or 7 members in their families. Only 8.9% of the sample families had 2 members. As SRI farming is labour intensive, the larger the family size helps to solve the labour problem in the task of practicing the SRI farming.

Table 4.3: Classification of Household Members by Size

Size of Household (Members)	No. of SRI Farmers	% of each Family Size
2	08	8.9
3	17	18.9
4	27	30.0
5	23	25.6
6	10	11.1
7	05	5.6
Total	**90**	**100.0**

Source: HARTI Survey Data, 2009

4.1.2.4 Family Income and Sources of Income

The sources of monthly household gross income from on farm, off farm and non farm activities of all the family members were considered to estimate of family income.

Table 4.4: Sources of Household Income

Sources of Income	No.	%	Average Household Income (Rs.)
On farm	90	100.0	12,031
Off farm	26	28.9	1,291
Non farm	71	78.9	11,548
Total	**90**	**100.0**	**24,870**

Source: HARTI Survey Data, 2009

There were three main income generation sources. Those are on-farm, off-farm and non-farm. The on farm refers to the income only from farming activities and the off farm income can be described as the income from agriculture activities without farming. The non farm income refers to the income from non agricultural activities (government, non government, private and self employment).

Table 4.4 illustrates that average household on farm income of the total sample was Rs.12,031/=. The average off farm household income was Rs.1,291/=, which represents 28.9% of the sample population. Some 68.9% of SRI farmers received Rs.11,548./= from non farm activities. The total average household income of the SRI farmers was Rs.24,870/= from the above mentioned all three sources. The district average monthly household incomes were Rs.22,400/=, Rs.28,829/= and Rs.23,380/= respectively in Kegalle, Anuradhapura and Hambantota districts.

Table 4.5: Level of Monthly Household Gross Income of SRI Farmers

Level of Monthly Gross Income (Rs.)	No. of Farmers	%
< = 10,000	12	13.3
10000<=20000	34	37.8
20000<=30000	23	25.6
30000<=40000	08	8.9
40000<=50000	05	5.6
> 50000	08	8.9
Total	**90**	**100.0**

Source: HARTI Survey Data, 2009

According to table 4.5, a higher proportion of SRI farmers (37.8) had received a monthly income between Rs.10,000.00-Rs.20,000.00 A majority (63.4%) of SRI farmers had received a monthly income between Rs.10,000.00-Rs.30,000.00, while 8.9% SRI farmers had received over Rs.50,000.

The table 4.6 indicates that the majority (56.7%) of SRI farmers received their monthly income from on-farm and non-farm activities, and their average income was

Rs.26,150.00. A considerable percentage (22.2%) of SRI farmers had received their monthly income from on farm, off farm and non farm occupations.

Table 4.6: Composition of Household Income by Sources of Income

Sources of Household Income	No.	%	Average Household Income (Rs.)
On farm only	13	14.4	20,455
On farm + Off farm	06	6.7	15,375
On farm + Non farm	51	56.7	26,150
On farm + Off farm + Non farm	20	22.2	27,324
Total	**90**	**100.0**	**24,870**

Source: HARTI Survey Data, 2009

The table 4.6 also reveals that 14.4% of the sample had received Rs.20,455.00 average family income only from on farm activities.

4.1.2.5 Main Occupations of SRI Farm Families

SRI farmers in the sample population in selected districts were engaged in different occupations. According to the male and female variation those occupations are categorized in the table 4.7. As shown in the table, the main occupation of 40.5% of the total family members was farming. That consisted of 61 male farmers and 24 female farmers. Farmer helpers represented 23.8% of the total family members in the sample. The main occupation of 11.9 was private sector employment.

Table 4.7: Type of Occupations of the Household Members by Sex

Type of Occupations	Male		Female		Total	
	No.	%	No.	%	No.	%
Farming	61	48.4	24	28.6	85	40.5
Farmer helper	09	7.1	41	48.6	50	23.8
Agriculture hired labourer	01	0.8	03	3.6	04	1.9
Non-Agriculture hired labourer	02	1.6	-	-	02	1.0
Government employment	11	8.7	06	7.1	17	8.1
Private sector employment	21	16.7	04	4.8	25	11.9
Foreign employment	03	2.4	04	4.8	07	3.3
Self employment	12	9.5	02	2.4	14	6.7
Other employment	06	4.8	-	-	06	2.9
Total	**126**	**100.0**	**84**	**100.0**	**210**	**100.0**

Source: HARTI Survey Data, 2009

4.1.2.6 Land Ownership

The study gathered information about land ownership, land tenure, extent of cultivation in *yala* 2008 and *maha* 2008/2009. Information of both SRI farmers and other farmers were collected to represent the socio-economic conditions in the study sample.

Table 4.8: Operational Land Owned by Farmers

	Home Garden		Highland		Lowland	
	No. of Household	Extent (acres)	No. of Household	Extent (acres)	No. of Household	Extent (acres)
No Land	-	-	63	-	-	-
0 < = 0.25	30	6.30	02	0.50	06	1.31
0.25<=0.50	36	18.00	08	3.81	13	6.1
0.50<=1.00	13	12.25	05	5.00	20	16.63
1.00<=2.00	11	20.50	09	14.15	14	24.68
2.00<=3.00	-	-	02	6.00	27	72.5
3.00<=5.00	-	-	01	3.50	08	28.36
>=5.00	-	-	-	-	02	14
Total	**90**	**57.05**	**90**	**32.96**	**90**	**163.58**

Source: HARTI Survey Data, 2009

The table 4.8 illustrates the extent of operational land distribution by types of SRI farmers. The data on extent of home garden, highland and low land are described in the above table. In the sample population the majority of the farmers owned less than 0.5 acres of home gardens. Some 27% of the farmers owned, 0.5 to 2 acres of land as their home gardens. The total extent of home gardens owned was 57.05 acres. Seventy percent of the sample population had no operational highland. Other farmers had operational highlands between 0 to 5 acres. The total highland ownership of the farmers was 32.96 acres. As the table indicates, total extent of land owned by the sample farmers was 163.58 acres. Majority of the farmers owned 2 to 3 acres of low land which amounted to 72.5 acres. Some 6 farmers owned less than 0.25 acres and only 2 farmers owned more than 5 acres of low land in the sample population.

The table 4.9 describes how the operational low land is categorized by ownership. This indicates that 60.1% of the farmers had their own low land. Twenty eight (28) farmers of the sample cultivated 28.10 acres of land on tenent '(Ande)' basis. All other farmers in the sample population were under different tenurial categories such as, jointly owned, lease, mortgage, *Thattu maru, Katti maru* encroached, and LDO Lands.

Table 4.9: Lowland by Tenurial Categories

Type of Tenurial Categories	No. of Household	%	Extent (acres)	%
Owned	55	61.1	96.89	59.2
Jointly Owned	05	5.6	6.25	3.8
Rented (*Ande*)	28	31.1	28.10	17.2
Leased	05	5.6	8.50	5.2
Mortgaged	02	2.2	1.50	0.9
Thattumaru	08	8.9	8.34	5.1
Encroached	06	6.7	13.00	7.9
LDO	01	1.1	1.00	0.6
Total	**90**	**100.0**	**163.58**	**100.0**

Source: HARTI, Survey Data, 2009
Note: Some farmers have more than one land under different tenurial categories

4.1.3 SRI Practice during *Yala* 2008 and *Maha* 2008/09 Seasons

The tenurial categories of SRI cultivations were considered in this study. Different tenurial categories were identified in *yala* 2008 and *maha* 2008/09 seasons in the study areas.

As shown in the table 4.10, 36 of farmers, had practised SRI during *yala* 2008 and had cultivated 18.80 acres of land extent. Out of them, in 2008 *yala* 17 SRI cultivated farmers (47.2%) had cultivated their own land which accounted 9.56 acres. The rest of SRI farmers can be categorized into jointly owned, rented, leased, *thattu maru* and encroached.

According to the table 4.10 during *maha* 2008/09, 86 farmers in the study sample had practiced SRI in 54.9 acres of land. Majority of the farmers (59.3%) had cultivated their own land and the cultivated extent was 28.90 acres. Fifty three percent of the farmers had their own land out of the total cultivated land during *Maha* season in the 2008/09.

According to the socio-economic status of the sample population 72% of the farmers were male and the rest were female.

Table 4.10: Cultivated Extent of SRI by Tenurial Categories

Type of Tenurial Categories	Yala 2008				Maha 2008/09			
	No. of Farmers	%	Extent Cultivated (Acres)	%	No. of Farmers	%	Extent Cultivated (Acres)	%
Owned	17	47.2	9.56	50.9	51	59.3	28.90	53.4
Jointly Owned	03	8.3	1.06	5.6	05	5.8	2.06	3.8
Rented (*Ande)*	10	27.8	4.69	24.9	22	25.6	13.82	25.6
Leased	02	5.6	1.00	5.3	01	1.2	0.50	0.9
Mortgaged	0	0.0	0.00	0.0	01	1.2	1.00	1.8
Thattumaru	05	13.9	1.99	10.6	03	3.5	2.31	4.3
Kattimaru	0	0.0	0.00	0.0	0	0.0	0.00	0.0
Encroached	01	2.8	0.50	2.7	05	5.8	5.00	9.2
LDO	0	0.0	0.00	0.0	01	1.2	0.50	0.9
Total	**36**	**100**	**18.8**	**100**	**86**	**100**	**54.9**	**100**

Source: HARTI Survey Data, 2009

4.1.4 Summary of the Socio Economic Status of the Farmers

As described earlier, total sample population comprised of 72% male farmers and 28% female farmers. Majority (44%) of the farmers were between 30-50 age group. Furthermore forty-six percent of the farmers had secondary level of education. The average household income of SRI farmers was Rs 24,870/= per month and the highest contribution was observed from the non farm (79%) sector.

