Final draft

Adaptation and Adoption of the System of Rice Intensification (SRI) in Myanmar using the Farmer Field School (FFS) approach

A PhD thesis

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Table of contents

Chapter 1 Introduction — *3*

1.1. Introduction — **8**

1.2. The issues affecting rice production and the lives of the rural communities in Myanmar **9**

Chapter 2 Significance and objectives of the study — *14*

2.1. The significance of this study — **14**

2.2. The objectives of the study — **16**

2.3. Organization of the thesis — **16**

Chapter 3 Historical background and evolution of FFS — *18*

3.1. Concept of agriculture and rural development — **18**

3.1.1. The old paradigm — 18

3.1.2. The new paradigm — 19

3.2. The approaches used to facilitate agriculture and rural development and their bottleneck 20

3.2.1. The approaches heavily relied on external inputs and input-based technologies — 21

3.2.2. General inequalities in agricultural ecosystems — 22

3.2.3. The socio-economic diversity of farming communities — 23

3.2.4. Lack of capacities and inadequate technical expertise — 24

3.2.5. The cost-effectiveness and the issue of sustainability — 25

3.3. The evolution of IPM — **26**

3.4. Integrated Pest Management (IPM) – What it actually means — **28**

3.5. Transformation of IPM into FFS — **28**

Chapter 4 The concepts and methodologies of FFS and SRI — *30*

4.1. Farmer Field School — **30**

4.1.1. The concept — 30

4.1.2. The principles of FFS — 30

4.1.3. The methodologies used in FFS — 32

4.2. The System of Rice Intensification (SRI) — **36**

4.2.1. The concepts — 36

4.2.2. The principles 39
4.2.3. The practices 41
4.2.4. Factors affecting the yields and adoption/adaptation of SRI 43

Chapter 5 Country, locations, and timeframe, and the project evaluated in the study 47

Chapter 6 Results and discussions 56

6.1. Increased yields of rice on a unit-area basis 56

6.2. Production increase per family 62

6.3. Changes in farmers' cost of production and net return 67

6.3.1. Cost and return in terms of unit area of land 67

6.3.2. Cost of production in terms of unit volume of rice produced 71

6.4. The pattern of yield stability with graduated FFS participants over 3 to 4 years 73

6.5. The use of new technologies and their contribution toward yield increases 78

6.5.1. The use of new technologies and farmers' subsequent yield increase 79

6.5.2. Joint contributions of higher quality seeds, better variety, and SRI to yield increase 81

6.6. Percent of farmers using different technologies 86

6.7. Spread effects of FFS in terms of yield increase by non-FFS farmers through adoption of new technologies 88

6.8. Percent of farmers in a community accessing the yield benefits from FFS 92

6.9. Factors influencing the adoption of practices by farmers 94

6.9.1. Factors influencing the adoption process of FFS farmers 94

6.9.2. Factors influencing the adoption process of non-FFS farmers 100

A. Adoption in the first year after the graduation of FFS 100
B. Adoption in the second and following year after the graduation of an FFS 105

6.10. The effect of field studies and farmer experimentation process 106

6.10.1. The effect of size of study-field on the scale of adoption by individual farmers 107

6.10.2. The Effect of size of FFS study-field on the number of farmers adopting practices 111

6.11. The effect of FFS field day 114

Chapter 7 Conclusions 119

List of Tables

Table 1: List of selected FFSs under category I graduated in 2001 54
Table 2: List of selected FFSs under category II graduated in 2002 54
Table 3: List of selected FFSs under category III graduated in 2003 54
Table 4: Rice yields within FFS in 2001 57
Table 5: Rice yields within FFS in 2002 57
Table 6: Rice yields within FFS in 2003 58
Table 7: FFS mean yields from 2001-2003 59
Table 8: The highest and the lowest percentage of yield increase 61
Table 9: Average increase in amount of rice produced by individual 63
FFS families in 2002 after their graduation in 2001 63
Table 10: Average increase in amount of rice produced by individual FFS families in 2003 after their graduation in 2002 63
Table 11: Average increase in amount of rice produced by individual FFS families in 2004 after their graduation in 2003 64
Table 12: Mean production increase per FFS family over three years, 2002-2004 65
Table 13: Unit cost of production and net return of farmers in 2002 67
Table 14: Unit cost of production and net return of farmers in 2003 68
Table 15: Unit cost of production and net return of farmers in 2004 69
Table 16: Mean unit cost of production and net return of farmers from 2002 -2004 69
Table 17: Cost of production for production of one ton of rice before and after FFS 71
Table 18: Farmers' mean SRI yields of rice on own fields, by FFS, after graduation in 2001 73
Table 19: Farmers' mean SRI yields of rice on own fields, by FFS, after graduation in 2002 74
Table 20: Farmers' mean SRI yields of rice on own fields, by FFS, after graduation in 2003 75
Table 21: Number of farmers using the new practices and their percentage of yield increases from 2002 to 2004 79
Table 22: Level of significance 81
Table 23: Contribution of good quality seeds 82
Table 24: Contribution of better rice varieties 82
Table 25: Contribution of SRI 83

Table 26: Number of non-FFS farmers associated with Category-I FFSs and their production increases (in percentage) from 2002 to 2004 88
Table 27: Mean trend of increase of farmer participation in the following years of an FFS........ 89
Table 28: Percent of mean increase of production by Non-FFS farmers from FFS 90
Table 29: Percent of farmers in a community benefiting from FFS 93
Table 30: Factors influencing the adoption of SRI by FFS farmers, 2002-2004, and average for the three years 95
Table 31: FFS farmers mean scores across FFSs in 2002 for factors that they felt influenced their adoption 96
Table 32: FFS farmers' overall scores across FFSs in 2003 for factors that they felt influenced their adoption 97
Table 33: FFS farmers' overall scores by FFS in 2004 for factors that they felt influenced their adoption.. 98
Table 34: Factors influencing the adoption of SRI by non-FFS farmers, 2002-2004, and three-year average 100
Table 35: Mean scores of non-FFS farmers across FFSs in 2002 for the factors that they felt influenced their adoption 102
Table 36: Mean scores of non-FFS farmers across FFSs in 2003 for factors that they felt influenced their adoption 103
Table 37: Mean scores of non-FFS farmers by FFS in 2004 for factors that they felt influenced their adoption 104
Table 38: Size of study-field and corresponding percent of production increase by individual FFS farm families 107
Table 39: Study-field size and its effect on farmers' production increase in 2002 108
Table 40: Study-field size and its effect on farmers' production increase in 2003 109
Table 41: Study-field size and its effect on farmer's production increase in 2004 109
Table 42: Mean effect of the size of FFS study-field on the number of farmers adopting SRI practices 111
Table 43: Effect of FFS study-field area on the number of farmers using SRI in 2002............. 112
Table 44: Effect of FFS study-field area on the number of farmers using SRI in 2003............. 112
Table 45: Effect of FFS study-field area on the number of farmers in 2004............................. 113

Table 46: Effect of FFS field day on the use of SRI practices in 2002 114
Table 47: Effect of FFS field day on the use of SRI practices in 2003 115
Table 48: Effect of FFS field day on the use of SRI practices in 2004 115
Table 49: Mean effect of FFS field day on the number of farmers adopting SRI practices....... 116
Table 50: Correlations... 117

List of figures

Figure 1: The pattern of yield increase in terms of percentage, 2001-2003 59
Figure 2: Rice yields in FFS study-fields 60
Figure 3: Farmers production of rice before and after FFS 65
Figure 4: Farmer's production costs and net incomes before and after FFS 70
Figure 5: The trends of stability of enhanced rice yields in farmer fields 75
Figure 6: The synergistic effect in SRI 84
Figure 7: Percent of farmers using different technologies 86
Figure 8: The trend of participation and benefits of non-FFS farmers from FFS 90
Figure 9: The trend of participation of the community in terms of accessing benefits from FFS 92
Figure 10: Factors influencing FFS farmers adoption 95
Figure 11: Ranking of the factors that influenced Non-FFS farmer's adoption 101
Figure 12: Corresponding yield increase 108
Figure 13: Effect of the size of FFS study-field on number of farmers adopting SRI 111

Chapter 1
Introduction

1.1. Introduction

Rice is the staple food for more than half of the world's population. In Asia, more than 80% of the people live on rice, and their primary food security is entirely dependent on the volume of rice produced in this part of the world. However, rice production increases are now lagging behind population growth. Overall, the total global rice is declining gradually even with the extensive use of the modern varieties such as high yielding and hybrid varieties. Moreover, the problems associated with the green revolution technological packages, compounded by the problems of soils, water, and pest and diseases have further complicated the efforts to maintain farmer's existing yields.

Rice is not only the staple food in Myanmar; it is a crucial commodity for both the country and the farmers for incomes and general livelihoods. Without appropriate technological breakthrough, the growth of rice production has declined from 4.5 percent in 1985 to 0.9 percent in 1993 (World Rice Statistics, 1995). Consequently, farmers are losing interest in rice production as it does not contribute much to their income. The need for improving rice production and the productivity of rice fields in the country is immense, and especially in areas such as in the upper north there is an urgent need to assist the communities to improve their rice production where opportunities for other income generating activities are very limited, and where the lives of the communities have been shattered by long-term civil war.

In the past decades to address many of these similar problems in a number of countries in Asia, Farmer Field Schools (FFSs) have been introduced. FFSs are a social methodology for introducing innovations to farmers, and use of the methodology, most notably in Indonesia, Philippines, Bangladesh, Vietnam, Thailand, and Cambodia, has been highly successful not only in raising the production level of rice, but in reorienting approaches to the development of agriculture as a whole. The results of FFS have demonstrated significant improvement in farmers' skill and knowledge to tackle the common problems of rural farming. FFS farmers, in many countries in Asia, have been able to reduce pesticide use to zero or near zero while increasing rice yields from 10 – 30%. As a result, farmers' profit margins increased from 15-25% (FAO Community IPM, 1997).

Very recently System of Rice Intensification (SRI) has emerged as a new and promising innovation to growing rice. Evaluation results of SRI, most notably from Madagascar and a number of countries in Asia, have indicated significant potentials for raising the productivity of rice fields many-fold using the practices of SRI.

Encouraged by these successes, both SRI and the FFS methodology have been brought together in Myanmar, especially in Kachin State and northern part of Shan State, through efforts of Metta Development Foundation in cooperation with NGO partners and local government bodies. This thesis presents and analyzes four years of evidence on how both of these innovations work, separately and (more importantly) together.

1.2. The issues affecting rice production and the lives of the rural communities in Myanmar

Low agricultural production: Myanmar, a country which was once a major rice exporter in the global rice market, has now multi-faced problems in its agriculture, particularly, low agricultural productivity which has diminished the overall economy of the country. It is hard to believe that a country, with larger per capita landholdings than many other South and Southeast Asian nations, has the lowest agricultural productivity. Low-level of research investment, less priority in extension, meager expenditure on irrigation and unskilled staff, all these have negatively contributed to the low production level.

Increasing farm incomes and production requires intellectual innovations, such as rural participation, action-oriented research for knowledge generation, mutual sharing, and integration and diversification of the farming systems where necessary. In addition, there is a need for deeper understanding about the diversities that exist within various agro-ecosystems to develop location-specific technologies to solve the particular problems of an agro-ecosystem. Unfortunately, none of these have any favorable existence in the country, at the moment.

Currently, large potentials exist to bring many abandoned as well as virgin lands into cultivation for crops that can fetch better cash and produce more nutrients, plus there are substantial large homestead areas available within each household that have the ability to produce the daily-needed vegetables of a family. Unfortunately, not many efforts have been seen on this, either by the government or by private or even NGO actors. A predominantly agricultural society when it underperforms badly affects the rural people. The deficiencies of the agriculture sector, however, also affect other sectors, i.e., health, education, environment, etc., as it is the main source of income.

Degradation of soils: Due to soil-related problems, around 14 million tons of rice is annually forgone on a global basis. Similarly, it is assumed that proportionate amounts are also gone for other crops, i.e., other cereals and vegetable crops, although concrete data are unavailable. For each season the rice straw from a hectare of rice land, if not recycled to the soil, can remove 160 kg potassium, 66 kg nitrogen, and 6 kg phosphorus, plus a significant amount of other micro-nutrients. In addition, each ton of rice grain removes 10-15 kg nitrogen, 1-5 kg phosphorus, and 1.5-7.5 kg potassium. Unless adequate amounts of nutrients are added or recycled to the soil, its productivity continues to decline. Along with other parts of the world, many rice soils in Myanmar, therefore, suffer from phosphorus, potassium, sulfur, zinc, and other micronutrient deficiencies. To increase yields of rice as well as other crops requires improving soil conditions, which needs an intensive study of the soils.

Malnutrition and health problems: Irrespective of age, malnutrition is a common problem in the rural areas. Generally, young children suffer most; the next are the pregnant women. The issue of pregnant mothers is serious, as they become less able to produce healthy babies. Malnourished children and adults are highly exposed to other diseases of which diarrhea, dysentery, malaria, goiter, and night blindness are pretty common. All these are the direct results of low agricultural productivity, particularly of inadequate or unbalanced food intake.

Treating these diseases requires substantial amounts of money, whereas farmers' economic affordability has already begun to fall with the decline of their production in agriculture. Viable solutions to these problems would require simultaneous improvement in household's food security and enhancing the regular diet of the family, with protein, carbohydrate, vitamins and minerals for which rice, fish, meat, vegetables and pulses are the major sources. This requires an improvement in the overall farming or agricultural production systems in the country. Increased incomes at household level can also prevent some other serious health-related problems. Such is the case of HIV, which has already become a grave concern as due to economic problems, many young women in the rural areas are forced into prostitution.

Resettlement issues: For many years, Myanmar has been badly affected by rebellion and insurgency. All long-term observers agree that the twin problems of insurgency and narcotics are inseparable. The recent cease-fire agreement between the government and different insurgent groups has led the insurgent soldiers, refugees, and internally-displaced peoples to return to their homes. However, lack of capital, appropriate knowledge and skill for income-generation have caused great difficulties to them in sustaining decent livelihoods. Very little provision is made to assist in the rehabilitation and resettlement of these peoples who are leading very miserable lives, being destitute in their own homes. Providing them practical training on small-scale agricultural development, given that plenty of unused land is available, would be the best option to address the plight of this group.

Environmental hazards: The destruction of uplands has posed a great danger to the environment of the country. Illegal and uncontrolled logging has already caused substantial damage to the local and reserved forest. As a result, the problems of soil erosion are worsening day by day. This has been further aggravated by farmers' traditional practice of slash-and-burn cultivation. Lack of specific technologies appropriate to uplands is leading to more soil erosion. Low income from farming is another reason why people get involved in illegal logging. To address these problems requires developing contour-based farming systems, accommodating to the sloping nature of the country's hills and mountains. Unlike in lowlands, vegetables and fruits are the major crops in uplands. Lack of seeds, appropriate varieties, and effective technologies are other problems impeding the productivity in uplands. All these require intensive training to farmers to improve their capacity.

Pesticides and health hazard: Pesticides use has been promoted by a misunderstanding that cultivating high-yielding varieties requires pesticides. Actually, in comparison with other Asian countries, the amount of pesticides used in northern Myanmar is not very high. One reason of this is the dominance of local varieties as many farmers still cultivate local varieties in huge areas. High-yielding varieties are used more in the irrigated areas. However, the type of pesticide that farmers apply to control usual pest problems, being the cheapest and most widely available, has created a serious concern. Endrin, a category-I insecticide, which was banned many years ago all over the world due to its high toxicity and serious long-term residual effect, is being frequently used by many farmers without adequate knowledge about it. If the use of such highly toxic insecticides is not prevented, this could lead to serious damage to the entire rice ecosystem with long-lasting ill-effects on the entire environment.

Lack of support service: Extension services in the rural areas, which are mostly provided by the government, are generally very limited for a number of reasons; among them, inadequate numbers of extension staff and lack of needed financial support are the most important ones. At the start of rice transplanting, government workers only provide farmers the premium price of rice as credit, which is very low. For many years, due to unavailability of quality seeds, farmers have been using their own seeds; for long-term uses, the quality and the varietal purity of those seeds have already deteriorated to a very low level, resulting in significant yield loss. Rural credit is also a problem as there is no well-established credit facility in the rural areas. As a result, farmers cannot afford to buy quality inputs.

The existing initiatives of local and church-based organizations, to improve the socio-economic status of the rural poor, have been largely constrained by their poor understanding in extension approaches and the limited capacity in delivery mechanisms. Most of their staff are working as volunteers with little or no training and limited knowledge and skill. Impacts are thus minimal. Providing them with appropriate training could enhance their capacity and improve the overall performance of those local organizations.

Low human resource development capacity: Myanmar has a per capita GDP of around US $1419 at current foreign exchange rates (1300 Ks for 1 USD, year 2005, World Factbook), the lowest in Southeast Asia. Out of 175 countries, Myanmar ranks 131st according to the Human Development Index (HDI). About 30% of young girls and 35% of young boys leave school after Grade IV, the final year of primary school, and many adults do not have formal education. Moreover, there is grave concern about the poor quality not only of primary education but of technical and higher education as well. Life expectancy is only 58.4 years, and there are high rates of maternal mortality and child malnutrition as well as poor rates of child survival. Declining quality of health care, poorly trained staff, inadequate equipment and facilities and absence of essential drugs are the general constraints to the basic health care service.

The situation described above indicates that the lives of people living in Myanmar communities, especially those in the rural areas, have been badly affected by a number external and internal challenges. Most of these are complex in nature, while some are the direct cause of long-term civil-war and conflicts. Although recently the geopolitical situation has been improved, facilitating development activities across the region where most of the minority communities such as the Kachin and the Shan are living, a general lack in capacity of local organizations has slowed down current efforts to improving the living standards of communities.

Given that rice is the main crop in Myanmar agriculture, there is great need to improve the general conditions of rice cultivation. The current average yields of rice, which is 2 tons/ha in the country are the lowest among the major rice producers in the world An improvement in rice yields and production in the country, particularly in areas where farmers have little to do other than rice cultivation, can make significant improvements in their lives.

Chapter 2
Significance and objectives of the study

2.1. The significance of this study

The problems that are stated above are actually inherent problems, carried over for a longer period of time. Solutions to each of these problems would, therefore, require deeper understanding of the nature of the problems, for example, the problems in agriculture are not the problems just for agriculture itself. Agriculture, as the base of the rural economy, should first generate income from within it, and the new incomes, once generated, would contribute to addressing many of the other problems related with health, education, and insurgency and resettlement issues.

Addressing the problems in agriculture, thus, deserves priority for the community and the country. As most of the problems in agriculture have resulted from lack of understanding and, in many cases, from a misunderstanding about the total agricultural system, there needs to be a substantial effort to remove this misunderstanding first, and then to improve the overall understanding of the entire agriculture system. This means farmers, being the primary stakeholders, are to be provided with appropriate education to improve their knowledge base on this overall aspect of agriculture and farming.

Though the primary task of agriculture extension is to provide farmers with such opportunities to study the production systems of different crops they grow, it is hard to find any government extension system in Asia involved in this. One important reason is that the government extension services are far away from their usual task of educating farmers. They are, instead, involved in technology transfer -- a top-down, one-way approach to information flow to farmers, which has made them only receivers, instead of learners.

The Farmer Field School (FFS) is a new approach that has emerged in Asia in an attempt to address many of these similar problems. FFSs were found to be very effective in a number of Southeast and South Asian nations, notably in Indonesia, Philippines, Vietnam, and Bangladesh. Farmers who participated in FFS were seen to make significant improvements in their knowledge base and understanding about farming and in their overall decision-making. They have been able to reduce pesticide use to zero or near zero. Reduced pesticide use and better fertilizer management enhanced rice yields significantly, as a result farmers' profit margin increased as well.

It is believed that the same approach would also be applicable to enhance the skills and capacity of farmers in Myanmar. Considering the country's low standing on the human development index (HDI) and the particular problems that Myanmar agriculture is now facing, possibly the approach could provide relatively more rapid success here than in other countries in Asia, and there are high possibilities that the success could be translated to other sectors fairly easily.

Meanwhile, the System of Rice Intensification (SRI) – a new approach to growing rice -- has drawn much attention since its emergence in Madagascar showing tremendous ability to increase rice yield in many parts of the rice world. Evaluations of SRI have shown in 23 rice-growing countries around the world, including as of 2005 Bangladesh, Cambodia, China, India, Sri Lanka, Nepal, Indonesia, the Philippines, Sierra Leone, The Gambia and Cuba, that with adjustments and modifications in the practices that govern cultivation methods, rice yields could be increased by SRI by two or three times, and sometimes even more, with more skillful management. With such potential for large-scale increase in the production of rice, the adoption of SRI so far, except in Madagascar, has remained slow to spread (Uphoff, 2002). The reason, perhaps, is that the approach is very knowledge-intensive and requires careful study and continuous experimentation to find out the most effective combinations of practices matching the rice plant with its growing environment, such as changing the spacing between plants, seedling age, planting depth of the seedlings, timing and methods of irrigation and drainage, as well as methods of weeding, etc.

With FFS being so successful in providing farmers with education for improving their knowledge base to tackle the growing environment of rice and other non-rice crops, it is assumed that the introduction of SRI through FFS would provide farmers most needed skills to determine the best adjustments within each practice used in SRI to exploit its full potential for maximizing the yield benefits.

SRI is an innovation in the biophysical realm based on synergies among practices when they are combined. However, this combination is not always fixed; rather it is relative to the conditions and environments where rice is grown. It needs to be explored based on actual growing conditions. On the other hand, FFS is an innovation in the social realm that establishes processes for farmers to explore and find answers on particular points of inquiry used with SRI. The inquiry could focus on how to find the best match among practices that govern the cultivation methods of SRI. Therefore, they seem supplementary to each other, and there is reason to believe that when SRI and FFS are combined, they will benefit each other – with FFS achieving maximum benefits for farmer-participants while SRI will have greater adoption/adaptation.

Now what needs to be seen is: 1) how far this happens, 2) how they interact with each other, and 3) what the ultimate results are. This invites an examination of the complex relationship between SRI and FFS when they are used together, in an open-ended exploratory manner, and how this relationship influences the adoption/adaptation process of SRI and subsequently the lives of people in the communities who are using it.

2.2. The objectives of the study

1. To investigate and assess the adoptability/adaptability of SRI by farmers using the FFS approach.
2. To study the interactions and relationships between SRI and FFS and the particular factors contributing to the adoption/adaptation process of SRI.
3. To assess the overall contributions and combined effects of both SRI and FFS in improving the socio-economic conditions as well as the livelihoods of resource-poor farmers in Myanmar

2.3. Organization of the thesis

The first chapter has introduced issues and challenges that generally affect global rice production, and then issues that are particularly relevant to the conditions in Myanmar, especially how they are affecting rice production and the lives of the rural communities in parts of the country where this study was conducted. Although most of the issues are very familiar and similar to many other places where farming is the main occupation for farmers, they are still the key concerns in agriculture and rural development which have set the ground for this study.

This Chapter 2 has described the rationale and significance of the overall study with a definition of specific objectives, and describes here how the thesis is organized. Chapter 3 will provide historical background of the concepts and the approaches that have been used to provide services to the farmers, pointing to the general limitations and particular bottlenecks of those approaches which have led to the evolution of FFS, based on secondary data and the author's own experience. The chapter has tried to produce a new definition of IPM, highlighting its conceptual differences from the terms of academies and the research institutes based on an emerging understanding from its actual practitioners, and then it undertakes to establish the pathway for how IPM has been transformed to FFS as an effective approach to agriculture extension and rural development.

Chapter 4 explains the general concepts, principles and the methodologies of FFS and SRI, especially how they are generally understood and used by different levels of practitioners, with a view to drawing lines where these two are supplementary as well as complementary to each other to address the general problems of farmers. Chapter 5 introduces the geographical locations, timeframe, particular study sites, and key determinants of the study.

Chapter 6 and Chapter 7 present the original contributions of this study to advance the frontiers of knowledge regarding FFS and SRI based on the systematic presentation of empirical results. These chapters present which core practices of SRI and FFS produce how much contribution to farmers' yield improvements and production increases of rice, and how and to what extent the new practices were adopted/adapted by the farmers, and in the adoption/adaptation process, which elements of FFS have had how much influence on farmers in their adoption/adaptation of SRI on their fields. Chapter 6 presents how effective was the combined use of SRI and FFS to enable communities to improve their skills and capacities for improving their livelihoods, especially raising the production of rice on a unit-area and per-household basis. It further documents how the impact of FFS/SRI has spread from a small group of FFS farmers, who started the FFS, to entire communities within a period of three to four years. Chapter 7 draws conclusions that both FFS and SRI are highly supportive to each other, and that their combined use has shown how effectively, even in difficult agronomic and socio-economic conditions, SRI can spread within and among communities to the benefit of rural households and their living environment.

Chapter 3
Historical background and evolution of FFS

3.1. Concept of agriculture and rural development

3.1.1. The old paradigm

Rural development can be broadly defined as the targeted or desired progress of the communities living in the rural areas. In the past, this has been largely viewed as a modernization program. Modernization equates development with four basic processes: capital investment, which leads to productivity increases; the application of science to production and services; the emergence of nation-states and large-scale political and economic organization; and urbanization. These processes are linked to changes in values and social structure. Modernization has commonly been conflated with models of development, mostly proposed by Western writers.

This model of development has focused almost single-mindedly on growth in production and the expansion of the market economy, where the state played a leading and crucial role. The assumption has been that growth and markets are best promoted by the state and by a range of external interveners, donors and non-government organizations (NGOs) who know best about the kind of production and market required. This whole process of rural modernization was rather bureaucratic, mostly dominated by large organizations with mostly male professionals and administrators in command of the process where economic criteria dominated decision-making. The social, environmental and political factors were relatively unimportant, and the participation of beneficiaries was mostly included as an afterthought. The so-called 'Green Revolution' which was largely followed in Asia was an important result of such model.

The model has proved to be rather mechanical and inflexible and has evidently failed on a number of counts. In many countries, it has not helped remove material poverty nor to conserve valuable social and environmental resources as could be seen in many poor countries as well as some resource-rich ones, where poverty still prevails even with worse condition than before, despite five or six decades of independent government and development policies and programs. This so-called modernization strategy is not capable of promoting sustainable development since its outputs have too often been both environmentally and institutionally unsustainable.

Sustainable development refers to improvement in livelihoods without undermining the livelihoods of future generations. Livelihoods do not mean income and wealth alone; the quality of life and of society as well as security and dignity must be as important as the others. The modernization concept has not succeeded in being inclusive; the very poor, and the occupationally, ethnically, racially, religiously or geographically disadvantaged have remained marginal, or lost out; women have been excluded, or subsumed into the household, which was assumed to operate on altruistic principles, unlike the rest of the economy. Many of the intangibles of development – autonomy, freedom, dignity, and peace – were omitted.

3.1.2. The new paradigm

The new paradigm represents a move from an industrial concept of technology development to an organic or holistic concept of development, with sustainable development replacing profit as the implicit objective; from a technocratic and exclusive approach to a participatory and inclusive concept of development management; and from resource control by big organizations to local resource management, often with a strong common-property orientation.

The big shift has taken place in thinking about agriculture throughout the whole world and particularly in the developing countries since agriculture is the backbone of the rural society. The move towards sustainable agriculture is pivotal for future development. The new paradigm drawing strongly on sociology and anthropology and values indigenous knowledge and farmers' science and respects farmers' perceptions and objectives; it recognizes that many farmers are women, with possibly different objectives and perceptions; it also looks to avoid reliance on external inputs where possible, looks for energy-efficient farming systems, tries to integrate conservation into production, and above all, treats farms as whole units in interaction with their environment both physical and institutional.

In development practice there has been a rise of farming-systems and research activities that strongly endorse the incorporation of social sciences alongside natural sciences in the exploration of technology development and dissemination. The concern over environment and health has led to a rapid development of alternatives in agriculture. There have been efforts to reduce the reliance on or even to eliminate chemicals from farming systems, at least from the food which people buy. This has led the emergence of organic or ecological farming as well as movements supporting this in every corner of the world.

In the new paradigm, there has been also a greater shift of emphasizing development and strengthening the local institutions and their capacity, whereas in the past, the existence of such organizations was even not recognized. The development of farmers' group and organizations has added new value to rural development through a process called community development where the issue of empowerment and capacity-building of the community has been duly emphasized. The participation of women in this whole process has been clearly recognized and added. There has been a bigger move in the professionals from economists, planners, agriculturalists and engineers to a greater involvement of other social scientists and management specialists to facilitate and institutionalize such process of community development.

3.2. The approaches used to facilitate agriculture and rural development and their bottleneck

Over the past fifty years or possibly even more, under different names and perceptions with different sets of objectives, a number of approaches have been used to facilitate rural development with particular attention to bring improvements in the field of agriculture and farming. The approaches, which have been mostly governed by purposeful objectives with broader set of conceptual understanding on how to bring change towards material aspects of productions and living of the communities and farmers, have had unique achievements as well as challenges that have often led to the replacement of an old approach or evolution of a new approach. The performances of the approaches have been determinant to a number of key factors: the target groups, their social and economic conditions, the conditions of their farming, the ecological conditions of the region, and the technologies used by farmers and promoted under different approaches. The most commonly used among such approaches are: 1) general ministry-based approaches; 2) training and visit (T&V) extension approach; 3) integrated approaches; 4) commodity-based approaches; 5) university-based extension approaches; 6) research-based approaches; 7) private sector approaches; and 8) participatory approaches.

3.2.1. The approaches heavily relied on external inputs and input-based technologies

The approaches, whether used by government or non-government or private organizations, in general, all have had a primary function to disseminate new technologies and, in many cases, necessary inputs needed to apply those technologies to improve the production and productivity of various crops and commodities. The development and dissemination of new technologies actually received particular impetus after the Second World War. It could be highly successful due to adequate infrastructure facilities and more importantly due to new technological interventions which increased the production potentials of different industries many fold. This unique success during this period created hopes that similar progress might also be possible in the field of agriculture if adequate technological breakthroughs could be made to increase the agriculture production similar to industries.