4.2 SRI Farming in the Study Area

4.2.1 Introduction

This section describes the distribution of SRI farmers in the Study area, their awareness of SRI method and the information about the training of SRI farming. In addition their involvement in the agronomical practices such as field preparation, bunds preparation, transplanting, water management, weed controlling, fertilizer application, compost production are discussed in detail.

4.2.2 Distribution of SRI Farmers

The distribution of SRI farmers with experience in farming and by sex, is described in the table 4.11. The majority of male farmers (38.5%) had 20-40 years of experience in rice cultivation while 16% of the females had the same experience. According to the table 4.11, 32% of the female farmers had less than 5 years of experience. In the total sample population 32.2% of the farmers, 20-40 years of experience in rice cultivation.

Table 4.11: Distribution of SRI Farmers by Sex and Experience

Years	Male		Female		Total	
	No.	%	No.	%	No.	%
<=5	4	6.2	8	32.0	12	13.3
5<=10	16	24.6	07	28.0	23	25.6
10<=15	08	12.3	04	16.0	12	13.3
15<=20	11	16.9	02	8.0	13	14.4
20<=40	25	38.5	04	16.0	29	32.2
Above 40	01	1.5	0	0.0	01	1.1
Total	**65**	**100.0**	**25**	**100.0**	**90**	**100.0**

Source: HARTI Survey Data, 2009

4.2.3 Awareness of SRI Method by Farmers

The sources of awareness on SRI method by the SRI farmers in the study area are given in table 4.12 Most of the farmers obtained knowledge about SRI method from non-governmental organizations, and it was 77.8% of the total sample. The other important way of knowing about SRI farming were from Samurdhi officers, Public and private media, Mahaweli Development Authority and the farmers who adopted the SRI method.

Table 4.12: Awareness of SRI Method

Source of Awareness	No. of Farmers	%
Non Government Organizations	70	77.8
Farmers who adopted SRI method	12	13.3
Samurdhi Officer	01	1.1
Public Media	04	4.4
Mahaweli Development Authority	03	3.3
Total	**90**	**100.0**

Source: HARTI Survey Data, 2009

4.2.4 SRI - Year of Commencement

The year of commencement of SRI farming in the sample population is given in table 4.13. Even though SRI was introduced in year 2000, the table indicates that 65.6% of the farmers had commenced SRI farming during year 2007-2009. During 2004-2006, 27.8% of the sample farmers had joined SRI farming.

Table 4.13: SRI Farmers by Year of Commencement

Year	No.	%
2000	2	2.2
2001-2003	4	4.4
2004-2006	25	27.8
2007-2009	59	65.6
Total	**90**	**100.0**

Source: HARTI Survey Data, 2009

As shown in the table 4.14, an average of 94.4% farmers had practiced SRI method in all three districts to obtain a higher yield. In the Hambantota district, 96.7% of the farmers had practiced SRI to obtained higher yield. An average of 26.7% of the sample farmers had started SRI method as a solution of water scarcity and the ratios for Kegalle, Hambantota and Anuradhapura are 3.3%, 30.30% and 43.3% respectively. In Anuradhapura district, farmers mainly adopted this method, as a solution to water scarcity.

Due to the attraction of the demonstration plots of SRI cultivation, 41.1% of the total sample had adopted this method. In Kegalle district 60% of the adopted farmers had followed this method by observing the demonstration plots. 41.1% of the farmers had practiced SRI method because of the reduction of the cost of production. The other reasons for adoption of this method were to consume poison free rice, less seed requirement, and less damage from pest and diseases.

Table 4.14: Reasons for the Adoption of the SRI Cultivation

Reasons	Kegalle		Hambantota		Anuradhapura		Total	
	N= 30		N= 30		N= 30		N= 90	
	No.	%	No.	%	No.	%	No.	%
Solution for water scarcity	1	3.3	10	33.3	13	43.3	24	26.7
To get maximum yield from the paddy cultivation	28	93.3	29	96.7	28	93.3	85	94.4
To reduce the production cost	14	46.7	5	16.7	18	60.0	37	41.1
Witnessing SRI demonstration plots	18	60.0	8	26.7	117	36.7	37	41.1
Guiding by the NGO officials	2	6.7	5	16.7	10	23.3	14	15.6
To consume the poison free rice	9	30.0	6	20.0	9	33.3	25	27.8
Ability to cultivate with minimum quantity of seed	5	16.7	1	3.3	0	30.0	15	16.7
To reduce pests and diseases	1	3.3	0	0.0	0	0.0	1	1.1
Encouragement by other SRI Farmers	1	3.3	0	0.0	0	0.0	1	1.1
Reduction of rat damages in the paddy field	3	10.0	0	0.0	0	0.0	3	3.3
Reduction of of weeds	1	3.3	0	0.0	0	0.0	1	1.1
Free inputs provided by the NGO	0	0	9	30.0	0	0.0	9	10.0
To produce high quality seed	0	0	2	6.7	1	3.3	3	3.3
Willingness to adhere the new practices	0	0	5	16.7	3	10.0	8	8.9
To conserve the soil in paddy field	0	0	0	0.0	1	3.3	1	1.1

Source: HARTI Survey Data,2009
Note: N denotes number of farmers reported and percentages are based on N

4.2.5 Continuation of SRI Method

The table 4.15 indicates the seasons of SRI cultivation by the total sample between 2000 to 2009. According to the table, 78.9% of the sample farmers had practiced SRI method in 1-4 seasons. About 12% of the farmers had practiced 5-8 seasons. The exceptional situation was that only one farmer had practiced SRI method for more than 16 seasons between the period 2000 to 2009. This indicates that majority of the farmers in the sample had given up cultivation under SRI method after practicing it in few seasons. Farmers expressed that SRI required more labour than the conventional method. But in reality, when the helping NGO was not functioning in the area, farmers were not practicing the SRI cultivation.

Table 4.15: Cultivated Seasons of Paddy under SRI from the Year of Commencement of the SRI Practice

Number of Seasons	2000		2001-2003		2004-2006		2007-2009		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
1-4	1	50.0	1	25.0	11	44.0	58	98.3	71	78.9
5-8			1	25.0	9	36.0	1	1.7	11	12.2
9-12			1	25.0	5	20.0			6	6.7
13-16			1	25.0					1	1.1
>16	1	50.0							1	1.1
Total	**2**	**100.0**	**4**	**100.0**	**25**	**100.0**	**59**	**100.0**	**90**	**100.0**

Source: HARTI Survey Data, 2009

4.2.6 Training on SRI Farming

Ninety SRI farmers were subjected to the questionnaire survey and it was found that 85 farmers had received formal training on SRI farming. The survey revealed that four farmers in Kegalle district and one farmer from Anuradhapura district had not obtained relevant formal training on SRI cultivation. Out of the trained farmers 98.8% of the farmers had received training from different non government organizations such as Oxfam, Gamidiriya, Jana Aruna Foundation and Mercy Crop. Only one farmer had received formal training from the Mahaweli Development Authority.

The farmers' evaluation of these formal training programmes is indicated in the table 4.16. Forty seven percent of the sample farmers said that the formal training programmes were very good. Some 40% of the farmers expressed that, they received a good training.

Table 4.16: Farmers' Evaluation of the SRI Training Programme

Farmers Evaluation	No.	%
Very good	40	47.1
Good	34	40.0
Satisfied	09	10.6
Fairly satisfied	02	2.4
Total	**85**	**100**

Source: HARTI Survey Data 2009

4.2.7 Compost Production

In SRI cultivation method it is essential to apply compost to the paddy field. The organic fertilizer was added to the soil while preparation of the paddy land. The literature has proved that, when the SRI method was introduced into the new paddy field the fertilizer recommendation was 50% of inorganic fertilizer and 50% of organic fertilizer.

In the second season, recommendation had changed at 75% of organic fertilizer and 25% of inorganic fertilizer. In the third season 100% of organic fertilizer was added to the

SRI paddy fields. The SRI promoters such as different NGOs had their own compost production method and they had provided the necessary information for farmers to produce the required amount of compost. Some times the host organization had supplied the required amount of compost to the cultivated land area. The study indicates that, 57.8% of farmers had produced compost for their SRI cultivation in the study area.

In SRI cultivation 94.4% of SRI farmers had applied organic fertilizer to their paddy fields, whereas only 5.6% of the farmers had not applied organic fertilizer. In the conventional method, only 8.9% of the farmers' had added compost to the fields and the rest of the farmers had not applied organic fertilizer.

4.2.8 Preparation of Paddy Bunds

In SRI method, normally the paddy bunds are not newly prepared. The retaining bunds with weeds and favorable organisms are important in SRI farming to control certain harmful micro organisms and promote beneficial micro-organisms in the paddy fields. The table 4.17 illustrates whether bunds were newly prepared or were renovatedold bunds in SRI and conventional method in the study area. According to the table 66% of the farmers had renovated all the bunds. But in the conventional method 98% of the farmers had constructed bunds.