Consequently, greater efforts were made in the field of research to develop new varieties, breaking the traditional yield barriers of many local varieties with an engineering approach to redesign the genetic make up of plants. The approach has been highly successful particularly in rice, corn and wheat, and ultimately in each of these crops a number of new varieties were developed. However, to exploit their maximum yield potentials, external inputs were needed to be supplied to the soils at different stages of plant growth which had made necessary the production of synthetic fertilizers and the development of many chemical-based industries to produce such fertilizers. Later, chemical pesticides were added to the production system to control the unwanted pest and disease infestations, which became a serious problem to many of these new varieties as they were made more vulnerable to such attack by the chemical-based cultural practices.

With all these advancements, the agriculture and rural development actually came to be understood in terms of the dissemination of technological package with new seeds and chemical fertilizers and pesticides. Although the primary function of agriculture extension was supposed to provide farmers with adequate knowledge on various aspects of production, this had hardly taken place. The top-down extension approaches largely became a mechanism for ‘technology transfer’ to farmers. Without adequate adaptation in the use of those new technologies, the majority of the farmers could not make enough economic progress as it was expected earlier.

3.2.2. General inequalities in agricultural ecosystems

Agricultural ecosystems are generally classified into two broad categories such as upland and lowland, according to topography. In Asia, upland areas include more than 50% of the total farmland while in terms of population they contain more than 60% of the total rural population In other regions such as in South America, the percent of people living in uplands is even more. The rest of the people live in lowland ecosystems. Lowland ecosystems are classified in turn, according to the source of water, either into rainfed lowland or irrigated lowland. Among them, the percentage of land under rainfed ecosystems is usually much higher than under irrigated ecosystems.

Among the above four ecosystems, the use of new technological package provided huge improvement only in the irrigated lowland ecosystems, which were the focus of what later came to know as the "Green Revolution." This was because the successful use of new varieties required large amounts of external nutrients, and the supply of those nutrients to the soils needed adequate water to dissolve and transport the nutrients to different parts of the plants. Irrigation water along with the use of new varieties and chemical inputs, all across the irrigated ecosystem, raised the productivity of rice, wheat and corn by two to threefold. To accelerate such growth, however, many governments made huge investment in irrigation infrastructure. Still the percentage of global irrigated land is comparatively low. The maintenance of such infrastructure in many places has become complicated. Overall, the total irrigated area instead of increasing has started declining, and the ultimate benefit of new technologies has already become stagnant or limited.

The benefits of these new technologies in other ecosystems are mostly insignificant. The very fragile environment of upland ecosystems is seldom able to utilize the Green Revolution technologies since most of the varieties were developed for lowland conditions. In addition, the use of chemical fertilizers or pesticides in the upland was very uneconomic as there was not significant response in terms of yield increases. Their application was also difficult because of the sloping nature of the fields, and the scarcity of water. On the other hand, although the new technologies provided some benefits to the rainfed lowland, particularly in the case of rice in rainy season the actual benefit is not as regular as in the irrigated lowlands.

As a result, the total benefit of new technologies could only be seen in some particular environments with some particular groups of people living in those ecosystems. This, on one hand, has created greater inequality between the general mass of farmers living in uplands and lowlands, and on the other hand, it has created tremendous pressure for the overuse of natural resources in lowlands, where cropping intensity has increased from 100 to 200-300 percent. This highlights the needs for new generations of technologies, which can promote effective and efficient use of natural resource management in a way that is highly sustainable and suitable for farmers in all conditions.

3.2.3. The socio-economic diversity of farming communities

Inequalities among farmers in resource endowment, particularly in land, capital and labor, have great influence over the use of new technologies. The benefits derived from the new technologies are highly relative to the general land holding and financial capital of the farmers. For the new technologies, the use of new seeds, chemical fertilizers and pesticides, irrigation, drainage and new equipment requires significant amounts of capital to invest. For small farmers, such investment was a great limitation. The new technologies, therefore, found more suitability with the rich farmers and spread more effectively as long as such investment was put forward.

To promote the use of new technologies, many extension services provided credit in terms of cash as well as direct inputs to the farmers. In such case again, the rich farmers were given priority since they are in a better position and have big influence in the societies. Poor farmers oftentimes find difficulty to access the benefits of such services as they are mostly unable to provide collateral for obtaining credit, which is an important criterion to access credit from government facilities.

In addition, from the perspective of national food security, it is more important for the governments to enhance the overall food production in the country than attaining food security at individual farmer level. Compared to poor and medium farmers, rich farmers always have greater value since they hold more land and could contribute more as an individual farmer to the national production. Therefore, they enjoy most of the benefits of the government services. Besides, they have more political clout. Consequently, the inequalities between the rich and the poor farmers continue to grow further. The problem was often not that the small farmers could not adopt the new technologies – they did in millions (Shepherd, 1998). But they did so later than the big farmers, once access to the technologies became easier. By this time, however, much of the financial benefits of the use of new technologies had already been exhausted by the earlier adopters. Mass adoption often contributed eventually to declining real crop prices. Bigger farmers again were in a better position to cope with this problem through cutting their costs of production or diversifying their farming systems.

All this underscores the needs for changing the paradigms of traditional service systems to promote alternative ideas and approaches that pay more attention to resource-poor farmers who constitute the vast majority in the rural communities of most of the developing nations, in addition to promoting alternative technologies as mentioned in earlier section.

3.2.4. Lack of capacities and inadequate technical expertise

Many extension services realizing the above inequalities undertook programs which usually target the resource-poor farmers who did not receive much attention in the usual services of the government. These programs have been primarily implemented in the fragile or unfavorable environments such as in uplands, and mostly by the NGOs. Although, many of these programs were very systematic and effective in their approach to enhance general awareness and participation of farmers and rural communities, their actual contribution to improving general well-being is still not very encouraging.

The major constraint, as viewed by many, is their lack of technical expertise in planning, designing and implementation of effective programs that provide farmers with adequate opportunities to gain needed knowledge on appropriate technology development and dissemination. Their overemphasis on social awareness aspects in many cases has actually undermined the technical dimensions of different projects they have carried out to improve the socio-economic status or livelihoods of rural people. In general, NGOs do not have enough qualified technical people who can provide effective service to the communities.

Inadequate numbers of well-trained extension workers are also a limitation to successful extension systems globally. Without enough well-trained staff members, extension is seriously limited in its ability to plan and execute sound programs. According to a FAO study carried out in 1989 indicated, about 40% of the extension personnel in developing countries had only a secondary school diploma, and some actually had less than a secondary education. Another 33% had an intermediate certificate diploma or its equivalent. About 23% had a university degree, and about 4% had some type of postgraduate qualification. This suggests that in all the developing countries, 40% of the extension personnel have inadequate technical and extension training. Furthermore, in countries where field personnel have these low education levels, the proportion and quality of subject matter specialists is also low.

3.2.5. The cost-effectiveness and the issue of sustainability

Cost-cutting, cost-effectiveness and the issue of sustainability are generally a great concern for all the approaches, either government or non-government systems of agricultural extension and rural development. In the case of government programs, if agricultural extension is to be successful in implementing useful initiatives, there must be tangible evidence of government commitment to agricultural extension. The best way to measure this commitment is to assess the financial resources allocated to extension over time. According to a FAO study (Swanson et al., 1990), on an average, only 0.5% of agricultural gross domestic product (AGDP) is invested in agricultural extension worldwide.

Since most of the government extension systems operate under civil service rules and regulations, once extension's budget declines because of budget cuts or is reduced in real terms because of inflation, then the general pattern is to maintain or raise the salary payments to the extension staff and to make up these line item deficits by reallocating funds from program budget. The net result is that while extension personnel may keep their jobs, they will have little support in the form of transportation, travel allowances, teaching aids, and demonstration kits to use in operating an effective educational and technology dissemination program, which ultimately affects the quality of the program.

Another important thing is that most of the government agricultural extension services in developing countries heavily rely on foreign funds. They mostly operate through various projects, most of which are funded by foreign aid. The government in most cases provides only the staff salaries. Project strategies, therefore, are highly influenced by foreign donors. The most dramatic example of such a case is the T&V extension methodology, which was mostly funded by the World Bank. Government had very little option but to implement the recommendations of the World Bank experts and advisors irrespective of the country or the region. Once project support was withdrawn, the overall sustainability of the approach became a great concern.

Similar problems also prevail in the case of NGOs which are believed to be most progressive agencies to bring forward the issues of farmer participations and to opening doors to the service of resource-poor communities. In most cases, NGOs, and particularly southern NGOs, have no other options except to receive funds from foreign donors and northern NGOs. If they lose their support, they are likely to have to close down. This means that they have to implement the agendas and the strategies of the donors or northern NGOs. This risks undermining the comparative advantages of NGOs, which were the rationale for channeling funds to and through them rather than to public sector organizations in the first place; their closeness to the beneficiaries and grassroots organizations and movements, their flexibility and capacity to learn, their special levels of inspiration and motivation, and so on (Fowler, 1988).

3.3. The evolution of IPM

IPM was evolved in response to address some of the critical problems encountered by the Green Revolution technologies or by technology-transfer approaches to agricultural extensions in general. The most important problem which actually led to the evolution of IPM was the infestation of brown planthopper (BPH) in Indonesia. It was in 1986 that serious infestation of BPH damaged almost the entire rice crop in central Java of Indonesia. Since the majority of the farmers lost their harvest, the government of Indonesia took serious interest to find out the actual reasons for such outbreak of an insect which was never before a major pest in rice. The government, accordingly, formed a committee comprised of a pool of experts from different disciplines including entomologists, and social scientists from FAO. The committee after long investigation and intensive study submitted a report to the government which, surprisingly, identified the heavy use of chemical insecticides as the main reason of the outbreak.

The findings astonished many, particularly those at the policy level, since they had been advised to advocate the use of chemical insecticides to control the infestation of insects. To their surprise, the investigation team explained that in rice fields there are both harmful insects, such as BPH, and beneficial insects; and most of the beneficial insects live on the upper parts of the plants while the harmful ones are on the lower parts. When insecticides are sprayed on the rice field, it is the beneficial insects which are killed first. The use of chemical insecticides in that particular year was so high that they destroyed most of the beneficial insects, which primarily control or keep the infestation of harmful insects low. The situation provided the harmful insects with an enemy-free environment, and as a result, they multiplied very quickly, and the pest population became huge, uncontrollable even with chemical insecticides. Another important reason of such a huge outbreak was the development of resistant strains of BPH. Due to prolonged use of chemicals, the majority of the BPH in that particular year had developed resistance. Therefore, none of the insecticides were actually effective to control the insects. That is how the population of BPH grew into a serious and damaging outbreak.

It has been quite apparent that the resurgence of pest problems, declining soil productivity, and degrading rice soils are part of the Green Revolution problems. Moreover, the traditional top-down extension approach, which has provided blanket recommendations to the farmers for many years based on specific research and messages, contributed to a huge deskilling of rural communities. Centrally-designed technology packages needed to be adjusted to specific field conditions. But the conventional extension services could not provide farmers with the knowledge they needed to make this adjustment. Ultimately, farmers became passive receivers of technology and were blamed as non-progressive when they did not utilize this or utilized it incorrectly.

As these lessons were becoming more distinct and clear, with more and more social, environmental, ecological, and economic problems identified in rural communities, *IPM emerged with a realization that the problem is not with the farmers, so much as with the methods used to provide services to farming communities.* The results of IPM demonstrated that by providing appropriate training methods, farmers could not only master the technical knowledge needed to improve their fields; they could actually become experts capable of using these knowledge to develop new initiatives to tackle local problems and take advantage of new opportunities as they arise.

All over Asia, farmers enthusiastically responded to IPM. Some farmers are primarily motivated by the reduced costs and reduced production risks obtained through application of ecological principles to crop management. Some are intellectually stimulated by the subject matter, and excited by the experience of designing and carrying out their own experiments. For others, the main attraction is the group interaction, discussions and debates, which are an important part of IPM teachings.

3.4. Integrated Pest Management (IPM) – What it actually means

IPM by itself is generally understood as an integrated approach to pest management. It recommends a combination of multiple practices used together to provide more effectiveness as control measures. This is the official definition widely taught in the academies – in universities and colleges, and in research institutes. The control measures that are involved in this management are generally classified as: 1) physical control, 2) cultural control, and 3) biological control, with 4) chemical control as a last resort. Recently, genetic control – meaning the use of genetically-resistant varieties -- has been highly promoted.

This classification of means is reasonable and it makes great sense to understand what it represents. But there is a large difference, perhaps a wide gap, between this definition and the way that IPM is understood and has been implemented after its evolution after the BPH outbreak in Indonesia. As could be noted from the previous section, IPM has evolved not just as an approach to pest control but also as an approach to agriculture extension; failing to realize this has oftentimes led to great differences in the understanding of IPM, especially in the field. The academic definition of IPM has been in existence for some years, from years before the emergence of BPH outbreak in Indonesia. Although the extension workers in almost all the counties in Asia were promoting such IPM in the field during the outbreak period, they were not able to stop the outbreak. What the outbreak had done was create a new understanding about the methods that have been used to provide service to the farmers. This particular understanding has led IPM to evolve as a new extension approach in agriculture, not just as an approach to pest control, although it started by dealing with pest problems. One could see this clearly from the account presented in the later chapters.

3.5. Transformation of IPM into FFS

The diversity of understanding about IPM often has led to great controversies – and in the way it has been implemented with farmers. Many practitioners of IPM have started calling it ICM (Integrated Crop Management) since it deals with not only pests but with all production practices. If IPM is considered as a technology, then perhaps they are right to call this ICM. But as many now argue, IPM is not dealing only with crops; through IPM, farmers are provided with training also on a variety of non-crop subjects, especially to developing their human capacity.

Then may it is better to call this Integrated People's Management (IPM), as some people are now actually doing.

All this happens because at the initial stage, a great number of persons, whether in the academies or in the field of extension, have failed to draw a distinction between the technical domain and the conceptual domain of IPM. As long as IPM is viewed simply as a technology, this difference would continue to evolve based on the subject matter that IPM is going to deal with, according to the needs of the farmers and the community. To get out of this pattern of thinking, one has to understand the evolution process of IPM as well as what it actually does to the farmers and the communities.

As mentioned earlier, the great failure of all the previously-used extension approaches to educate farmers has led to the appearance of many problems that are now associated with concerns about the sustainability of the entire agricultural system. IPM considers that these problems, those already created, and many that can be anticipated – or even remain unforeseen -- are part of the process. They are very complex in nature too and cannot be separated from the other. Therefore, it requires a great deal of effort and analysis to understand the complexity of the problems, which could only be possible through providing appropriate education to the farmers. Drawing upon such understanding, IPM began by providing farmers with appropriate education on a variety of subjects using a non-formal approach to education so that they understand the complexity of the problems, through studying the entire production system, and they can then make appropriate decisions accordingly. This is what is actually done through an institution called the Farmer Field School. Linking IPM to FFS makes great sense as a way to conceptualize the overall strategy of IPM, so that the process of learning and acting is integral to the learning and action itself as a holistic approach to extension.

Chapter 4
The concepts and the methodologies of FFS and SRI

4.1. Farmer Field School

4.1.1. The concept

Over the entire last decade, after transforming the paradigm from IPM to FFS, the concept of FFS has remained largely open to be evolved based on the needs of the people that it is intended to serve and of the practitioners who are using it. The understanding that has broadly expanded the area and scope of FFS, even from agriculture to non-agriculture sectors, is very new and has taken place only recently within a few years. According to this understanding, farming is considered as a matter of decision-making, such as which crop to grow, which variety to use, which management practices to apply, how much capital to invest, how much area to cultivate, and so on. The success of farming, therefore, depends on the quality of decision-making regarding all these practices which is basically determined by the degree of understanding for each of these subject matters. Farmers, by tradition, have a wealth of experience, but they also have many misconceptions and fears, as many of them were unable to avail themselves of the formal opportunity to study basic science. Farmer Field Schools provide farmers with the basics they need so that with their inherent diverse experience and with the newly acquired scientific knowledge they can make better decisions and ultimately become expert decision-makers to improve production and incomes significantly in a sustainable manner.

The particular subjects on which FFS provides farmers with basic education are agroecology, agronomy, soil science, plant protection, water management, economics, social science, etc., and the approach that is used to provide such education is basically a non-formal approach, which is used for teaching adults. As the school is established in the field, and the students are farmers, it is called Farmer Field School (FFS).

4.1.2. The principles of FFS

The following principles are largely adopted in FFS. For the facilitators, they serve as guidelines on how to guide the farmers to grow crops and improve other activities.

Grow a healthy crop: A healthy crop that is free from disease and other infestations and that has a higher degree of defense, can recover from injuries and damages associated with insect attack and disease infestation much quickly than can a weaker crop. Quality seeds and seedlings, good and resistant varieties, balanced nutrients, and appropriate management practices usually provide the foundation for a healthy crop. Mistakes in any of these areas usually result in poor establishment of crop, which then becomes highly vulnerable to insects and diseases. To recover the situation, farmers usually opt for pesticides, which do not deal with the main problem. Effective pest management does not rely on one single activity. It is rather a process to understand how to grow a healthy crop. Farmers in FFS are guided in this process.

Conserve natural enemies: Insects are, oftentimes, misunderstood as (all) harmful. No insects are effectively harmful unless their population reaches damaging numbers. Moreover, many insects such as parasites, predators and pathogens have long been recognized as beneficials by nature because they eliminate or keep in check the pests and disease vectors that lead to crop damage. Recent research shows that microbial antagonists and competitors of plant diseases are also important. Vertebrate natural enemies are also essential for control systems. Conservation usually implies avoiding inappropriate pesticide applications, which kill natural agents, and improving soil organic matter necessary for beneficial soil microorganisms. Natural enemy habitat protection and development are more active methods of conserving natural enemies (e.g., owl houses, mulching for spiders, floral nectaries for parasites). Inoculation or inundation of reared natural enemies may be possible under special circumstances, but usually only after conservation efforts have already been implemented.

Observe the crop regularly: Managing a crop effectively requires close and regular observations of the field, particularly of the conditions of plants, soil, water, weeds, and climate such as temperature, sunlight, humidity, etc., as crop development is primarily determined by the combined effect of all of these. Decisions taken without such observations are blind and, in most cases, inappropriate, which usually leads to the use of unneeded chemicals in the fields. Regular field observations provide farmers with the opportunity to study and understand the field situation through an analytical process known as Agroecosystem Analysis (AESA). This provides the basis to make decisions regarding any activity which are most appropriate at that particular stage of a crop. As a result, the crop performs better, unwanted costs are minimized, and yield level is improved. Through regular observations, farmers learn how the crop physiology and morphology changes with a change in the climate and other factors that govern the crop production.

Regard farmers as experts: This principle reinforces the fact that farmers need to eliminate their dependency on others to solve their problems. This could only be possible when they become, and consider themselves, experts in their own fields. Therefore, developing farmers as experts has been adopted/adapted as a key principle of FFS. Many, however, consider this as the ultimate goal of FFS. An expert is an expert not because he knows everything, but because he knows how to know the unknown things. Similarly, learning of something specific ends when that particular thing has been learned. But learning never ends when someone learns how to continue learning. FFS provides farmers with a process to continue learning for their whole life. They are guided with learning principles so that they know how to carry on learning and become experts on things currently unknown to them.

4.1.3. The methodologies used in FFS

The methodologies used in FFS vary from one program to other and from one country to another based on the overall perception and the design of the program, and also based on the target groups of FFS. Although there is a core set of methodologies that have been consistently used in every program, there have been later additions of some new methodologies that were not originally part of FFS, to tackle the growing needs of the communities, sparked by scholarly arguments of farmers and different levels of practitioners. Adding these to the core set of methodologies has enriched the performance of FFS in many instances. Similarly the FFS program in Myanmar had used a variety of methodologies; some were tailored to some particular locations, while many were common to all areas covered by the program. Among them, the following have been seen to make desirable impacts in influencing the adoption/adaptation of technologies, specifically the use of SRI under most FFS.

Discovery-based learning, or farmers' experimentation

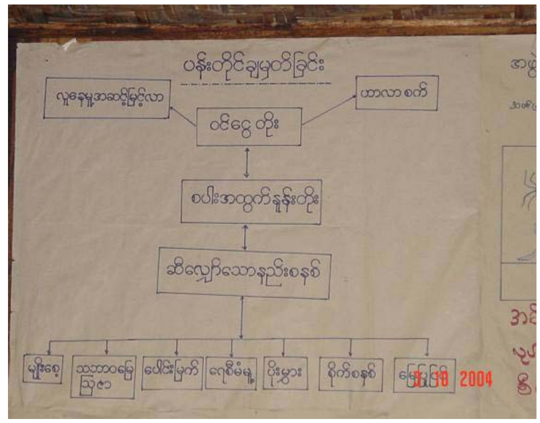
People are known to say,

When we hear, we remember some,
When we see, we remember more.
When we do, we remember the most,
But when we discover, we never forget.

Discovery-based methods are the key to FFS. While these methods provide the primary basis in FFS, there are other methods too which are generally used to set and facilitate the discovery process. FFS in all aspects is a natural process of learning. The methodologies used in FFS are primarily intended to create more natural opportunities for farmers so that they learn from actual situations on a continuous basis. In doing so, the most common methodologies used are:

Season-long field study: FFS is actually a place for season-long study. If the FFS is on rice, it is a season-long study on rice; if it is on vegetables, it is a season-long study on vegetables. To facilitate such study farmers require a study-field. In the study-field, they grow crops and establish studies and experiments to learn various issues in crop production such as soil management, water management, pest management, etc. The studies are generally classified into two categories: one is the general study which is very common in most of the FFS, and the other is concept-specific study, which is determined based on the need and the interests of the farmers.

Action research: Problems are countless, and they are very common to farmers' regular lives. Solving a problem may help the farmers for the time being, but it does not help in the longer run unless they learn how to solve the next problem, as new problems continue to emerge with new issues. Therefore, the next important methodology used in FFS is to guide farmers through the problem-solving process. The methodology used in problem-solving is as common as the methodology used by researchers when try to solve a particular problem. Farmers are usually provided with guidelines on how to set up experiments or conduct action research. The action research they conduct is based on their problems and the issues they identify during field observation and agroecosystem analysis, which is a regular weekly activity of FFS.



Participatory planning: FFS usually begins with a planning process. During the planning, it is explained to the community about the general purpose and the working methodologies of FFS. They are then asked about their specific expectations. Based on cause-and-effect analysis, the expectations are prioritized into specific objectives of the FFS. The objectives are then qualified and quantified with specific measurable indicators so that after a certain period, the community can assess the progress of FFS. Based on these indicators, specific activities of FFS are determined. Later, an action plan is prepared by identifying the needed materials and determining a tentative schedule to perform the activities. The activities of FFS begin immediately after the action plan is prepared. The action plan actually acts as a guideline for the farmers to work together and maintain their regular responsibilities. The action plan is usually prepared for one season or one full year based on the nature of the FFS. If the FFS works on crops, the action plan is prepared for one season.

Working in groups: A general proverb says, "*Two brains are usually better than one, and similarly three brains are better than two*." While working alone, one can learn something but when working in a group one can learn more as it provides more opportunities for learning. Besides, as individuals, trying something new is often difficult, but with group support it becomes easier.

Working in a group, therefore, is an important methodology of FFS. FFSs are usually organized for a group of about 25 farmers of a community with common interests. This number is roughly the number that can comfortably work together. These 25 are then divided into smaller groups of five persons each so that all members can better participate in field observations, analysis, discussion, and presentations. In small groups, they grow crops, establish studies and experiments, and monitor and analyze them. After having small-group discussions to gain an in-depth understanding of the phenomena observed, and to reach agreement on what has occurred, the findings then are presented and shared in the large group. This provides each group with an equal opportunity to learn from each other. Working in groups also provides the opportunity to build unity and solidarity among the farmers. It builds leadership within each of the farmers because every one of them, while working in FFS, has a chance to be the leader of the small and the large group.

Participatory monitoring and evaluation (PME): The introduction of PME to FFS provided a unique opportunity to farmers to understand the results of their work. PME is usually organized at the end of the crop season. During PME, which is comprised of a number of tools, farmers in groups systematically evaluate which activities of FFS worked well and which did not. This leads them to identify the particular successes and challenges of FFS. The analysis of the particular successes and challenges provides them with opportunity to revise the old plan and prepare a new one.

The simultaneous process of planning, which is done at the beginning, and monitoring and evaluation, which is done at the end of the season, helps the communities to gain skills in planning, monitoring and evaluation. They gradually become efficient in 1) problem identification, 2) goal setting, 3) action plan development, and 4) monitoring and evaluation. The process further guides them how to continue the development efforts even after the FFS is graduated.

Field-days: 25 farmers of an FFS form the core group of farmers in the village. The group participates in all the regular activities of FFS and therefore is called the primary beneficiaries of FFS. But the ultimate benefits of FFS are targeted for the entire community of a village. Since FFS is a very intensive process of learning, it is difficult to accommodate more than 25 farmers in one FFS at a time. Therefore, it begins with a manageable group of 25 farmers.

Through working in the FFS, farmers usually gain a significant amount of knowledge in various aspects of farming. Field-days provide an important opportunity for dissemination of such knowledge among all the farmers in the community. Field-days are usually organized toward the end of the FFS or during the graduation of the FFS. During field-day, while presenting the learning to a diverse group of peoples, which include community farmers, village leaders, government officials including extension workers and specialists, farmers gain tremendous encouragement and recognition. The recognition from such a diverse group greatly helps them to become established as important resource-persons in the community. In such a way, the field-day becomes an informal knowledge and experience-sharing channel.

4.2. The System of Rice Intensification (SRI)

4.2.1. The concepts

The conventional concept for rice production: According to the standard view or the 'modern' concept of growing rice, which has become 'traditional' in that it is static and is not being subjected to revision and further improvement, the rice plant and its growing environment are generally considered as a *closed system*, where output is associated directly with the inputs supplied to the system (Uphoff, 2002). In this view, soil is considered as a store-house of nutrients essential for the growth and development of rice plant, and over time after growing rice for many years, the capacity of this store gradually declines as rice plants, on a continual basis for growing year after year, take up needed nutrients from it. Therefore, the store needs to be filled up with those appropriate types and amounts of nutrients that have been taken up to make sure that new rice crops have enough nutrients for its production. This is a zero-sum view, where the system is not regarded as itself contributing to its own operation, able to replenish its capacities. It is a view dependent on outside (exogenous) interventions.

Additionally, in this view, rice varieties, either local or improved, are considered to possess an given yield ceiling or a barrier, which is the virtual limit for expressing their genetic potential; even with more inputs and/or better environmental conditions, no variety has a capacity to cross such barrier. Generally, such limits are higher in the modern varieties, being artificially raised through conventional plant breeding of genetic modification, than in the local varieties. The creation of modern varieties such as high-yielding varieties (HYVs) or hybrid varieties with their higher yield target requires that more nutrients be supplied to the soil from external sources since the amount available in the soil is not considered enough to meet their demand. To meet such huge demands, farmers usually opt for synthetic fertilizers as they are less costly (especially when subsidized) and easily available and more convenient to use, especially on large-scale operations.

Therefore, the cultivation of these modern varieties is always dependent on fossil-fuel-based synthetic fertilizers and later, after the emergence of pest insects and diseases, on synthetic pesticides – mostly insecticides and herbicides. The overall consequences of this concept of growing rice, especially how it is making impacts - both positive and negatives - to the lives of the farming communities and the environments and ecosystems, were already described in earlier chapters.

The SRI concepts: Contrary to what has been expressed above, deriving from the experience of SRI, rice plants are regarded more as organisms with their own innate capacity, like other living beings, to respond constructively to the way they are treated. Rather than being driven by a single input like fertilizer, the ultimate response of the plant depends on the combined effects of a large number of forces and factors that govern the growing environment of rice. Therefore, the main determinant of the growth and development of the plant, and its subsequent yields, derives from how this growing environment, which includes seeds, seedlings, soil, water, nutrients, air, and the prevailing weather and climatic conditions, is managed.

Rice plants being living organisms have more ability, like other living being, to adapt to new conditions and to absorb the trauma at a younger stage than at any other stages. Therefore, rice seedlings, when transplanted at very young stage, can easily absorb the transplanting shock and can still maintain their ability to grow with full potential.

Like plants, soil is also considered as living -- full of lives, with microbes thriving on and in it. The activities of these huge numbers of microorganisms make the soil a living body. Rather than being a store house, it is virtually a living-machine that produces nutrients for plants depending on the way it is managed, and depending on the energy that is supplied to it. Generally, composts and manures are considered the primary source of such energy, and the amount, the time allowed, and the type of the organic materials that are supplied to the soil have a large influence on the overall activities and the populations of these huge numbers of microorganisms.

Contrary to what people general understand, these organic materials are provided to the soil not as a supply of nutrients to the plants but rather as a source of nutrients and carbon to the microorganisms. It is generally believed that microorganisms cannot uptake carbon, which is essential for their survival, from air, and no synthetic fertilizers contain carbon at all. The supply of organic nitrogen through green manures also influences (positively) the populations of microorganisms that cannot fix atmospheric nitrogen.