Table 4.17: Method of Preparation of Bunds

Method of Cleaning Bunds	SRI Farming		Conventional Farming	
	No.	%	No.	%
Cleaning and constructing the bunds	30	33.3	88	97.8
renovating the bunds	60	66.7	2	2.2
Total	**90**	**100.0**	**90**	**100.0**

Source: HARTI Survey Data, 2009

4.2.9 Transplanting Seedlings

In SRI method early transplanting is recommended and seedling is transplanted when only the first two leaves had emerged. Usually, the seedlings of 8-15 days of age are suitable for transplanting. The young seedlings are carefully removed from the nursery bed and smoothly carried to the field. These removed seedlings should be transplanted as soon as possible. It is also recommended to transplant the removed seedlings within 15-30 minutes. The placing of the seedlings has to be done with the recommended spaces.

Table 4.18: Age of Transplanting Seedlings

Age of the Nursery (days)	SRI Farming		Conventional Farming	
	No.	%	No.	%
7-9	36	40.4	0	0.0
10-12	43	**48.3**	1	2.8
13-15	09	10.1	11	30.6
16-18	02	1.1	13	36.1
>18	0	0.0	11	30.6
Total	**90**	**100.0**	**36**	**100.0**

Source: HARTI Survey Data, 2009

Note: One farmer had used seeder under the SRI method and only 36 farmers had adopted transplanting method under the conventional category

The table 4.18 illustrates the age of the seedlings in SRI method and conventional method in the study area. In SRI method 88.7% of the farmers transplanted seedlings of 7-12 days. The rest of the farmers transplanted the seedlings of 12-18 days. The farmers who transplanted seedlings between 13-18 days had found it difficult to adopt the practices in SRI method due to the continues involvement in conventional practices. In conventional method the majority of the farmers (66.7%) had transplanted seedlings after 16 days of age.

Table 4.19: Planting Space in SRI and Conventional Method

Planting Space (cm)	Sri Farming		Conventional Farming	
	No.	%	No.	%
5	0	0.0	06	16.7
7.5	0	0.0	15	41.7
10.0	0	0.0	08	22.2
12.5	0	0.0	05	13.9
15.0	14	15.6	02	5.6
17.5	29	32.2	0	0.0
20.0	43	47.8	0	0.0
22.5	04	4.4	0	0.0
Total	**90**	**100**	**36**	**100**

Source: HARTI Survey Data, 2009

The planting spaces adopted by farmers in SRI and conventional method are given in table 4.19. The recommended planting space for SRI is 25 cm x 25 cm. Majority of farmers (47.8%) transplanted seedlings within the space of 20 cm x 20 cm. Farmers had not adopted the recommended space because they thought that the recommended space would be unproductive. Only 4% of the sample farmers had transplanted seedlings within the space of 22.5 cm x 22.5 cm. That space was also less than the recommended space of SRI method. In conventional method, majority, (41.7%) of the sample had transplanted the seedlings with the space of 7.5 cm between the plants.

Table 4.20: Number of Seedlings Transplanted Per Hill

Number of Seedlings Planted	SRI Farming		Conventional Farming	
	No.	%	No.	%
1	59	66.3	0	0.0
2	28	31.5	0	0.0
3	02	2.2	10	27.8
4	0	0.0	20	55.6
5	0	0.0	0.6	16.7
Total	**89**	**100.0**	**36**	**100.0**

Source: HARTI Survey Data, 2009

The recommend number of plants per hill is one plant in SRI method. Around 66% of the sample farmers had transplanted one plant per hill and 31.5% of the farmers had transplanted two plants per hill. Due to the fear of destroying of the plants, some farmers had transplanted two plants per hill. But in the conventional method 55.6% of the farmers had transplanted four plants per hill(table 4.20)

4.2.10 Weed Controlling

In SRI method, weeding can be done by hand or mechanically. Mechanical weeding is practiced by using a mechanical hand weeder. Those weeders were distributed among farmers by different non-government organization. Both hand weeding and mechanical weeding increase the soil aerobic. The mechanical weeder has vertical rotating toothed wheels that churn soil as the weeder is pushed down across the alleys. In conventional methods most of the time weedisides are used for weed control. In commercial farming, use of weediside requires less man days. But in SRI method, the mechanical and hand weeding are labour intensive.

Table 4.21: Weed Controlling Method

Method	SRI Farming		Conventional Farming	
	No.	%	No.	%
Weeder	88	97.8	0	00
By hand	39	43.3	06	6.7
Weedicide	07	7.8	54	93.3

Source: HARTI Survey Data, 2009

The weed controlling methods used by SRI and conventional farmers in the study area are given in table 4.21. SRI farmers in the sample population had used more than one method to control weeds. Some 97.8% of the farmers had used weeders for weed control and 43.3% of the farmers had controlled weeds by hand weeding. Even in SRI method 7.8% of farmers had applied weedicide for weed control. In conventional method 93.3% of the farmers had used weedicides for controlling of weeds.

4.2.11 Water Management

Rice has traditionally been grown in submerged conditions. Rice has also been able to tolerate standing in water. When rice grow under submerged condition, the oxygen condition of the soil is reduced compared to the dry soil. Rice can be grown in a wide range of soil conditions in Sri Lanka. For example, rice can be grown, in very dry conditions. It is called "kakulama", and seeds are directly spread in dry fields and when rain comes seeds are germinated. In addition in the wet zone some paddy fields are water logged throughout the year. Most of the times in the conventional method farmers tend to keep water logging conditions in the paddy fields. In the SRI farming it is required to practice alternative wetting and drying of the paddy fields.

Table 4.22: Frequency of Water Management Practices Adopted by the Farmers for 3.5 Month Paddy Varieties

Period of Cultivation *(No. of days)	SRI Method		Conventional Method	
	Average no. Days under Drying Condition	Average no. Days under Logging Water	Average no. Days under Drying Condition	Average no. Days under Logging Water
1 - 30	17	13	12	18
31 - 45	8	7	5	10
46 - 75	15	15	9	21
76 - 105	23	7	22	8
Total	**63**	**42**	**48**	**57**

*(Based on 105 days Paddy Varieties)

As indicated in the table 4.22 average number of days under dry conditions of SRI paddy fields and conventional fields were calculated during four phases of paddy cultivation of 3.5 month paddy variety. Accordingly average number of days of drying and wetting the paddy field were calculated separately as within 1-30 days, 31-41 days, 46-75 days and 76-105 days. In SRI farming the average days under drying conditions in the paddy fields were 63 days whereas the water logging in the paddy fields was around 42 days. This situation is somewhat different from conventional method. The average days under dry condition were 44 days and water logging in the paddy fields was around 41 days. Both in SRI and conventional methods 3.5 month of age paddy varieties were grown, and the water requirement in SRI method was about 20 days less than that in conventional method.

4.2.12 Amount of Water Saved

As this study is a Socio-Economic research, it was unable to measure the accurate water requirement for individual paddy fields. Therefore, the amount of water saved by SRI method was obtained by interviews with SRI farmers.

The average amount of water which can be saved by this method was 1/3 of water requirement of conventional method. Thirty six percent of the sample population, stated that half the water requirement in conventional method was enough to cultivate SRI method (table 4.23).

Table 4.23: Amount of Water Saved by SRI Method

Share of Water Quantity	SRI Method	
	No. of Farmers	%
Can't be saved	5	5.6
1/10	2	2.2
1/8	7	7.8
1/5	6	6.7
¼	25	27.8
1/3	5	5.6
2/5	2	2.2
½	33	36.7
2/3	1	1.1
¾	4	4.4
Total	**90**	**100.0**
Average	**1/3**	

Source: HARTI Survey Data, 2009

4.2.13 Comparison of Cultivation Period

According to www.ikisan.com the duration of SRI cultivation is reduced by 10 days. In order to test this, the duration of cultivation in SRI and conventional method was compared in this study.

Table 4.24: Comparison of Cultivation Period in Between SRI Method and Conventional Method

	No. Reported	%	Number of Days Lesser or Higher than the Conventional Method		
			4<=7	7<=10	10<=15
Period is same	47	52.2			
Period of SRI method is lesser	12	13.3	10	2	0
Period of SRI method is higher	31	34.4	13	17	1
Total	**90**	**100.0**			

Source – HARTI Survey Data 2009

Fifty two percent (52.2%) of the sample population had expressed that the cultivation period was same in SRI method and conventional method. Only 13.3% of sample farmers said that the cultivation period in SRI was lesser than the conventional method

(table 4.14). But 34 % of the sample farmers reported that cultivation period in SRI was higher than in the conventional method. In the major irrigation systems, water issuing pattern is based on a time table. Therefore when water was issued first time, SRI practicing farmers had to prepare their nurseries. Then the transplanting period in SRI cultivation was obviously getting late by around 8-12 days.

4.2.14 Seed Requirement

SRI paddy cultivation requires less seed (2 kg/acre) and fewer plants per unit area (25 x 25 cm) whereas in general paddy cultivation 40 kg seed is required per acre. [http:// www.ikisan.com/links/ap.ricesri-shtm]

Table 4.25: Seed Requirement - Kg/Acre

District	SRI	Conventional
Hambantota	15.18	51.61
Anuradhapura	6.88	44.30
Kegalle	10.78	36.64
Average	**10.28**	**44.14**

Source: HARTI Survey data, 2009

In the study area, the average seed requirement in SRI method was 10.28 kg/acre. But the seed usage was different among the districts: It was 15.18 kg per acre in Hambantota district, 6.88 kg per acre in Anuradhapura district and 10.78 kg per acre in Kegalle district. As mentioned in the literature 2 kg of seed paddy is enough for one acre. But farmers tend to use less amount of seed per acre. Most of the farmers do not like to face the risk of planting one plant per hill. Therefore, they try to transplant more seedlings per hill and try to reduce the spaces between two plants.

In conventional method, the average amount of seed usage is 44.1 kg per acre, this usage also varied in three districts: 51.61 kg per acre in Hambantota district, 44.30 kg per acre in Anuradhapura district, 36.64 kg per acre in Kegalle district. Seed requirement of conventional method in Hambantota district was higher than in the other districts due to the sandy nature of soil.

4.2.15 Controlling of Pests

Table 4.26: Number of Pest Control Methods and Number of Farmers

Type of Pest Control	Total			
	No.	%	Quantity per Reporting	
			ml	g
Chemical	10	11.1	175	800
Non Chemical	45	50	64.20	9.85
Not Used	39	43.3	-	-
Total	**90**	**100**	**x**	**x**

Source: HARTI Survey Data, 2009

The table 4.16 illustrates, the number of farmers who had used pest control methods and types of pest control method in SRI cultivation. Use of chemical pest control methods were less in SRI cultivation compared to the same in conventional method. The chemical users were around 11.1% of the SRI cultivators. The non chemical users were around 45% of the total sample population. The neem extraction was the common type of non chemical pesticide used in the SRI cultivation. 43.3% of the total sample population had not used pest control methods in SRI Cultivation.

4.2.16 Tiller Formation

The literature shows that, Recommended SRI practices enhance tillering ability of plant and that individual plant can grow up to 100 fertile tillers or even more.

According to the study, the average number of tillers in the study was around 23 in SRI method. But in the conventional method 05 tillers were observed as average tillers. The average number of tillers in SRI method in Anuradhapura, Hambantota and Kegalle district per one plant were 25, 18, and 24 in respectively. (Table 4.17)

Table 4.27: Tiller Formation in a Rice Plant under SRI Method and Conventional Method

Number of Tillers per Rice Plant	Total	
	SRI Method	Conventional Method
2-5	0	74
6-10	6	16
11-20	40	0
21-30	31	0
31-40	10	0
41-50	3	0
Average No. of Tillers	23	5

Source: HARTI Survey Data, 2009

4.2.17 Extent of SRI Cultivation

The cultivated low lands under SRI practices during 2008 *yala* and 2008/09 *maha* seasons are shown in the table 4.18. According to the table, during 2008 *yala*, 54% of the sample population had cultivated their lowland under SRI practices whereas during 2008/09 *maha* 96% of the farmers had cultivated under SRI method. The total extent of cultivated land was around 19 acres. During 2008/09 *maha* around 54 acres had been cultivated under SRI method. In both seasons more than 50% of the total sample had practiced SRI and more than 40% of farmers had cultivated low land area between 0.25 acres to 0.5 acres. The number of farmers who cultivated more than 2 acres of low land under SRI method was not available for 2008 *yala,* and only one farmer had cultivated 3 acres of land during 2008/09 *maha.*

Table 4:28: Area Cultivated under SRI: *Yala* 2008 and *Maha* 2008/09

	2008 *Yala*				2008/09 *Maha*			
Size of Lowland	**No. of Farmers Reporting**	**%**	**Extent Cultivated (Acres)**	**%**	**No. of Farmers Reporting**	**%**	**Extent Cultivated (Acres)**	**%**
0-0.25	7	19.4	1.37	7.3	14	16.3	3.12	5.8
0.25-0.50	21	58.3	9.62	51.2	48	55.8	23.06	42.6
0.50-0.75	4	11.1	2.43	12.9	3	3.5	1.78	3.3
0.75-1.00	2	5.6	1.88	10.0	16	18.6	15.88	29.4
1.00-1.50	1	2.8	1.50	8.0	1	1.2	1.25	2.3
1.50-2.00	1	2.8	2.00	10.6	3	3.5	6.00	11.1
2.00-3.00	0	0.0	0.00	0.0	1	1.2	3.00	5.5
Total	**36**	**100.0**	**18.80**	**100.0**	**86**	**100.0**	**54.9**	**100.0**

Source: HARTI Survey Data, 2008

In the Kegalle district only one farmer had cultivated 2 acres of land using SRI method and all other farmers had cultivated less than one acre of land both in *yala* and *maha* seasons. (Annex 1)

In Hambantota district only one farmer had cultivated 3 acres of land during 2008/09 *maha* and one farmer had cultivated 0.5 acres of land in 2008 *yala*. All other farmers had cultivated less than one acre of land under SRI method. (Annex 2)

In Anuradhapura district during 2008/09 *maha* season, 3 farmers had cultivated 6 acres of land and one farmer had cultivated 1.25 acres of lowland under SRI method. All other farmers had cultivated less than one acre of land. (Annex 3)

4.2.18 Grain Yield

According to the literature, the SRI yield is higher than in the conventional method. According to Abeysiriwardena (2009) SRI was not capable of giving extraordinary high yields. According to the study the different land sizes had given different yields. The table 4.29 indicates the SRI yield in the study area.

Table 4.29: Yield of Paddy under SRI: *Yala* 2008 and *Maha* 2008/2009

2008 *Yala*				2008/09 *Maha*		
Size of Lowland	**No. of Farmers Reporting**	**%**	**Production Per acre (Bu/ac)**	**No. of Farmers Reporting**	**%**	**Production per acre (Bu/ac)**
0-0.25	7	19.4	88	14	16.3	99
0.25-0.50	21	58.3	92	48	55.8	110
0.50-0.75	4	11.1	76	3	3.5	69
0.75-1.00	2	5.6	90	16	18.6	113
1.00-1.50	1	2.8	35	1	1.2	88
1.50-2.00	1	2.8	100	3	3.5	96
2.00-3.00	0	0.0	0	1	1.2	50
Total	**36**	**100.0**	**86**	**86**	**100.0**	**104**

Source: HARTI Survey Data, 2009

The average yield of SRI cultivation during *maha* 2008/09 was 104 bushels per acre, whereas 2008 *yala* season, the average yield was 86 bushels per acre. In yala 2008 the highest yield was obtained from 1.5-2 acres of land. In *Maha* season 2008/09, the highest yield was obtained from the land size of 0.75-1 acres. The amount of production was 113 bushels per acre.

4.2.19 Alternative Practices of SRI Method

The other SRI farming practices were investigated in selected areas. Hence, some farming practices are difficult and innovative farmers in the sample population had adopted some alternative activities in SRI farmers. Some innovative farmers (13%) had used trays to carry the seedlings from the nursery beds to the paddy fields. This was because carrying of 8 days old seedlings was a very delicate operation to handle. Therefore they had made their own trays to carry the seedlings. Other than that 16.7% of the farmers in the sample population had used banana stems and a six- feet long flat wooden board to carry seedlings to the paddy field. To reduce the damages in uprooting the seedlings, 16.7% of the innovative farmers had made safe uprooting equipment.

4.3 Problems and Constraints in Promoting SRI Farming

This section presents the problems related to SRI farming, constraints in SRI promoting and suggestions to promote SRI farming and advantages and disadvantages of SRI farming.

4.3.1 Problems and Constraints

Problems and constraints of SRI method were observed in three districts. The most important problems were shortage of labour and inputs to producing compost. It was indicated by 33.3% of the total sample population. The problem of finding inputs to produce compost was highest (42%) in the Anuradhapura district. (Table 4.30)

In the Kegalle district out of 30 SRI farmers only 19 farmers stated that they had faced problems in SRI farming. Others did not answer the problem. In Kegalle (36.8%), Anuradhapura (30.8%) and Hambantota (33.3%) districts the main problem was shortage of labour in. In Hambantota district, around 89% of the farmers expressed shortage of skilled labour for transplanting and weeding. Farmers in Hambantota district are trained to broadcasting seed paddy. The shortage of necessary equipment in SRI method was also a considerable constraint, specially in the Kegalle district (32%). Water management plays an important role in SRI method. This method needs frequent wetting and drying of paddy field. Management of water had become a problem for11.1% farmers.

Weeding and transplanting require much money, compared to the other practices in SRI farming.

Table 4.30: Type of Present Problems and Constraints in Cultivating SRI Method

Type of present problems and constraints	Kegalle		Hambantota		Anuradhapura		TOTAL	
	N= 19		N=18		N= 26		N= 63	
	No.	%	No.	%	No.	%	No.	%
Shortage of inputs for producing compost	7	36.8	3	16.7	11	42.3	21	33.3
Shortage of weeders	6	31.6	0	0.0	3	11.5	9	14.3
Shortage of labour	7	36.8	6	33.3	8	30.8	21	33.3
Lack of skilled labour for transplanting and weeding	1	5.3	16	88.9	3	11.5	20	31.7
Difficulties in producing organic pesticides & compost	1	5.3	0	0.0	0	0.0	1	1.6
Lack of knowledge about the SRI method	1	5.3	0	0.0	1	3.8	2	3.2
Land tenure problems (*Ande etc.)*	1	5.3	0	0.0	3	11.5	4	6.3
Excessive rain water / Scarcity of water	1	5.3	1	5.6	5	19.2	7	11.1
Damages from animals (Rats, cattle etc.)	2	10.5	0	0.0	1	3.8	3	4.8
Transportation problems to carry the seedlings to the field	1	5.3	0	0.0	0	0.0	1	1.6
Crop duration in between SRI and the other method	0	0.0	2	11.1	0	0.0	2	3.2
High cost for transplanting & weeding	0	0.0	3	16.7	4	15.4	7	11.1
Negative approach towards the SRI	0	0.0	0	0.0	1	3.8	1	1.6

Source: HARTI Survey Data, 2009

4.3.2 The Popularity of SRI

The recorded number of SRI farmers in Sri Lanka during the study period was around 756. This indicates that there is a problem with diffusion of SRI method. Therefore attention was given to find out the reasons for un-popularity of SRI method among farmers. Higher requirement of labour (66%), need to resort to many activities (37%) and lack of knowledge (29%) were the main reasons for not adopting SRI method. (Table 4.31).