As mentioned earlier, the growth and the populations of microorganisms are also influenced by the management practices of soil such as irrigation, drainage, cultivation, etc., as they provide different conditions necessary for different types of microorganisms. For example, submerged (reduced) condition is favorable only for anaerobic microorganisms. Therefore, in such condition these multiply very quickly and largely, while that environment is detrimental for aerobic microorganisms, and as a result, they die back. Similarly, vice versa happens under oxidized condition, when soil is kept moist at the level of field condition but not saturated; aerobic microorganisms multiply and anaerobic microorganisms die. If the soil is managed with alternate irrigation and drainage, this simultaneous wetting and drying, and the subsequent decompositions of microorganisms can create a continuous supply of nutrients within the soil which is more favorable to plants than that supplied from external sources. *Nurturing the growth and populations of microorganisms, thus, is considered the key to the dynamics of nutrient availability in the soil and concurrent supply to the plants.*

Another view, based on previously thoughts about the yield ceiling, is that the genetic potentials of most of the existing rice varieties have been rather fully exploited and therefore, to raise the yield level further, there needs to be the development of new varieties with higher level of yield ceiling. One reason of this is the focus of the development of a super-rice variety, which is still uncertain as such variety is yet to come. Contradicting the idea of a yield ceiling, SRI experiences in a large number of rice-growing countries, including China, India, and Myanmar (where this study was carried out) have consistently shown that the existing varieties have more genetic potential than has been previously thought and that this can be tapped by altering the management practices (Uphoff, 2002). *The driving force of the new concept of growing rice with SRI is the innovative management of the entire rice environment, which of course is not new, as scientists and plant breeders have long recognized that environmental influences at each point in time can change the genetic expression of any organism with any particular genetic makeup.*

4.2.2. The principles

The principles of SRI vary from practice in that the former are the guiding force while the latter is an outcome of such guidance, and therefore, the principles are more important than the practices. The principles that have determined SRI practices are:

Rice is not an aquatic plant: With rice having been grown over centuries under submerged conditions, there is a general belief that rice plants grow better under saturated conditions. This belief is strengthened when it is seen that rice plants develop aerenchyma (air pockets) in their roots when grown under submerged condition. But SRI experience tells a different story, that the development of aerenchyma is an indication that the plant is enable to survive flooded condition through the development of these aerenchyma, but that this need not be an ideal adaptation. The latter conclusion is confirmed by the fact that rice plants, when grown under well-oxygenated soil conditions, produces vigorous root system. A plant grown with SRI practices requires 5 to

10 times as much force as is required to uproot a similar plant grown under submerged conditions. Profuse growth allows the roots to spread to larger areas to be able to absorb more nutrients than can a plant grown under flooded condition. SRI plants can grow better with very little nutrients or no nutrients supplied from outside at all.

Rice plants loose some of their growth potential when transplanted at an older age: SRI capitalizes upon an in-built pattern of physiological development in rice which was first identified by a Japanese scientist named T. Katayama before World War II, when he found while studying the growth and development of cereal plants, that these plants produce their tillers in a sequential order (Katayama, 1951; Uphoff, 2002). Later Father Henri de Laulanié, during his work in Madagascar in 1960s-1980s, observed that a plant's ability to produce tillers was reduced gradually with the age of the seedlings when transplanted, with younger seedlings producing a larger number of tillers. He found that rice seedlings transplanted before the fourth *phyllochron* – a physiological development unit of plant growth, the time interval during which one or more phytomers (units of tiller, leaf and root) develop -- produced the highest number of tillers. Therefore, to exploit the maximum potential for tillering, rice seedlings need to be transplanted before the beginning of the fourth phyllochron, usually when they are around 10-15 days old. This difference is based on the management of the seedlings. Under better management conditions, 10-day-old seedlings could reach such stage.

Enough spacing to grow fully: Rice seedlings when planted earlier need to be provided enough space to express their full potentials in terms of growth of leaves, tillers and roots. Enough space, along with other favorable conditions, allows the plant roots to grow profusely both vertically in deeper parts of the soil and horizontally to cover a larger area, and when roots are spread to a larger volume of soil, they tap more nutrients, which results in the development of larger plants with larger numbers of tillers and grains.

Careful transplanting: Transplanting shock associated with uprooting, transportation, and transplanting is an important stress to rice seedlings; therefore, they need to be handled very carefully. Seedlings when they get affected lose their potential to grow fuller, and perhaps this is one reason why, when they are transplanted in usual ways, they are not seen to produce as many tillers as SRI.

Specific soil amendment practices to facilitate the growth and development of microorganisms: The supply and the availability of nutrients in the soil are mainly determined by how it is managed. Specific soil management practices include providing alternate oxidized and reduced conditions to the soils so that both aerobic and anaerobic microorganisms can grow and die in alternating conditions and their continuous decomposition supplies nutrients to the soil, as mentioned earlier. This would be maintained by alternate flooding and drying.

Specific soil management also can supply adequate amounts of organic material so that this improves the nutrient supply for microbes. Studies conducted with sugarcane in Brazil indicate that non-leguminous plants, of which rice is one, when grown without chemical nitrogen, can fix 150-200kg of nitrogen per hectare (Uphoff, 2002). In another study conducted in England and Wales indicated that alternate flooding and drying of soil can enhance the availability of water-soluble phosphorus in the soil by 185 to 1900 per cent (Turner and Haygarth, 2001).

All these dynamics can make the application of chemical fertilizers unnecessary if there are unavailable reserves of nutrients in the soil that can be mobilized or mineralized as a result of the work of microorganisms. Another important finding, which is again contrary to the general belief, is that plants can grow satisfactorily with much lower concentrations of nutrients than have previously been thought necessary provided that the limited supply is constantly available over time rather than at few points in time (Primavesi, 1994, from Uphoff, 2002). This again diminishes the need of external fertilizers, especially the chemical forms.

4.2.3. The practices

The practices that have been translated based on the principles mentioned above vary from location to location, and also from season to season, considering the differences of the soils in different geographical locations as well as the climatic conditions in different seasons. They also vary according to farmers' general understanding, their knowledge base to manipulate the practices to suit into their particular conditions, and their overall affordability in terms of costs associated with hiring labor. The SRI practices that are being introduced to farmers in Myanmar are:

1. **Planting younger seedlings,** usually 10-12 days old, but not older than 15 days. Usually in wet season due to comparatively higher temperatures, 10-day-old seedlings are widely used, but in winter, especially in areas with cold temperatures where very young seedlings sometimes have problems in establishment, farmers prefers to use 12 to 15-day-old seedlings. A little older seedlings are preferred in certain areas, particularly in the wet season, where standing water is a problem.
2. **Planting seedlings one by one:** Though the majority of SRI farmers use one seedling per hill, in some cases they use up to two seedlings. This is mainly to avoid any loss of seedlings due to pest or other damage, which can happen within a few days of transplanting if they are not planted carefully.
3. **Planting with wider spacing:** There has been no fixed spacing found being commonly used by SRI farmers in generals, but 25x25cm, 30x30, and 35x35cm have been seen most often. Spacing also depends on the inherent quality of the soils. The better the soils, the wider the spacing is appropriate for getting higher yield.
4. **Planting seedlings as immediately as possible:** Seedlings once uprooted from the seedbed are generally transplanted within half an hour with SRI practices, and many farmers have even been seen to do this immediately after uprooting, as their seedbeds are already inside the main field.
5. **Using compost:** Although most farmers use compost/manure, the amount varies in terms of its availability and also because there has been no fixed or recommended rate to follow. Composts are used mostly before transplanting during land preparation, but it is preferred to use this with the preceding crop.
6. **Alternate irrigation** is practiced up to the initiation of panicles, and then the field is just kept moist. The number of irrigations needed during the entire crop period, and the gap between two irrigations, depends on the type of soil; sandy soils need more irrigation than other types of soil.
7. **Cultivating the soil:** Soil is generally cultivated using a rotary weeder, which is primarily done to control the growth of weeds. Soil cultivation is also needed to aerate the soil but the number of times for weeding varies from 2 to 5 during the entire tillering period, based on farmers' choices and affordability.

4.2.4. Factors affecting the yields and adoption/adaptation of SRI

Growing period

Although in the tropics and subtropics, rice can be grown year-round based on the characteristics of the varieties such as photosensitivity and photo-insensitivity (the latter can be grown year round), the growing periods, especially the day-length, temperature, rainfall, etc., have great influence over the yields of rice. Rice yield usually is lower in the wet season than in the dry season, because high rainfall and clouds limit the number of sunny days in the wet season. The wet season also affects the rice yields with SRI as heavy rains keep rice soils most of the time either saturated or completely flooded (with no or little opportunity for drying). In addition, in areas where there are not enough drainage facilities, deep flooding further limits the scope of SRI. Therefore, the dry season is more favorable for SRI as there is also better control over the management and supply of irrigation water. However, this does not mean that SRI cannot be used in the wet season. It can be used as efficiently as in the dry season where there are good drainage facilities. But under other conditions, all the principles and the practices that have been evolved based on those principles could not be effectively used because of high rainfall and standing water.

Labor requirements

Due to the need for careful transplanting, generally it takes more than the usual number of days of labor for transplanting rice with SRI methods, although when farmers get used to the new practices, the transplanting time is just about equal to what is needed with conventional practices. Whether this is an important factor affecting the adoption/adaptation of SRI is a general question that should be considered. Yet, it does not require any specific study to determine whether or not it affects the adoption/adaptation process, as there are plenty of similar experiences to be considered to explain the matter. In the 1960s, with the introduction of the new high-yielding varieties, a similar situation arose when farmers were advised to transplant rice in a line. This was very new to them, and many farmers at the time were not confident about this. Nonetheless, this is now no longer a problem, as almost every part of the world where transplanting is done, farmers invariably practice line-transplanting. SRI experiences tell the similar story that farmers once they have mastered the practices need even less time than they needed for the earlier practices. With wider spacing they now require a lesser number of seedlings to be transplanted which is an offsetting factor, reducing labor requirements. Nevertheless in some cases, as can still be seen, some farmers are not transplanting their rice in lines (or squares) when using just some practices of SRI. This is not necessarily related with the general use and practices of SRI itself but is certainly an important issue for investigation and learning.

Experimentation

Given that SRI practices are intensive in nature, and since success in achieving the best yields depends on effective combination of the practices that are used together, there is a need for continuous experimentation to find which combinations are best based on the particular growing environments where farmers are living. This experimentation, of course, has a major role in the overall adoption/adaptation of SRI by farmers. While farmers generally have had no risk of crop failure in experiments with SRI, if this happens it can happen for some other reasons not particularly linked to using SRI. Still, if they see the yields that they obtained from experiments with SRI are lower than those with their conventional practices, there is a tendency to be discouraged from trying SRI next year. This actually has happened in few instances (roughly in 10% cases), where farmers at the beginning were too enthusiastic, and have tried SRI on a large part of their lands.

Therefore, there is a need for guiding farmers on how to conduct such experiments, especially at the beginning, regarding how much area of SRI should be tried at first, and what kinds of experiments should be conducted, and how to deal with such experiments. The experiment results, like the process itself, have also great influence over the adoption/adaptation process of SRI. In most cases, to avoid the risk of yield reduction, farmers are generally encouraged to conduct experiments in a smaller part of their field, but the better yields from such small plots are oftentimes not very exciting for the other farmers in the community, and thus this can be an important reason to slow the adoption/adaptation process of SRI. Besides, the desire for experimentation is unevenly distributed within the farming community, and only a minority of them are predisposed to experiment, to innovate, to be the first adopters, while the majority prefer to take a wait-and-see attitude. Therefore, there are greater possibilities that the adoption/adaptation of SRI could be positively influenced by the experimentation process of

FFS, especially to influence the adoption/adaptation of the majority of farmers who prefer to take a wait-and-see attitude.

Sharing process

The adoption of anything usually takes place through a process of sharing, and generally, two types of sharing are noticeable associated with the adoption/adaptation of SRI. The first one is very much formal and thus could be called formal sharing. It takes place between farmers and service providers – the organizations or groups that usually bring the idea to the farmers. The methods and the approach that are used in this sharing process have a great influence, as the extent of this sharing is largely determined by those methods and approaches. The second level of sharing is very informal and takes place spontaneously among farmers. It is often called as the 'roll-on' or spread effect of the first level of sharing, and the extent of this sharing is largely determined by the effectiveness of the technologies that are used. The overall impact of the first level of sharing, especially on the knowledge base of the farmers, and how this knowledge is translated into visible gains such as yields and incomes, has also a larger influence on the second level of sharing.

FFS being an effective approach to agriculture extension has its own mechanisms of sharing, and how these mechanisms are functioning with SRI and influencing its overall adoption/adaptation when, within FFS, SRI is used as the major strategy for growing rice, is an interesting area to examine. Within the FFS, if there is a high adoption/adaptation rate of SRI, then which particular elements of the sharing process play more contributing roles to this adoption/adaptation, and whether these elements could independently be used without FFS to facilitate the adoption/adaptation of SRI, becomes another interesting matter to be investigated.

Adoption and adaptation of SRI

Adoption and adaptation are very common terms used in the agriculture extension, especially in technology transfer. Adoption generally refers to application of particular technologies by farmers without modification, while adaptation also means application of technologies by farmers with some modification according to the particular conditions of the fields and the needs and constraints of farmers. Adoption of technologies without modifications will create problems if the technologies do not fit into the prevailing environment and the particular physical conditions of the fields. Further, the process is not really very innovative if it offers farmers little opportunity for learning so that they can and will make further improvements in their production systems. The dissemination of SRI generally involves both the process of adoption and adaptation. Adaptation is seen at the initial stage when FFS farmers are involved in experimentation to find out adjustments within the practices of SRI to fit into their field conditions. Adoption generally takes place later, based on their experiments once farmers can see the practices already adjusted to their field conditions. Both the process, however, can take place simultaneously. The uptake and spread of SRI by its nature involves both processes of adaptation and adoption. However, using both terms whenever we refer to the spread of SRI is rather awkward. In the chapters that follow, we will use just the word ‘adoption’ with the explicit understanding that this involves the concurrent activities of adaptation and learning.

Chapter 5
Country, locations, time frame, and the project evaluated in the study

Country: Myanmar is the largest Asian mainland country after India and China. It lies on the western side of Indochina between latitudes 10^{O} 00' and 28^{O} 30' N, and longitudes 92^{O} 10' and 101^{O} 10' E, the northernmost areas lying outside the tropics. Elevations range from sea level to 5,881 meters on the snow-capped mountain of Kha Ka Borhazi in the extreme north. Most of the country comprises low-lying plains along three parallel river systems, flanked by mountain ranges along the eastern and western frontiers. The estimated human population in 2004 was 54 million. Agriculture dominates the economy, constituting 49% of the GDP in 1995-96 and 35% of export earnings. Rice alone accounts for 25% of the GDP in Myanmar. The country has substantial economic potential and significant natural resources in the form of underutilized cultivable land area, natural gas, marine resources, and mineral wealth.

Kachin State – the location of the study: Kachin State is the northernmost state of Myanmar. It is bordered by China to the north and east; Shan State to the south; and Sagaing Division and India to the west. It lies between north latitude 23° 27' and 28° 25', and longitude 96° 0' and 98° 44'. The area of Kachin State is 34,379 sq. miles, and the capital is Myitkyina. The majority of the state's 1.4 million inhabitants are ethnic Kachin, also known as Jinghpaw, and the state is officially home to another 13 ethnic groups, including Bamar, Rawang, Lisu, Zaiwa, Maru, Yaywin, Lawngwaw, Lachyit), and Shan. No census has been taken in almost a century. Although a large percentage of the population in the cities is Buddhist, the majority of the population in the state is Christian. The Kachin language is the lingua franca in the state, and has a written version based on the Roman alphabet. The economy of Kachin State is predominantly agricultural. The main products include rice and sugarcane. Mineral products include gold and jade.

Although the traditional Kachin society is based on shifting cultivation, lowland rice plays a major role in the lives of the communities. In rural societies, cultivation of rice, the primary source of food security as well as incomes, is the major agricultural activity. Rice yields are poor, only two to three tons per hectare, especially in the upper-north of the country, which contributes to general food security among many farm households. Moreover, poor farmers have to surrender a large part of their harvest to pay off their debts borrowed for cultivation and household consumption between harvests. Quota sales of paddy to the government, at a lower-than-market price, were a great burden until abolished in 2004. Baseline information obtained from local farmers during PRA sessions conducted in January 2000 across the State indicated a trend of growing poverty, compounded by many social and economic problems, in most of the rural areas in Myanmar.