Table 4.31: Reasons for Unacceptability of SRI Method among Other Farmers

Reasons for Un-popularity of SRI Method	Kegalle		Hambantota		Anuradhapura		TOTAL	
	N=28		N= 30		N= 29		N= 87	
	No.	%	No.	%	No.	%	No.	%
Lack of knowledge about the SRI method	9	32.1	9	30.0	7	24.1	25	28.7
Status of tenure of the land (*Ande, Thattumaru)*	8	28.6	0	0.0	1	3.4	9	10.3
Lack of equipment (weeders and space marker)	2	7.1	1	3.3	0	0.0	3	3.4
The SRI project was terminated by the NGO	1	3.6	0	0.0	0	0.0	1	1.1
Required more labour for transplanting and weeding	15	53.6	20	66.7	23	79.3	58	66.7
Government provided subsidy for the fertilizer	1	3.6	1	3.3	2	6.9	4	4.6
SRI method can't be practiced for larger size of lands	1	3.6	3	10.0	3	10.3	7	8.0
Other farmers having negative approach towards the SRI	0	0.0	5	16.7	5	17.2	10	11.5
Not obtained better yield by SRI farmers during the last season	0	0.0	2	6.7	1	3.4	3	3.4
The SRI project was not implemented through the respective FO	0	0.0	5	16.7		0.0	5	5.7
SRI practices contradicts with water issues in the MI	0	0.0	0	0.0	4	13.8	4	4.6

Source: HARTI Survey Data, 2009

N denotes number of farmers reported and percentages are based on N

4.3.3 Continuation of SRI Farming

According to the study, most of the farmers continued SRI farming with the assistance of relevant NGO's such as, World Vision, Oxfarm, Merci Corp etc. These NGO's had provided inputs for the SRI farming. Therefore, when NGO's terminated their activities, there was a problem for the continuation of SRI practices among farmers. In the study, special attention was given to understand the situation of continuation of the SRI practices. As indicated in the table 5.3, 61.6% of the farmers who had connection with the NGO's expected to continue SRI practices. 24.4% of the farmers expected to discontinue the SRI practices, when NGO's terminated their activities. Out of the total sample, 14% of the farmers were unable to express their future plan on continuation or discontinuation.

Table 4.32: Farmer's Expectation on Continuation of SRI Farming

	Kegalle		**Hambanota**		**Anuradhapura**		**TOTAL**	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Expected to continue the SRI practices	17	56.6	16	53.3	20	66.7	58.88	61.6
Expected to discontinue the SRI practices	4	13.4	11	36.7	6	20.0	23.3	24.4
Unable to report	9	130	3	10.0	4	13.3	13.3	14.0
Total	**30**	**100.0**	**30**	**100.0**	**30**	**100.0**	**90**	**100.0**

Note: Four farmers in Kegalle district haven't had any connection with respective NGO

4.4 Cost of Production in SRI and Conventional Method

This section compares the cost of production of paddy under SRI method and the conventional method in the study area. The findings related to cost benefit analysis in three districts are discussed separately. The yield and returns of SRI and conventional method are also described in this chapter.

In this analysis average cost required to cultivate one acre of paddy in SRI method and conventional method was calculated separately.

4.4.1 Cost of Production in the Kegalle District

4.4.1.1 SRI Farming

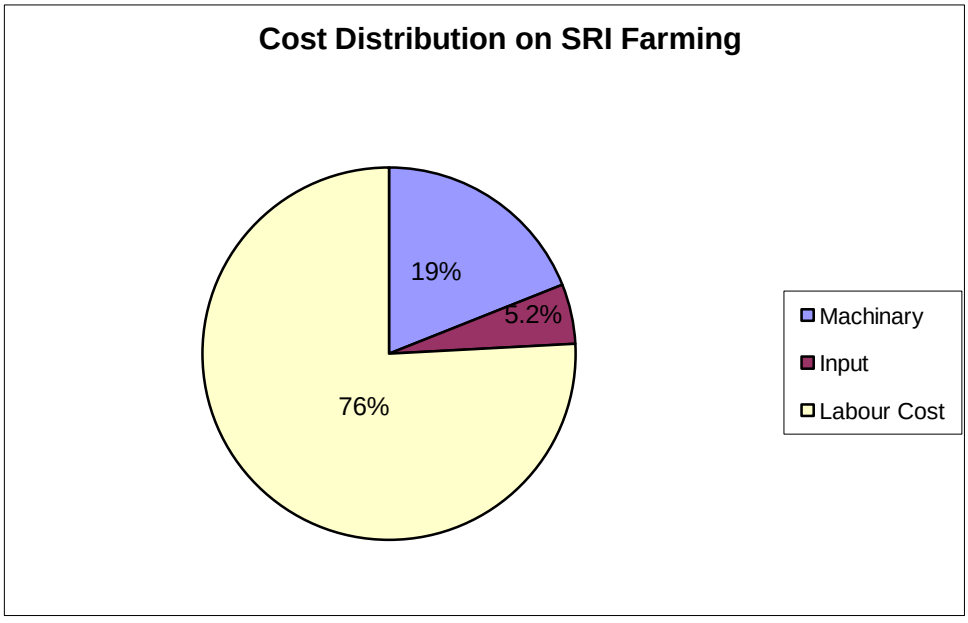
The data on cost of production was gathered for Maha season 2008/2009. The source of water use in the Kegalle district for the SRI cultivation was rain fed water. The table 4.33 illustrates the total cost of cultivation per one acre with and without family labour. The total cost required to cultivate was Rs.36,439/= per acre with family labour and Rs.11,795/= without family labour: This indicates that, the family labour cost was 2/3 of the total cost. In Kegalle district it was difficult to use machineries because of small plot size and sloppiness of lands. The highest cost was incurred for harvesting in Kegalle and it was Rs. 6,999/= per acre. In SRI method marking of the field can be identified as extra activity and it required higher amount of labour which cost Rs.6,582/= per acre. In SRI method, planting should be done with 8-10cm spacing between plants. Therefore special marking system must be adopted in this method. The labour cost for weed control also was higher in the Kegalle district and it was Rs.4,047/= per acre. In SRI method machinery was needed for ploughing, threshing and winnowing. Ploughing needed Rs.3,755/= per acre of land and threshing and winnowing needed Rs.2,645/= per acre and the total cost of machinery was Rs.6,859/= per acre. The total input cost of SRI method in Kegalle district was Rs.1,902/= per acre. In SRI method inorganic fertilizer usage was very low and therefore the cost for input was relatively lower than other labour and machinery costs. The total labour requirement for one acre in SRI method was 56.48 man days which consisted of 6.56 hired labour days and 49.92 family labour days. The wage rate in the district was Rs 450/- per day.

Table 4.33: Cost of Production per acre of Paddy under SRI Method - Kegalle District

Type of Operation	Cost (Rs/ac)			
	Labour	Machinery	Input	Total
All Nursery Preparation	753	-	-	753
General Land Preparation	1,502	-	-	1,502
1st , 2nd and 3rd Ploughings	1,974	3,755	-	5,729
Plastering Bunds	511	-	-	511
Marking & Planting	6,582	-	815	7,397
Application of Fertilizer	633	-	875	1,508
Weed Controlling	4,047	-	-	4,047
Pest and Disease Control	227	-	184	411
Water Management & After Care	1,904	-	-	1,904
Harvesting	6,999	-	-	6,999
Threshing &Winnowing	2,171	2,645	-	4,816
Transport	377	354	-	731
Others (Sprayer, Land rent, Bags etc.)	-	105	28	133
Total-Including family labour	27,678	6,859	1,902	36,439
Total-Excluding family labour	3,035	6,859	1,902	11,795

Source: HARTI Survey Data, 2009

Figure 4.1: Cost Share of SRI Farming – Kegalle District



Source: HARTI Survey Data, 2009

As shown in the figure 4.1, 76% of the total cost consisted of the labour cost in SRI method. The least cost was the input cost which was 5.2 % of the total cost and the machinery cost was 19% of the total cost.

4.4.1.2 Conventional Farming

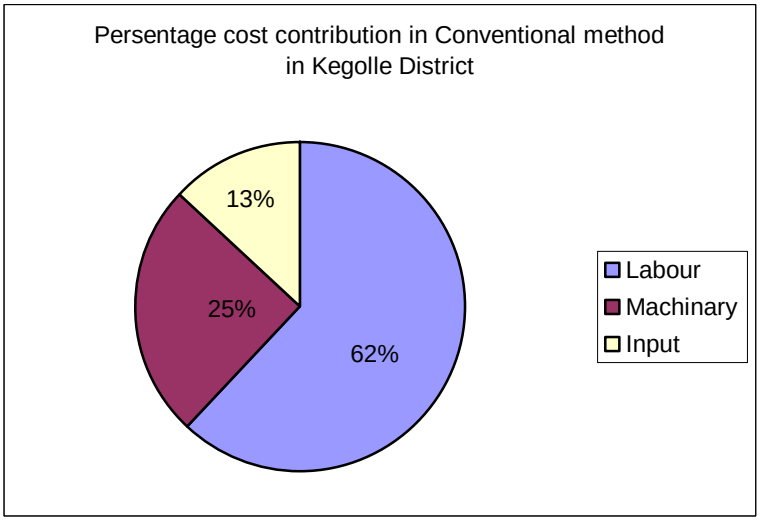
The total cost of cultivation of paddy in conventional method including family labour was Rs 34,582.00 per acre. The cost distribution is categorized under 3 main cost items such as labour machinery and input. The total cost of production excluding family labour was Rs.17,524.00 per acre. The total calculated family labor cost was Rs 17,058.00 per acre under the conventional method. The total labour cost was Rs. 21,390.00. The machinery and input costs were Rs.8,658.00 and Rs 4,534.00 per acre respectively. The total labour requirement for one acre was 41 man days which consisted of 34 family labour days and 7 man days of hired labour. In conventional method in land preparation it was essential to plough the third time. Therefore ploughing cost was higher than that in the SRI method. (Table 4.34)

Table 4.34: Cost of Production per acre of Paddy under Conventional Method – Kegalle District

Type of Operation	Cost (Rs/ac)			
	Labour	Machinery	Input	Total
All Nursery Preparation	449	-	-	449
General Land Preparation	1,406	-	-	1,406
1^{st} , 2^{nd} , 3^{rd} Ploughings	1,181	5,196	-	6,377
Plastering Bunds	1,143	-	-	1,143
Transplanting/Broadcasting	5,290	-	2,330	7,620
Application of Fertilizer	346	-	1,042	1,387
Weed Controll	208	-	625	833
Pest and Diseases Control	260	-	526	786
Water Management & After care	2,598	-	-	2,598
Harvesting	6,189	-	-	6,189
Threshing &Winnowing	1,730	2,983	-	4,713
Transport	590	301	-	891
Others (Sprayer, Land rent, Bags etc.)	-	178	11	190
Total-Including family labour	21,390	8,658	4,534	34,582
Total-Excluding family labour	4,331	8,658	4,534	17,524

Source: HARTI Survey Data, 2009

Figure 4.2: Cost Share of Conventional Method Paddy Cultivation-Kegalle District



Source: Survey Data, 2009

4.4.1.3 Yield and Returns

The Table 4.35 shows the yield and returns for one acre of paddy in the SRI method and the conventional method in the Kegalle district. The average yield per acre in SRI method was 1635 Kg of paddy under SRI whereas it was 1404 Kg in the conventional method. This indicates that in SRI method the paddy yield is slightly higher than the conventional method by 231 Kg. The price of paddy in SRI method was also higher than conventional method in Kegalle district. The Seed requirement in SRI method was also lower compared to that of the conventional method. The unit cost (money needed to produce 1 Kg of Paddy) was half compared with the conventional method in the Kegalle district.

Table 4.35: Yield and Returns for Paddy in SRI and Conventional Method - Kegalle District

Yield and Returns	SRI (Rs/Acre)	Conventional (Rs/Acre)
Average Yield (Kg)	1,635	1,404
Market Price (Rs/Kg)	32.79	28.53
Gross Income (Rs)	53,603	40,066
Profit Including Family Labour Cost (Rs)	17,165	5,484
Profit excluding Family Labour cost (Rs)	41,808	22,543
Per Unit Cost including Family Labour (Rs)	22.29	24.63
Per Unit Cost excluding Family Labour (Rs)	7.22	12.63
Seed Requirement (kg)	10.78	36.64

Source: Survey Data, 2009

4.4.2 Cost of Production in Hambantota District

4.4.2.1 SRI Farming

The data required to calculate the cost of production of SRI farmers was collected from the Badagiriya colonization scheme in the Hambanthota district. The data was collected during 2008/2009 Maha season. The table 4.36 illustrates the cost of cultivation per acre of paddy under SRI Method in the Hambanthota District. The total cost of production including family labour was Rs.53,357.00 per acre whereas cost excluding family labour was Rs.32,855.00. The total family labour cost was Rs.18,502.00 per acre of land. The total labour, machinery, input costs were Rs.31,590.00, Rs.15,784.00 and Rs.3,983.00 respectively. The most labour intensive activity was transplanting. Twenty two percent of the total cost was incurred on marking and transplanting in Hambanthota district and it was Rs.13,024.00 per acre.

Table 4.36: Cost of Production per acre of Paddy under SRI Method - Hambantota District

Type of Operation	Cost (Rs/Acre)			
	Labour	Machinery	Input	Total
All Nursery Preparation	995	-	-	995
General Land Preparation	3,313	-	-	3,313
1st , 2nd, and 3rd Ploughings	258	5,173	-	6,431
Plastering Bunds	443	-	-	443
Marking & Planting	11,873	-	1,152	13,024
Application of Fertilizer	713	-	1,226	8,949
Weed Controlling	7,137	-	-	7,137
Pest and Diseases Control	405	-	1,432	1,836
Water Management & After Care	3,950	1,316	-	5,267
Harvesting Threshing &Winnowing	1,146	6,763	-	7,909
Transport	1,356	1,388	-	2,745
Others (Sprayer, Land rent, Bags etc.)	-	143	173	316
Total-Including family labour	31,590	14,784	3,983	50,357
Total-Excluding family labour	13,088	14,784	3,983	31,855

Source: HARTI Survey Data 2009

In Hambantota, most of the operations were mechanized (Table 6.4). Therefore the cost required for machines were relatively higher than other activities. Most of the farmers had used combined harvesters for harvesting, threshing & winnowing operations. The NGO called SIDO Organization had provided seed (AT 362, 10 Kg), compost fertilizer (400Kg) and pesticides (3 packet of Neem grow) for -0.5 acre of paddy land .Other than the compost fertilizer, SRI farmers had used inorganic fertilizer for their paddy fields.

4.4.2.2 Conventional Farming

In Hambanthota district the total cost of cultivation of conventional method including family labour was Rs.34,930.00. The highest cost was incurred for machinery expenditure and it was 43% of the total cost. Ploughing and harvesting including threshing and winnowing needed more money in this method. Due to fertilizer subsidy, the cost for fertilizer was relatively low in all three districts. (Table 4.37)

Table 4.37: Cost of Production per acre of Paddy under Conventional Method - Hambantota District

Type of Operation	Cost (Rs/Acre)			
	Labour	Machinery	Input	Total
General Land Preparation	1,299	-	-	1,299
1st, 2nd and 3rd Ploughing	-	5,603	-	5,603
Plastering Bunds	2,873	-	-	2,873
Broadcasting	1,761	-	3,099	4,859
Application of Fertilizer	474	-	1,922	2,396
Weed Controlling	288	-	1,790	2,078
Pest and Diseases Control	305	-	455	760
Water Management & After Care	4,258	-	-	4,258
Harvesting Threshing &Winnowing	42	7,679	-	7,720
Transport	1,198	1,063	-	2,261
Others (Sprayer, Land rent, Bags etc.)	-	263	559	822
Total-Including family labour	12,497	14,608	7,825	34,930
Total-Excluding family labour	5,893	14,603	7,825	28,321

Source: HARTI Survey Data 2009

Figure 4.3: Share of Cost of Production of SRI Farming in Hambanthota

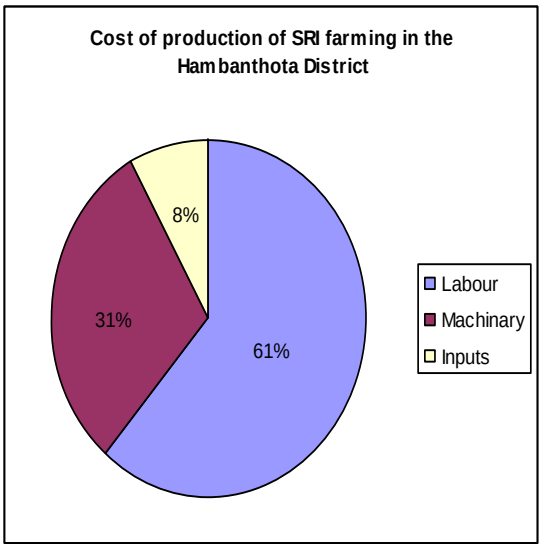
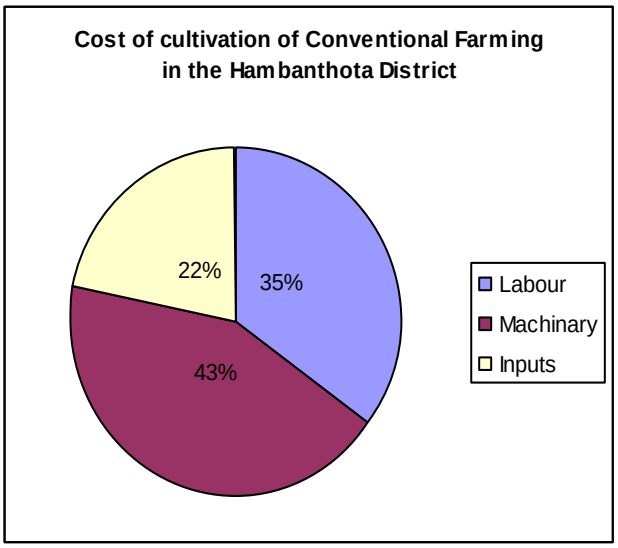


Figure 4.4: Percentage Cost of Production of Conventional Farming in the Hambanthota



4.4.2.3 Yield and Return

The labour cost share was 35% in conventional method whereas in SRI method it was 61%. This indicates that in the SRI method the labour requirement is higher than in the conventional method. But the machinery and the input costs of SRI method was comparatively lower in the SRI method than in the conventional method. (Table 4.26 and 4.38).