The project (evaluated in this thesis) Farmer Field School for Sustainable Agriculture Development in Myanmar was created in an attempt to address the basic food security needs of farmers particularly of Kachin State and some parts of Shan State in northeast Myanmar. Since 2001, when the FFS methodology was introduced, the project has tried to develop the skills and capacities of farmers so that with the new skills they could improve their rice production and consequently enhance their incomes. The project has implemented FFSs in partnership with three local and church-based organizations and a national NGO, Metta Development Foundation, discussed below. This collaboration has been a model on how to work in partnership with local and church-based organizations. According to the nature of the partnership, the project has developed a core group of trainers, facilitators and coordinators within each of the partner organizations. The facilitators have been primarily responsible for establishing FFSs across the communities, while the coordinators have provided follow-up and backstopping support to the facilitators. The national NGO, Metta, has been responsible in overall coordination among the partner organizations and management of the entire project. The specific objectives of the project were:

1. To enhance and empower the decision-making ability of 180 rural household communities in Myanmar, particularly in Kachin State and Shan State; this was planned to be achieved through improving their overall management capacity in rice-based farming systems.
2. To facilitate and strengthen community efforts and participation in planning, implementing, monitoring and evaluating rural community-based initiatives for promoting sustainable rural development.

3. To create self-reliant capability within the local and national organizations; the local organizations would implement Farmer Field Schools at community levels, and the national organization (Metta Foundation) would coordinate the implementation of FFS at local levels.
4. To enhance broader awareness and influence other local, national and international organizations to create interest for supporting, sponsoring and implementing Farmer Field Schools in other parts of Myanmar.

SRI was introduced to the FFSs in 2001 based on initial results of some experiments conducted on FFS training plots during the first season-long training-of-trainers [TOT] course under the project as mentioned in Chapter 1. It needs to be mentioned here that TOT was the main activity to develop the capacity of the FFS facilitators. During the first TOT, although the transplanting of rice was done a month late and the subsequent yield was disappointing (1.97 to 2.73 tons/ha), the profuse tillering and the vigorous growth of plants impressed the participants. Accordingly, they decided to introduce SRI to their FFSs.

The organizations involved in the project

Metta Development Foundation, being the main project stakeholder has been in the forefront of the project. Metta identified the local partners and developed the project with the assistance of the author as mentioned below. Accordingly, it has maintained regular coordination with all three partner organizations as well as with the external funding agencies such as MISEREOR and SwissAid which funded the entire activities of the project.

Established in 1998 as national NGO, Metta started its development activities with the specific aim of assisting communities whose lives have been shattered by long-term internal conflicts, and who have been largely displaced from their homelands. Although Metta’s work began with the process of reconciliation, helping communities in resettlement and reconstruction activities mostly in Kachin State, over the years it has expanded its operations to other states of Myanmar with more and more engagement in the areas of rural development. Metta's main objectives are to:

- create a framework for self-help initiatives;
- support sustainable community-based projects;
- facilitate skills training; and
- establish partnerships with like-minded organizations or individuals.

Metta today is engaged in development activities across five states and three divisions within the Union of Myanmar. In the inaugural year of 1998, Participatory Action Research (PAR) paved the way for Metta to work with communities. However, since 2000, Farmer Field School activities have become the mainstay of Metta programs. Metta also partners with the World Food Programme in its "Food for Work" initiative.

The major programmatic features of Metta Foundation now are: 1) Community development using FFS and PAR, 2) Community health and education, 3) Capacity building, and 4) Rural reconstruction. Under the areas of community development, Farmer Field Schools are one of the largest programs. Metta programs are grass-roots initiated. As such they operate with the participation of local communities in various aspects of planning, implementation and evaluation. Local resources are mobilized wherever possible, and women are afforded the same level of representation as men. The establishment of a community organization network which serves as a forum for sharing experiences and expertise forms part of the strategy for reaching out to communities from a diverse range of ethnicity and faith backgrounds.

Kachin Independence Organization (KIO) has been an important partner of the project. Kachin troops formerly formed a significant part of the Burmese army. With the unilateral abrogation of the Union of Burma constitution by the military government in 1962, Kachin forces withdrew and formed the Kachin Independence Organization (KIO). Aside from the major towns and railway corridor, Kachin State has been virtually independent from the mid-1960s through 1994. After the 1994 civil war between the government forces and KIO, a peace treaty was signed, permitting continued KIO effective control of most of the Kachin State under aegis of the Myanmar military. Although the ceasefire immediately resulted in the creation of numerous splinter factions from the KIO and Kachin Independence Army (KIA) – the army wing of KIO, KIO still remains as the largest group. The peace treaty has also led KIO to undertake development programs to improve the socio-economic situation in the region, especially in areas controlled by them. Agriculture was identified as the key area for improvement. However, limited technical staff and lack of experience was found to be their major constraint in this. The project included KIO as a major partner and offered technical and training support to develop needed FFS facilitators/coordinators within it to establish FFS in its controlled areas.

Kachin Baptist Convention (KBC), the denominational organization of Christian Baptists in Kachin State, is another important partner of this project. Aside from religious activities, the organization is actively engaged in development activities, enabling direct support to the Baptist communities living across the state under the auspices of its development department. Limited capacity, especially lack of enough technical staff has been found to be a major challenge to provide effective service to these communities. The project offered training and technical support to the selected facilitators and coordinators of the KBC who established FFS in their working areas.

Catholic Diocese, particularly the Diocese of Myitkyina, has been the other partner of the project. A large percentage of the Christian communities in Kachin State are Catholic. The Diocese of Myitkyina, headed by an appointed bishop from the Vatican, is the official representative of Catholic communities in Kachin State. Like the KBC, the Diocese also has social programs to support communities to alleviate their plight of poverty. Currently, under the Diocese of Myitkyina, there are 27 parishes across the state. Through the parishes, they selected interested farmers and volunteers from the Catholic communities, and the project provided particular training support to those selected peoples to become facilitators and coordinators of FFSs. The facilitators established FFSs within their communities.

The role of the author in the project: The author, the formerly a rice production specialist with the International Institute of Rural Reconstruction (IIRR), based in the Philippines, has been intimately involved with the project, working closely with Metta Development Foundation as an independent consultant in designing and developing the project based on his diverse experiences with FFSs in South and Southeast Asia. During project implementation, he has played a key advisory role in overall coordination, management and implementation of the project.

Time period:

The first phase of the project started in 2001 for three-year period. During this period (2001-2003), the project established 258 FFSs in around 200 communities and trained 5,202 farmers of which 4,080 were male and 1,116 female. Compared with the third year, the scale of operation and the number of FFSs established in the first and second year of the project was limited. Initially, it took little longer time for the partner organizations and the project team, the facilitators and the coordinators to understand the concept and overall methodology of the project. Nevertheless, in the third and final year of the first phase, the project made huge improvements in terms of the number and quality of FFSs. The overall impact of the project, the increased yields of rice, the skills and capacities of farmers, facilitators, and coordinators had created great enthusiasm among the communities and partner organizations. As a result, since 2004, a new phase of the project has begun for another three-year period. Under the new phase, in 2004 the project established more than 100 FFSs. The overall period of data gathered and analyzed for this study was from 2001 to 2004.

Particular locations of the study: Across the entire project area, three distinct locations were selected for the study. The locations are Myitkyina, Waimaw, and Lai Za of Kachin State. In each of the locations, FFS methods had been implemented for at least a three-year period. Individual FFSs were facilitated each for around a one-year period, and after this period, the set of farmers who had constituted that FFS became known as a 'graduated' FFS (FFS alumni).

FFS selected for the study: From the above locations, three categories of FFS were selected for the study. The first category (category I) includes those FFS participants who graduated in 2001; and the second category (category II), those who graduated in 2002; while the third category (category III) is those who graduated in 2003. Post-graduation experience for category I could thus be studied for three additional years; category II graduates for two more years; and Category III for one further year.

For the study, a total of 30 FFS were selected, with 10 from each category as shown in **Tables 1-3**. While most of the FFS were selected randomly, preferences were given to those FFS that had better access for data collection and close interactions with farmers so that information would be more available and more reliable. FFSs belonging to category I are in the first batch of

FFSs assisted by the project, and similarly, category II and category III are the second and third batches of FFSs graduated in 2002 and 2003, respectively.

Map of Myanmar

Table 1: List of selected FFSs under category I graduated in 2001

FFS No	FFS site	Location	Township and State
1.	Nawng Hkying	Myitkyina	Myitkyina township, Kachin State
2.	10 Miles	Myitkyina	Myitkyina township, Kachin State
3.	Gat Sha Yang	Myitkyina	Myitkyina township, Kachin State
4.	N-gan	Myitkyina	Myitkyina township, Kachin State
5.	Nawng Hkyi	Waimaw	Waimaw township, Kachin State
6.	Gara Yang	Waimaw	Waimaw township, Kachin State
7.	Ja Pu	Waimaw	Waimaw township, Kachin State
8.	Awng Mye Tit	Waimaw	Waimaw township, Kachin State
9.	Mai Sak Pa	Lai Za	Bhamo township, Kachin State
10.	Lawa Yang	Lai Za	Bhamo township, Kachin State

Table 2: List of selected FFSs under category II graduated in 2002

FFS No	FFS site	Location	Township and State
1.	Hka Wang	Myitkyina	Myitkyina township, Kachin State
2.	Pung Dung	Myitkyina	Myitkyina township, Kachin State
3.	Chyara Pati	Myitkyina	Myitkyina township, Kachin State
4.	Mali Hka	Myitkyina	Myitkyina township, Kachin State
5.	Mading	Waimaw	Waimaw township, Kachin State
6.	Katsu	Waimaw	Waimaw township, Kachin State
7.	Thing Nan Kawn	Waimaw	Waimaw township, Kachin State
8.	N-Myen	Waimaw	Waimaw township, Kachin State
9.	Ding Hkung	Lai Za	Bhamo township, Kachin State
10.	Nalung (lower)	Lai Za	Bhamo township, Kachin State

Table 3: List of selected FFSs under category III graduated in 2003

FFS No	FFS site	Location	Township and State
1.	Lahta Maw Hpang	Myitkyina	Myitkyina township, Kachin State
2.	Khan La	Myitkyina	Myitkyina township, Kachin State
3.	Nam Koi	Myitkyina	Myitkyina township, Kachin State
4.	Nan Nawn Pa	Myitkyina	Myitkyina township, Kachin State
5.	Jam Ga	Waimaw	Waimaw township, Kachin State
6.	Nam San	Waimaw	Waimaw township, Kachin State
7.	Sam Pai	Waimaw	Waimaw township, Kachin State
8.	Gang Dau	Waimaw	Waimaw township, Kachin State

9.	Dinga Yang	Lai Za	Bhamo township, Kachin State
10.	Daw Hpum	Lai Za	Bhamo township, Kachin State

Data collection and analysis process: Primary data regarding all the determinants of the study were collected through a structured questionnaire using open and closed-end questions. During observation and data-collection, different levels of farmers, both direct and indirect participants of FFS, community leaders, and project staff such as FFS facilitators, project coordinators, etc., were interviewed in groups and individually. To validate the data, in addition, focus-group discussions were concurrently organized with all levels of peoples in the communities.

The primary data were complemented and in some cases supplemented with secondary data compiled by the project staff at various times and stages of the project. Samples of data collection formats are available in the attachment. The data were systematically recorded and are presented in graphs, tables, figures, and plates, being analyzed using standard statistical procedures.

With all these the chapter has tried to present the project which made the basis for this study, as well as where this project was implemented, who were involved in this implementation. The chapter has also introduced the particular locations and period of the study as well as explained the data collection and analysis process. Based on such data, particular impacts of the project and the overall results of the study are presented in the next chapter.

Chapter 6
Results and discussions

6.1. Increased yields of rice on a unit-area basis

As an important part of the learning process, farmers who participated in the FFSs grew rice on their FFS study fields using different combinations of SRI practices. The yields obtained within those study-fields were compared with yields from traditional methods obtained from their own lands, where rice was grown using the conventional practices that same year. A comparison of yields with SRI practices within FFS study-fields with those from conventional practices on farmers' own fields was made in three consecutive years, from 2001 to 2003 as presented below.

Percent of yield increase within the FFS of category I in 2001

In the first year of the study, the comparisons of yield data obtained from 10 selected sites of category I FFSs in 2001 are presented in **Table 4.** These data indicate that the yields achieved within the FFS study-fields were significantly higher than farmers' traditional yields. The percentages of such increases within the FFS study-fields were found to range between 100 and 280 percent with the mean increase of 158 percent.

In these sites, farmers' traditional rice yields, considered as the baseline, ranged from 1.5 t/ha to 3 t/ha with a mean of 2.1 t/ha. Compared to these, the average SRI yields obtained within the FFS fields of all the 10 FFS ranged from 3 t/ha to 7.8 t/ha where the mean average was 5.4 t/ha.

Variations among the traditional yields of farmers within the selected sites were mainly due to local conditions, such as soil quality and water management practices which differed from one site to other. While the same reasons could be attributable to the yield differences within the SRI study-fields of FFS, there were other reasons such as the number and type of practices used within the individual study-fields that also contributed to those differences.

Table 4: Rice yields within FFS in 2001

FFS site	Rice yields (tons per hectare)		
	Baseline	FFS yield	% Increased
Nawng Hkying	2	5.0	150
10 Miles	2	5.4	170
Gat Sha Yang	1.8	6.8	280
N-gan	1.7	4.8	182
Nawng Hkyi	2	4.3	113
Gara Yang	3	7.5	150
Ja Pu	3	7.8	160
Awng Mye Tit	1.5	3.0	100
Mai Sak Pa	2	4.9	145
Lawa Yang	1.9	5.0	163
Mean	2.1	5.4	158

Percent of yield increase within the FFS of category-II in 2002

The pattern of yield increase observed in the second year of the study, within the 2002 FFSs, was found to be very similar to the one in 2001. According to the yield data presented in **Table 5**, farmers' average baseline yields in the selected sites ranged from 1.2-3 t/ha with a mean average of 1.9 t/ha, while the average SRI yields obtained within the FFS study-fields ranged from 2.9 – 12.4 t/ha, with the mean of 6.7 t/ha. This was a mean increase of 257 percent over farmers' baseline yield. The increases among individual FFSs ranged from 100–520 percent. This large variation could be for a number of reasons which are discussed later.

Table 5: Rice yields within FFS in 2002

FFS site	Rice yields (tons per hectare)		
	Baseline	FFS yield	% Increased
Hka Wang	2.0	12.4	520
Pung Dung	2.0	8.5	325
Chyara Pati	1.8	8.2	356
Mali Hka	1.7	6.5	282
Mading	1.7	3.7	118
Katsu	2.0	5.4	170
Thing Nan Kawn	3.0	11.9	297
N-Myen	2.0	5.2	160
Ding Hkung	1.2	2.9	142
Nalung (lower)	1.5	3.0	100
Mean	1.9	6.7	257

Percent of yield increase within the FFS of category-III in 2003:

In the third year, 2003, though there was some variation observed in terms of percentage, again great consistency was observed in terms of the patterns of yield increase that occurred within the FFS study-fields, like those observed in the two preceding years. The mean rice yield obtained within the study-fields of 2003 was found to be 216 percent higher than that of farmers' baseline yields. The percent of yield increase within the individual FFS ranged from 125 to 289 percent. Farmers' baseline yields within the selected sites ranged from 1.2 to 3.2 t/ha, with a mean of 2.2 t/ha; the yields within the FFS study-fields were found to be 2.7 to 9.2 t/ha, with a mean of 7.1 t/ha.

Table 6: Rice yields within FFS in 2003

FFS site	**Rice yields (tons per hectare)**		
	Baseline	FFS yield	% Increased
Lahta Maw Hpang	2.0	6.2	209
Khan La	2.0	7.2	260
Nam Koi	1.4	3.4	139
Nan Nawn Pa	2.3	7.5	226
Jam Ga	1.2	2.7	125
Nam San	2.6	7.7	196
Sam Pai	3.2	10.0	213
Gang Dau	3.2	9.2	188
Dinga Yang	2.3	8.9	289
Daw Hpum	2.3	8.5	269
Mean	2.2	7.1	216

The mean from 3 years

Based on comparisons between rice yields that farmers usually obtained on their fields using their own conventional methods and practices, and the yields that were obtained within the FFS study-fields using different practices of SRI, over the three consecutive years from 2001-2003, the overall trend of yield increase across the FFS as shown in **Table 7 and Figure 1** could be regarded as very consistent.

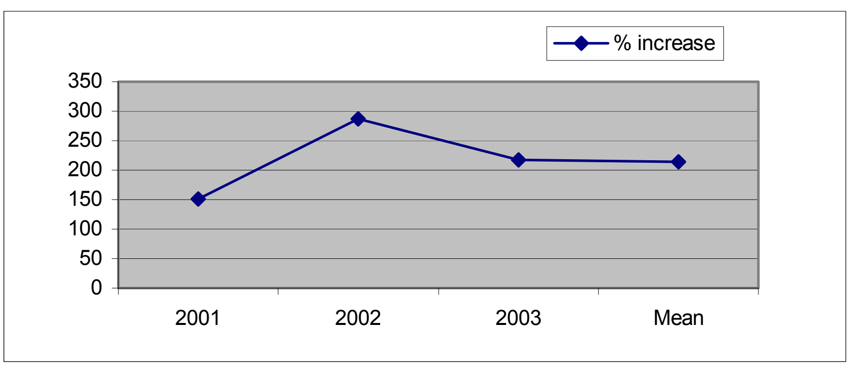
Table 7: FFS mean yields from 2001-2003

Year	**Rice yields (tons per hectare)**		
	Baseline	FFS yield	% Increased
2001	2.1	5.4	158
2002	1.9	6.7	257
2003	2.2	7.1	216
Mean	2.1	6.4	210

In 2001, the first year of FFS program, the mean percentage of yield increase within the FFS study-fields was found to be 158, and in the following year this increase was recorded as much higher, 257 percent, while in the third year it was 216 percent. The mean increase from the three years stood at 210 percent, which means the FFS yield was more than three times the farmer's baseline yield. This is undoubtedly a huge improvement.

One reason for which such a large improvement could be recorded would be that farmers' baseline yields within the selected sites were unusually low. However, the mean baseline yield of 2.1 t/ha is in fact the average across the entire country, and specifically the average in Kachin State where the study was conducted.

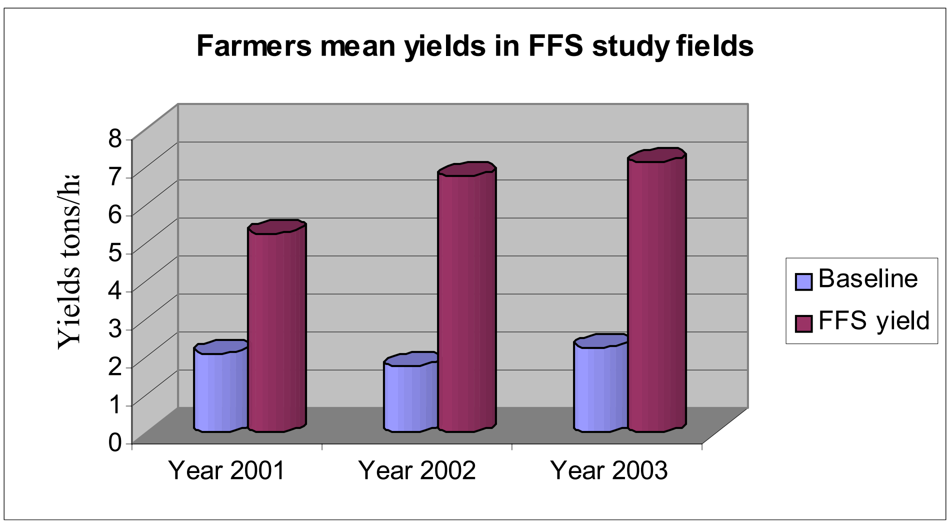
Figure 1: The pattern of yield increase in terms of percentage, 2001-2003



Part of the reason for such low yields generally is that farmers usually do not apply any manure in their rice paddies, nor do they use any chemicals. The seeds they use are not pure selections, and they usually use very old, tall and weak seedlings. The resultant low yield is the cumulative effect of all of these old and traditional practices.

Another reason that may have helped improve the yields so drastically was that farmer's traditional practices involved no application of chemical fertilizers on their fields, so there would have been no chemical suppression or inhibition of soil biota. The achievement of higher yields without any use of chemicals appears consistent with experiments conducted in Brazil with sugarcane, noted in Chapter 5, that plants in Gramineae family can benefit from the fixation of free atmospheric nitrogen in their rhizosphere through processes of BNF in soils that have a long history of no inorganic N being applied compared to ones that were supplied with inorganic nitrogen. To get such vigorous yields as recorded with SRI in the FFS field-study fields, there had to be considerable BNF or other kinds of N cycling, since they were not obtained with the use of any chemical nitrogen from outside.

Figure 2: Rice yields in FFS study-fields



Although some variation was observed in terms of the percentage of average yield increase in the different years, this could easily be attributable to the diversity of local conditions such as soil, water and climate, as mentioned earlier. Besides, in the first year, the FFS facilitators were not as confident in their use of SRI methods as they became later in the second and third years of FFS experience. Therefore, the lowest percent of yield increase observed in the first year could be due to the limited competency of the facilitators in their guiding the farmers to establish effective field studies.

Table 8: The highest and the lowest percentage of yield increase

Year	Percent of yield increase		
	lowest	highest	average
2001	100	182	158
2002	100	520	257
2003	125	289	216

There were sharp variations observed in the percent of yield increases that occurred between the FFS on their study-fields in each of the three years at all the selected study sites. Though a number of factors could be responsible for this difference, the main factors that contributed were the numbers and types of practices that farmers used within each of the FFS fields. Generally, as described in Chapter 5, SRI is comprised of a number of practices which are basically governed by some underlying principles, and the use of such practices was not uniform in all the FFSs. During the regular learning session of FFSs, farmers were informed about those underlying principles, and accordingly they decided, based on their level of understanding and knowledge base, what practices and how many practices they thought would be suitable in their conditions. As a result, the number and type of practices that farmers used within the FFS study-fields varied from one FFS to another, as analyzed and evaluated below.

In addition to SRI, the use of rice variety and quality seeds also made some contribution to the yield increases, and their use was also not uniform within all the FFSs. Based on such differences, therefore, the percent of yield increase from one FFS to another varied noticeably. How much yield difference is possible for using such diverse practices, and how much contribution a single practice could make when it is used alone or together with other practices in different combinations is addressed in the following sections.

6.2. Production increase per family

Production increase is the ultimate benefit that farmers usually derive from FFS participation. Such increases in production could be considered as one key indicator to determine the effectiveness of FFSs. In the first year of FFS, farmers are usually engaged in learning together through growing crops within the study-fields of FFS. In the previous section, the results of farmer's learning about SRI were presented and discussed in terms of their improving rice yields within the FFS study-fields. This section considers results in terms of their impact on farmers' own rice production when their FFS learning was applied on their own fields. It needs to be mentioned here that farmers usually applied their FFS learning on their own fields in the following year, although few of them already began applying SRI methods in the same year that they were learning these.

Farmers' abilities to increase their own rice production were studied in terms of the amount of extra production that they derived on a per-household basis after use of the FFS practices, notably SRI, on their own fields. Farmer's such abilities were studied in three consecutive years from 2002 to 2004 on the basis of the total volume of rice that they produced before FFS training and after FFS participation.

Amount of rice increased per family in 2002 under category-I FFS

This category represents the first batch of FFS farmers who graduated in 2001, looking at the farmers' volume of production recorded in 2002 as this was the first year when all could apply their learning on their own fields. Based on the data collected from the selected sites **(Table 9)**, it was evident that farmers gained tremendous ability to enhance their own production to a significant degree. Before they participated in FFS, their average rice production varied between 1,700 kg and 2,700 kg/household, with a mean of 2,188 kg/household. One year after graduation from FFS, they were able to raise their rice production to the level of 3,700 kg to 4,500 kg/household, with the mean average of 4,152 kg/household. This indicated a net increase of from 1,600 kg to 2,500 kg of rice for those households in the communities that participated in FFSs, with a mean increase of 1,964 kg/household.

Table 9: Average increase in amount of rice produced by individual FFS families in 2002 after their graduation in 2001

FFS site	(N)	Production of rice per family in Kg		
		Before FFS	After FFS	Added production
Nawng Hkying	24	2200	4000	1800
10 Miles	20	2000	3900	1900
Gat Sha Yang	18	2050	4150	2100
N-gan	22	1700	4200	2500
Nawng Hkyi	20	2700	4300	1600
Gara Yang	15	2300	4300	2000
Ja Pu	23	2700	4700	2000
Awng Mye Tit	18	1900	3800	1900
Mai Sak Pa	23	2100	3700	1600
Lawa Yang	19	2200	4500	2300
Mean	202	2188	4152	1964

Amount of rice increased per family in 2003 under category–II FFS

In the second year of the production study, based on the yield data plotted in **Table 10,** farmers who graduated in the second batch of FFSs in 2002 were able to raise their mean average from 1,948 kg/household to 4,186 kg/household with an average increase of 2,237 kg/household. Before they participated in FFS, their average baseline yields were 1,700 kg/household to 2,200 kg/household. After one year, in 2003 these averages were raised to 3,800 kg to 4,600 kg per household.

Table 10: Average increase in amount of rice produced by individual FFS families in 2003 after their graduation in 2002

FFS site	(N)	Production of rice per family in Kg		
		Before FFS	After FFS	Added production
Hka Wang	20	2100	4300	2200
Pung Dung	18	2000	3800	1800
Chyara Pati	22	1950	4300	2350
Mali Hka	20	1800	4000	2200
Mading	22	1700	3900	2200
Katsu	20	1900	4450	2550
Thing Nan Kawn	18	2200	4600	2400
N-Myen	20	1900	4300	2400
Ding Hkung	18	2100	3900	1800
Nalung (lower)	20	1900	4300	2400

Mean	198	1948	4186	2237

Amount of rice increased per family in 2004 under category–III FFS

The pattern of production increase in the third year within the third batch of FFS graduates in 2004 was found to be very similar to that the first and second batches of FFSs made in the first and second year of the study, respectively. In this third batch, the FFS farmers who graduated in 2003 gained a net mean increase of 2,185 kg/household of extra rice compared to their previous production mean which was 1,995 kg/household. The average production that farmers achieved on their fields after their graduation ranged from 3,800 kg to 4,800 kg per household, providing a net increase of 1,600 kg to 2,700 kg/household.

Table 11: Average increase in amount of rice produced by individual FFS families in 2004 after their graduation in 2003

FFS site	**(N)**	**Production of rice per family in Kg**		
		Before FFS	After FFS	Added production
Lahta Maw Hpang	20	2000	4000	2000
Khan La	22	2000	3800	1800
Nam Koi	20	2200	4400	2200
Nan Nawn Pa	20	1800	4200	2400
Jam Ga	24	2000	4300	2300
Nam San	19	2100	4800	2700
Sam Pai	20	2000	4500	2500
Gang Dau	25	1900	4000	2100
Dinga Yang	20	2200	4200	1600
Daw Hpum	22	1800	4100	2300
Mean	212	1995	4218	2185

The mean from 3 years:

From the production data presented in **Tables 9-11,** great consistency has been observed in the overall trends of production increase. In a three-year consecutive study, >600 farmers within 30 different sites (10 sites from each year) were seen to maintain a very similar pattern of production increase, with no fluctuation in any of the years. This indicates the great skills that farmers achieved from FFS sessions as the result of their participation.

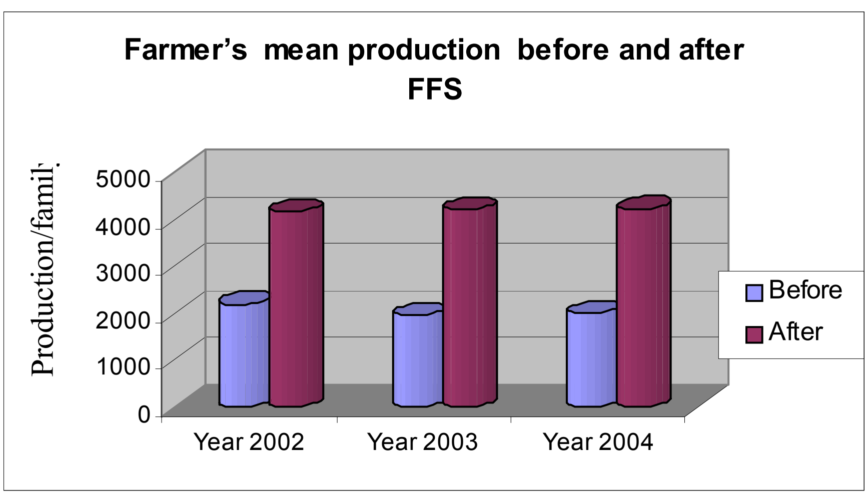
It appears from the three years of consolidated data presented in **Table 12** that farmers' mean production per household, which seemed to be pretty similar in almost all the sampled sites before they participated in FFS, was just little over than 2 tons. After their FFS participation, this production mean was more than doubled, to more than 4 tons per household.

Table 12: Mean production increase per FFS family over three years, 2002-2004

Year	(N)	Production of rice per family		
		Before FFS	After FFS	Added yield
2002	202	2188	4152	1964
2003	198	1948	4186	2237
2004	212	1995	4218	2185
2002-04	612	2043	4186	2129

An important characteristic of this large production increase is that it happened not just for a few individuals or a handful of farmers within the FFS; rather all the farmers who participated in FFSs, irrespective of their categories, size of landholdings, and their resource endowments, were able to make significant production gains, though there were some variations among families in terms of the amount of production gains accessed by an individual family. This is to be expected since the resource endowment and the financial and technical capacity of all farm households within the community are not the same.