Table 4.38: Yield and Returns of Paddy in SRI and Conventional Method - Hambantota District

Yield and Returns	SRI	Conventional
Average Yield (Kg)	2,421	2,776
Market Price (Rs/Kg)	31.10	27.38
Gross Income (Rs)	75,291	75,985
Profit Including Family Labour Cost (Rs)	16,925	41,751
Profit excluding Family Labour cost (Rs)	35,427	48,356
Per Unit Cost including Family Labour (Rs)	24.11	12.33
Per Unit Cost excluding Family Labour (Rs)	16.47	9.95
Seed Requirement (kg)	15.18	81.61

Source - Survey data, 2009

In the Hambanthota district the average yield from conventional method was higher than that in the SRI method. The seed requirement per acre of land in SRI method was 15.18 Kg and in the conventional method it was 82.61 Kg. In Hambanthota district the price of 1 Kg of paddy in SRI method was higher than in the conventional method because the seed quality of SRI paddy was completes and filled (Table 4.28)

4.4.3 Cost of Production in Anuradhapura District

4.4.3.1 SRI Farming

The Table 4.39 presents the cost of cultivation per acre of paddy under SRI method under the major irrigation systems of the Anuradhapura district during 2008/2009 maha season. The total cost of production per acre including family labour cost was Rs.33,847/=. This consisted of Rs. 25,502/= for labour (including family labour), Rs.7,053/= for machinery and Rs.1,292/= for inputs. The labour expenditures marking and transplanting cost was Rs.8,631/= per acre while weed control needed Rs.5,742/= per acre. The total man days required for cultivating one acre of land under SRI method in Anuradhapura district was 51 days and this was double the requirement of conventional method. Under the SRI method average 39 hired man days and 12 family labour days had been utilized.

Table 4.39: Cost of Cultivation per acre of Paddy under SRI Method - Anuradhapura District

Type of Operation	Cost (Rs/Acre)			
	Labour	Machinery	Input	Total
All Nursery Preparation	730	-	-	730
General Land Preparation	1,786	-	-	1,786
1st, 2nd and 3rd Ploughings	365	4,241	-	4,607
Plastering Bunds	481	-	-	481
Marking & Planting	8,631	-	258	8,889
Application of Fertilizer	837	-	850	1,687
Weed Controlling	5,742	-	-	5,742
Pest and Disease Control	296	-	67	363
Water Management & After care	1,815	-	-	1,815
Harvesting	3,970	-	-	3,970
Threshing &Winnowing	491	2,153	-	2,643
Transport	-	595	-	952
Others (Sprayer, Land rent, Bags etc.)	356	64	117	181
Total-Including family labour	25,502	7,053	1,292	33,847
Total-Excluding family labour	5,353	7,053	1,292	13,699

Source: HARTI Survey Data, 2009

4.4.3.2 Conventional Farming

In Anuradhapura district the data were collected from Galnawa in the Mahaweli system H during the 2008/2009 *maha* season. The total cost of cultivation in conventional

method was Rs.25,564 per acre. That consisted of Rs.12,413 for labour (Without family labour) Rs.7,138 for machinery and Rs. 6,013 for inputs. The highest labour cost was for harvesting and highest machinery cost was for ploughing and the costliest input was fertilizer in the conventional method. All farmers had used combine thresher (Sunamie) for threshing and winnowing operations. The total number of man days needed to cultivate one acre of land was about 23 man days, which consisted of 8.61 man days of hired labour and 14.12 man days of family labour. (Table 4.40)

Table 4.40: Cost of Cultivation per acre of Paddy under Conventional Method - Anuradhapura District

Type of Operation	Cost (Rs/Acre)			
	Labour	Machinery	Input	Total
General Land Preparation	1,630	-	-	1,630
1st, 2nd and 3rd Ploughings	-	4,271	-	4,271
Plastering Bunds	1,688	-	-	1,668
Broadcasting	1,782	-	2,077	3,859
Application of Fertilizer	468	-	1,355	1,823
Weed Controlling	323	-	1,695	2,018
Pest and Disease Control	242	-	543	785
Water Management & After care	1,362	-	-	1,370
Harvesting	4,509	-	-	4,509
Threshing &Winnowing	213	2,496	-	2,710
Transport	215	310	-	525
Others (Sprayer, Land rent, Bags etc.)	-	53	343	396
Total-Including family labour	12,413	7,138	6,013	25,564
Total-Excluding family labour	5,089	7,138	6,013	18,239

Source: HARTI Survey Data 2009

In SRI cultivation 75% of the total cost per acre was the labour cost. This lobour category involved both hired and family labour. Input cost in the SRI method was very low. In conventional method, also labour cost was the highest (48%). The input cost in the conventional method is 24% and it was higher compared to that in the SRI input cost.

Figure 4.5: Share of Cost Components of SRI Method, Anuradhapura District

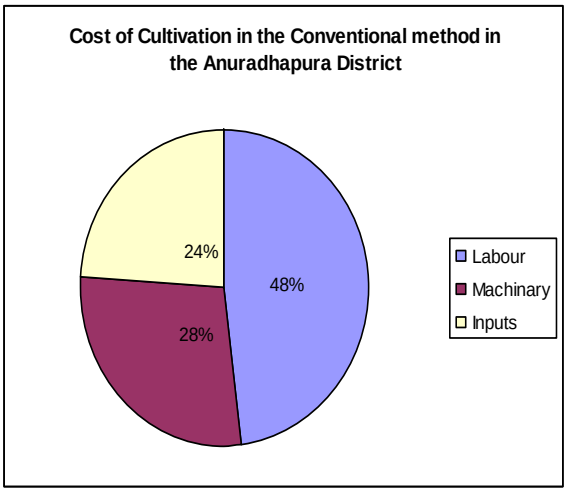
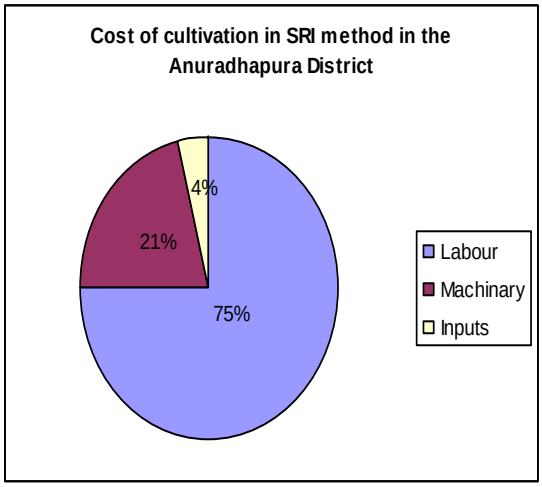


Figure 4.6: Share of Cost Components Conventional Method, Anuradhapura District



In Anuradhapura district, the total cost of production per one acre in SRI method was higher than in the conventional method. The average yield from SRI was slightly higher than in the conventional method. The market price of SRI cultivated paddy was Rs. 31.48 whereas in the conventional method it was Rs.29.68. The study revealed that the grain quality and the percentage of filled grain was higher in the SRI cultivated paddy than in the conventional method. The unit cost per one Kg of rice including family labour was Rs.14.74 in SRI whereas in the conventional method it was Rs.11.56. The seed requirement in conventional method was 10 times higher than the SRI method.

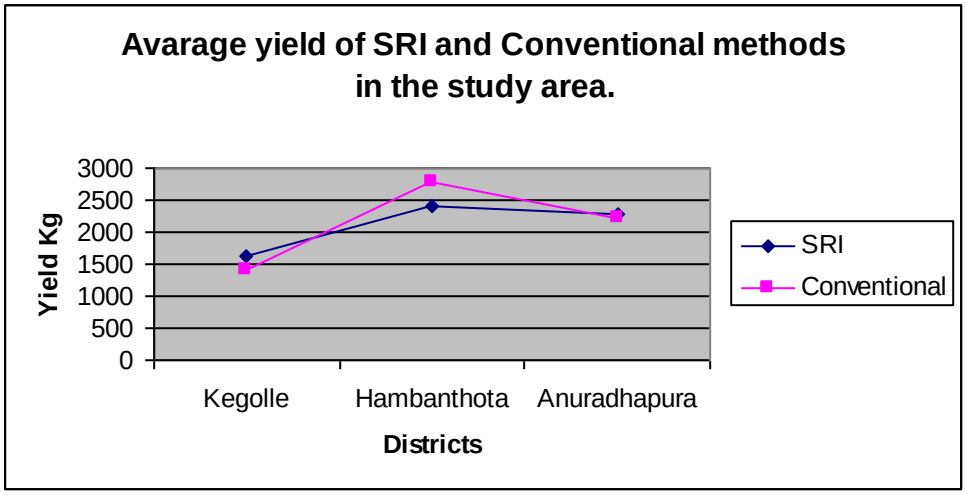
4.4.4.3 Yield and Return

Table 4.41: Yield and Returns of Paddy in SRI and Conventional Method - Hambantota District

Yield and Returns	SRI (Rs/Acre)	Conventional (Rs/Acre)
Average Yield (Kg)	2,296	2212
Market Price (Rs/Kg)	31.48	29.68
Gross Income (Rs)	72,269	65,648
Profit Including Family Labour Cost (Rs)	38,422	40,084
Profit excluding Family Labour cost (Rs)	58,570	47,408
Per Unit Cost including Family Labour (Rs)	14.74	11.56
Per Unit Cost excluding Family Labour (Rs)	5.97	8.24
Seed Requirement (Kg)	4.88	44.30

Source: Survey data, 2009

Figure 4.7: Yield Comparison of SRI and Conventional Method



The figure 4.7 shows the yield variations of SRI and conventional method in the study area. This Indicates that SRI and conventional rice yields were more or less similar in the Kegolle and in the Anuradhapura districts whereas in Hambanthota district conventional yield was little higher than the SRI yield.

4.5 Yield Comparison of SRI and Conventional

The yield comparison of SRI and conventional method in the study area was done using the T test. Here two hypotheses were tested.

H_1 – There is a difference between the mean yields in the two populations
H_0 – There is no difference between the mean yields in the two populations

T-Test Total Sample

Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error Mean
Yeild	1	59	119.175	64.4691	8.3932
	2	59	121.371	97.1711	12.6506

According to the T test the computer output from performing an independent two samples on the yield data gives a p- value of 0.603. This is not sufficiently low to conclude that position does affect mean yield. Therefore, we fail to reject $H_1$and it indicates that SRI and conventional yields are not significantly different.

The t test details are annexed.

Hypothesis Test

H_1 – There is a relationship between labour and SRI farming
H_0 – There is no relationship between labour and SRI farming

Chi Square test statistic is (X^2)

$$X^2 = \sum_{i=1}^{k} \sum_{j=1}^{h} \left\{ \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \right\}$$

O = Observation Value
E = Expected Value
k = Number of rows
h = Number of columns
I = Rows
J =columns
$\sum$ =Summation
X^2 =Chi Square Value

Rejection Rule
If X^2 calculated value > X^2 table value H_0 is rejected

Table 4.42: Labour Problem in SRI Cultivation

SRI practicing	Problems of Labour Shortage for Cultivation		
	Yes	**No**	**Total**
Yes	24	22	46
No	21	42	63
Total	45	64	109

Source: Survey Data, 2009

According to the chi square function the calculated X value is 3.878 but at the ά .1 levels the Chi square table value is 2.706.

This indicates that the calculated value is higher than the table value. Therefore we can reject the Null hypothesis. This proves that there is a relationship between the labour shortage and SRI Cultivation with 90% probability.

CHAPTER FIVE

Conclusion and Recommendations

The socio economic standard of both SRI and conventional farmers do not show much difference. The age limit of the farmers and the educational background were also similar when compared with conventional farmers.

Marking and Transplanting are most specific practices under SRI cultivation. Early transplanting is recommended and seedling is transplanted when only the first two leaves have emerged. The study has revealed that the majority of SRI farmers (88.7%) had transplanted seedlings of 7-12 days. In conventional method the majority of farmers (66.7%) had transplanted seedlings after 16 days of age and the recommended planting space was 25cm x 25cm. But the study reveals that the majority of the farmers (47.8%) had transplanted seedlings in a space of 20cm x 20cm. Only 4 per cent of the sample had transplanted their seedlings in the space of 22.5cm x 22.5cm.

Transplanting is the highest cost factor in farming and the 24 % of the total cost accounts for transplanting. The next labour consuming practice under SRI cultivation is weed controlling which is done by hand or mechanically. According to the study 98 per cent of the farmers had used weeders for weed controlling. In SRI cultivation, there is specific water management system and it requires wetting and drying of the paddy land. Therefore it needs extra labour compared to the conventional method. Study reveals that, in SRI cultivation 94 per cent farmers had applied organic fertilizer in to their paddy field, whereas only 6 per cent farmers had not applied organic fertilizer. Rice plants grown under SRI method are very strong and vigorous and the root system of the plants also develop well. Therefore application of chemical fertilizer is not required in this method. Literature has proved that in SRI method farmers could expect more than 100 tillers from one rice bush but according to the present study, average number of tillers was around 23 per bush.

The average yield of SRI cultivation in the study area was 2,296 kg/acre whereas in the conventional method it was 2212kg/acre. This was higher than the national average yield of the conventional method too. (in 2009 national average yield of paddy 1,734kg/acre). However there was no significant yield variation between SRI and conventional methods.

In SRI farming amount of inorganic fertilizer needed to cultivate paddy was less compared to the conventional method. Therefore by introducing SRI method fertilizer cost can be reduced. The government fertilizer subsidy programme requires more foreign exchange yearly.

The cost of production of SRI farming with and without family labour was higher than in the conventional method. This is mainly due to the labour cost for several agronomical practices involved in SRI method. There is a small price variation in the market between the SRI cultivated paddy and the normal paddy. The millers explain that SRI paddy yielded more rice and these are heavier than the normally cultivated paddy.

The SRI method was practiced by few innovative farmers in the country. Except in special cases the significant yield improvements cannot be seen in this method. But SRI method can be promoted to achieve environmental gains such as soil quality, ground water, natural enemies and pest etc. In addition SRI method produces seeds with high vigor, therefore it can be promoted for seed paddy production. Furthermore, SRI method can be used to cultivate traditional paddy varieties.

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Annex 1

Cultivated Extent of Lowland under SRI Practice during *Yala* 2008 and *Maha* 2008/09 Seasons by size of Lowland

District: Kegalle

Size of Lowland	*Yala* 2008				*Maha* 2008/09			
	No. of Farmers Reporting	%	Extent Cultivated (acres)	%	No. of Farmers Reporting	%	Extent Cultivated (acres)	%
0 – 0.25	6	24.0	1.12	9.3	8	30.8	1.62	15.5
0.25 – 0.50	13	52.0	5.62	46.6	14	53.8	6.19	59.1
0.50 – 0.75	4	16.0	2.43	20.2	3	11.5	1.78	17.0
0.75 – 1.00	1	4.0	0.88	7.3	1	3.8	0.88	8.4
1.00 – 1.50	0	0.0	0.00	0.0	0	0.0	0.00	0.0
1.50 – 2.00	1	4.0	2.00	16.6	0	0.0	0.00	0.0
2.00 – 3.00	0	0.0	0.00	0.0	0	0.0	0.00	0.0
Total	**25**	**100.0**	**12.05**	**100.0**	**26**	**100.0**	**10.47**	**100.0**

Annex 2

Cultivated Extent of Lowland under SRI Practice during *Yala* 2008 and *Maha* 2008/09 Seasons by size of Lowland

District: Hambantota

Size of Lowland	*Yala* 2008				*Maha* 2008/09			
	No. of Farmers Reporting	%	Extent Cultivated (acres)	%	No. of Farmers Reporting	%	Extent Cultivated (acres)	%
0 – 0.25	0	0.0	0.00	0.0	0	0.0	0.00	0.0
0.25 – 0.50	6	75.0	3.50	58.3	23	76.7	11.37	55.8
0.50 – 0.75	0	0.0	0.00	0.0	0	0.0	0.00	0.0
0.75 – 1.00	1	12.5	1.00	16.7	6	20.0	6.00	29.5
1.00 – 1.50	1	12.5	1.50	25.0	0	0.0	0.00	0.0
1.50 – 2.00	0	0.0	0.00	0.0	0	0.0	0.00	0.0
2.00 – 3.00	0	0.0	0.00	0.0	1	3.3	3.00	14.7
Total	**8**	**100.0**	**6.00**	**100.0**	**30**	**100.0**	**20.37**	**100.0**

Annex 3

Cultivated Extent of Lowland under SRI Practice during *Yala* 2008 and *Maha* 2008/09 Seasons by size of Lowland

District: Anuradhapura

Size of Lowland	*Yala* 2008				*Maha* 2008/09			
	No. of farmers reporting	%	Extent cultivated (acres)	%	No. of farmers reporting	%	Extent cultivated (acres)	%
0 – 0.25	1	33.3	0.25	20.0	6	20.0	1.50	6.5
0.25 – 0.50	2	66.7	1.00	80.0	11	36.7	5.50	23.7
0.50 – 0.75	00	0.0	0.00	0.0	0	0.0	0.00	0.0
0.75 – 1.00	0	0.	0.00	0.0	9	30.0	9.00	38.7
1.00 – 1.50	0	0.0	0.00	0.0	1	3.3	1.25	5.4
1.50 – 2.00	0	0.0	0.00	0.0	3	10.0	6.00	25.8
2.00 – 3.00	0	0.0	0.00	0.0	0	0.0	0.00	0.0
Total	**3**	**100.0**	**1.25**	**100.0**	**30**	**100.0**	**23.25**	**100.0**