Figure 3: Farmers production of rice before and after FFS



A number of other factors could account for the variations of individual farmers' production gains. Within the FFS cohorts, on average a farm family was found to grow rice on around 1.5 hectares of land. Although a majority of the farmers gained the production increase from this same area, in some sites some farmers were found to expand their production to new lands, while in other sites some were seen to reduce their production area with more intensive practices applying SRI on some limited land, which they learned was more effective while participating in the FFS. This was also an important reason for variations in production increases. Another reason could be soil quality. In some sites the soils were very fertile where with similar management practices, production increases were found to be higher than in other sites. The number and the types of practices adapted by individual farmers, as mentioned before, could also be some good reasons for the variation.

Whatever the case may be, this large production increase achieved by all the FFS farmers points out two important facts; one, the effectiveness of the technologies that made such increase possible, and two, the effectiveness of the learning process provided through FFSs that made it possible for all the farmers to adopt the new methodologies on their own fields. The combined effect of both could be explained as the result of the simplicity and productivity of the technologies communicated through the regular interaction of farmers facilitated by the process of experimentation in FFS. How this interaction and experimentation influenced the farmers' knowledge base and decision-making, and to what extent they were able to utilize the learning and the corresponding technologies, will be discussed in the coming sections based on the specific results of farmers' experimentation.

6.3. Changes in farmers' cost of production and net return

Cost of production was studied in terms of cost of seeds, seedlings, plowing, and labor needed for transplanting, weeding, harvesting and threshing of rice in three consecutive years from 2002 to 2004. In addition, the value of land rental was considered. There was no cost calculated for irrigation since rice was grown only in wet season when farmers did not apply any irrigation. Net income was computed based on the amount of harvested rice only. Both the cost and the return were computed in terms of kilograms (kg) of rice since the rice price was not stable due to heavy fluctuation of local currency values. The conversion rate of Myanmar local currency was also not very stable. So it is better to make comparisons in real terms, i.e., physical volumes, rather than in financial terms, i.e., monetary values.

6.3.1. Cost and return in terms of unit area of land

Farmers' per-unit production cost and return in 2002 for category-I FFS

In the first year of the study, based on the computed cost and return analysis done before FFS (in 2001) and after FFS (in 2002), while there had been tremendous differences noticed in farmer's net incomes, the production costs either remained pretty similar or were reduced to some extent with no sharp differences in the amounts before and after the FFS at all **(Table 13)**.

Table 13: Unit cost of production and net return of farmers in 2002

FFS	(N)	Production cost (kg/ha)			Yield (kg/ha)		Net income (kg/ha)		
		Before FFS	After FFS	% change	Before FFS	After FFS	Before FFS	After FFS	Increase
Nawng Hkying	24	1740	1820	4.6	2000	5000	260	3180	2920
10 Miles	20	1720	1820	5.8	2000	5400	280	3580	3300
Gat Sha Yang	18	1600	1750	9.4	1800	4900	200	5090	4890
N-gan	22	1620	1750	8.0	1700	4800	80	3050	2970
Nawng Hkyi	20	1700	1800	5.9	2000	4250	300	2450	2150
Gara Yang	15	2500	1820	-27.2	3000	7500	500	5680	5180
Ja Pu	23	2500	1800	-28.0	3000	7800	500	6000	5500
Awng Mye Tit	18	1700	1750	2.9	1500	3000	-200	1250	1450
Mai Sak Pa	23	1800	1800	0	2000	4900	200	3100	2900
Lawa Yang	19	1850	1800	-2.7	1900	5000	50	3200	3150
Mean	202	1865	1791	-4.0	2084	5422	219	3631	3412

Before farmers started their FFS experience, they needed to spend on average 1,865 kg of rice to cultivate one hectare of land, and with this expenditure they could make back only a net additional income of 219 kg of rice. Compared with this, after they had participated in the FFS and learned SRI methods, they needed to spend on average a lesser amount of rice (1,791 kg/ha), and with this lesser expenditure, they were able to make a net additional income of 3,631 kg/ha of rice, with 3,412 kg/ha more income than previously. Results were similar the next year.

Farmers' per-unit production cost and return in 2003 for category-II FFS

The levels of cost and return found for the second year in 2003 were pretty similar to those found in 2001. According to the collected data and the computed cost and return analysis done in 2003, FFS farmers, after the FFS, were found to be making a net benefit of 4,926 kg/ha from rice with 4,757 kg as the mean extra income, compared to 169 kg/ha of rice as the net income before the FFS with their convention practices. In their production costs, only a small difference was noticed, which was not significant at all.

Table 14: Unit cost of production and net return of farmers in 2003

FFS	(N)	Production cost (kg/ha)			Yields (kg/ha)		Net income (kg/ha)		
		Before FFS	After FFS	% change	Before FFS	After FFS	Before FFS	After FFS	Increase
Hka Wang	20	1740	2040	17.2	2000	12400	260	10360	10100
Pung Dung	18	1720	1840	7.0	2000	8500	280	6660	6380
Chyara Pati	22	1640	1740	6.1	1800	8200	160	6460	6300
Mali Hka	20	1600	1740	8.8	1700	6500	100	4760	4660
Mading	22	1600	1660	3.8	1700	3700	100	2040	1940
Katsu	20	1720	1820	5.8	2000	5400	280	3580	3300
Thing Kawn	18	2040	1900	-6.9	3000	11900	960	10000	9040
N myen	20	1700	1760	3.5	2000	5200	300	3440	3140
Ding Hkung	18	1680	1720	2.4	1200	2900	-480	1180	1660
Nalung (lower)	20	1740	1780	2.3	1500	3000	-240	1220	1460
Mean	198	1713	1797	4.9	1882	6723	169	4926	4757

Farmer's per-unit production cost and return in 2004 for category-III FFS

In the third year of the cost and return study done in 2004, the pattern of cost and return was also found to be very similar to those in the two preceding years. According to the study, farmers' mean production cost before they started FFS, calculated based on what they spent in 2003, was found as 1,794 kg/ha, as against 1,798 kg/ha after the FFS, calculated based on what was spent in 2004. This means there was no difference between the costs of rice production before and after the FFS. On the other hand, a very great difference was noticed in net income, which was 5,306 kg/ha after the FFS as against 455 kg/ha before the FFS, enabling each family to gain on average of 4,852 kg more income from each hectare of land.

Table 15: Unit cost of production and net return of farmers in 2004

FFS	(N)	Production cost (kg/ha) Before FFS	After FFS	% change	Yields (kg/ha) Before FFS	After FFS	Net income (kg/ha) Before FFS	After FFS	Increase
Lahta Maw Hpang	20	1640	1720	4.9	2000	6170	360	4450	4090
Khan La	22	1750	1720	-1.7	2000	7200	250	5480	5230
Nam Koi	20	1620	1720	6.2	1400	3350	-220	1630	1850
Nan Nawn Pa	20	1720	1740	1.2	2300	7500	580	5760	5180
Jam Ga	24	1600	1740	8.8	1200	2700	-400	960	1360
Nam San	19	2040	1920	-5.9	2600	7700	560	5780	5220
Sam Pai	20	2240	1980	-11.6	3200	10000	960	8020	7060
Gang Dau	25	1820	1840	1.1	3200	9230	1380	7390	6010
Dinga Yang	20	1740	1820	4.6	2300	8940	560	7120	6560
Daw Hpum	22	1820	1800	-1.1	2300	8490	480	6690	6210
Mean	212	1794	1798	0.22	2249	7104	455	5306	4852

Mean from three years

Data derived from three consecutive years, from thirty different locations **(Tables 13-15),** clearly shows the superiority of the FFS/SRI practices over farmers' traditional practices in terms of enhancing their net incomes to a very significant level **(Table 16).** Over the three-year period within the FFS program, great consistency has been observed in the enhanced net incomes of farmers, with no decreasing trend. Also, there has been no record of any significant increase in production cost compared to their previous conditions, while in many sites the cost of production has instead declined.

Table 16: Mean unit cost of production and net return of farmers from 2002 -2004

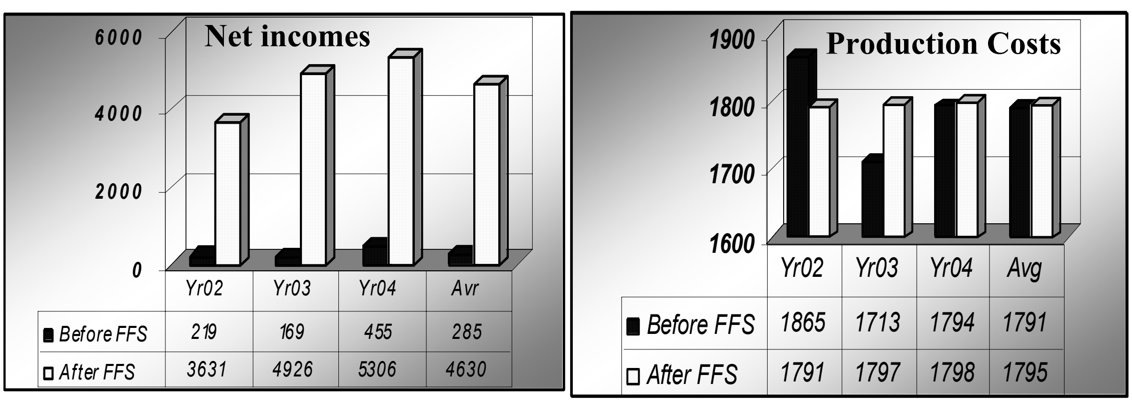
Year	(N)	Production cost (kg/ha) Before FFS	After FFS	% Change	Rice yields (kg/ha) Before FFS	After FFS	Net income (kg/ha) Before FFS	After FFS	Increase
2002	202	1865	1791	-4.0	2084	5422	219	3631	3412
2003	198	1713	1797	4.9	1882	6723	169	4926	4757

2004	212	1794	1798	0.2	2249	7104	455	5306	4852
Mean	612	1791	1795	0.2	2076	6425	285	4630	4346

With no additional expenditure, farmers' mean net incomes were enhanced tremendously. This enabled them to gain on average an additional income of 4,346 kg/ha of rice compared to their previous conditions before participating in the FFS process. The mean net income from the three-year average was found to be 4,630 kg/ha calculated in term of the volume of rice they produced after the FFS, as compared with 285 kg/ha before the FFS.

This overall result of cost and return analysis indicates that the SRI methods used within FFS to enhance the production of rice were absolutely low-cost; indeed, farmers did not incur any additional cost. This is contrary to what has been common with the conventional approach to agricultural improvement, where to enhance or maximize yields, each unit of production/yield increase required a corresponding incremental cost. Most of the technologies used within the FFS are unlike those used with conventional methods; they have no environmental or ecological cost, nor are there any health risks associated with their use, which is very common when using chemicals with the conventional methods.

Figure 4: Farmer's production costs and net incomes before and after FFS



The results of the use of the technologies have revealed another crucial finding which is contrary to people's general belief that low-cost technologies are not very effective when large-scale yield increases are needed. The steady and very consistent experience of yield increase on a unit area basis, production increase per family, and finally, net income increase per unit area basis, were all very significant over three consecutive years in a large number of experimental sites (>600).

This should undermine that general belief. The technologies and the practices that farmers used within the FFS are being presented and discussed in the coming chapters.

Another emerging finding is that since SRI requires careful transplanting, many believed that this will require more labor, and that there must be an increase in production cost. This sounds logical to people who have no practical experience with SRI; actual experience with SRI in this study tells a different story. Although there is tendency for some labor requirement to increase somewhat at the beginning, to do careful transplanting, this small amount of extra labor does not really add significantly to the overall cost of SRI production because there are other offsetting savings and gains. This has been consistently seen in three consecutive years during the study.

6.3.2. Cost of production in terms of unit volume of rice produced

The cost of production when calculated on per unit volume of rice gave a very different picture from the common method of cost calculation which is on an area basis, using acre or hectare as the denominator for calculation. In fact, the calculation of costs and returns in terms of the unit volume of rice produced as a result of their expenditure gives farmers a better idea about real costs, as the volume of production is the ultimate desire of farmers who are cultivating rice, not just how many acres of rice they cultivate. With unproductive traditional methods, farmers must expend almost as much rice as they get from their fields in return.

Table 17: Cost of production for production of one ton of rice before and after FFS

Sites	2002			2003			2004			2002-2004		
	(N)	B	A	(N)	B	A	(N)	B	A	(N)	B	A
Site-1	24	870	364	20	870	165	20	820	279	64	853	269
Site-2	20	860	337	18	860	216	22	875	239	60	865	264
Site-3	18	889	357	22	911	212	20	1157	513	60	986	361
Site-4	22	953	365	20	941	268	20	748	232	62	881	288
Site-5	20	850	424	22	941	449	24	1333	644	66	1041	506
Site-6	15	833	243	20	860	337	19	785	249	54	826	276
Site-7	23	833	231	18	680	160	20	700	198	61	738	196
Site-8	18	1133	583	20	850	338	25	569	199	63	851	373
Site-9	23	900	367	18	1400	593	20	757	204	61	1019	388
Site-10	19	974	360	20	1160	593	22	791	212	61	975	388

Av	202	895	330	198	910	267	212	798	253	612	868	283

B = Before FFS, A = After FFS, (N) number of farmers

According to the data presented in **Table 17**, where the production cost of rice was presented on the basis of production cost per ton of rice grown before FFS with farmer's traditional methods, and after FFS with SRI methods, farmers' average production cost of rice after FFS was found to be simply one-third of what they used before. This means the production cost of rice grown with SRI method is generally three times lower than that of farmers' conventional methods over the three years of the study from 2001 to 2003.

This finding about the costs and returns associated with the different methods of production, particularly the advantage from SRI, surprised FFS participants who initially thought that SRI was costlier than their usual methods. Farmers, on average, in the study area grow rice on around 1.5 hectares area, and before FFS training using their traditional methods used to spend 2,687 kg to produce about three tons of rice (based on the data presented in **Table 16**). Now after the FFS, using SRI methods they are able to produce a similar amount of rice from that area by spending only about 849 kg of rice; with that amount of expenditure on production, they can get 6-7 tons of rice.

6.4. The pattern of yield stability with graduated FFS participants over 3 to 4 years

Based on the results presented in the previous sections, it is clear that the practices that promulgated within FFSs are highly effective to enhance the yields, production, and net income of farmers. The following section presents the status of yield stability observed over several years on farmers' fields after they started using the new practices. To study yield stability, rice yields were recorded within the same FFS for a two- to four-year period from 2001 to 2004, based on the duration of farmers' participation in the project as described already. It needs to be mentioned here that while most of the farmers began using the new practices that they learned from FFS on their fields in the next year, some farmers started using the new practices on their own fields in the same year simultaneously with the practice on FFS study-fields. This provided an opportunity to study yield stability since the beginning year of FFS in each of the selected sites.

The pattern of rice yields and their stability in category-I FFSs

As the first batch of FFSs started in 2001, there has been an opportunity to the study the yield patterns for some four-year periods since the beginning of FFS. The yield pattern observed in this batch from 10 selected sites **(Table 18)** appears to be very stable with no declining trend at all.

Table 18: Farmers' mean SRI yields of rice on own fields, by FFS, after graduation in 2001

FFS	(N)	Yields (tons/ha) in graduation year 2001	(N)	Yields (tons/ha) after graduation year		
				Year 1	Year 2	Year 3
Nawng Hkying	4	4.3	24	4.5	5.0	4.9
10 Miles	4	4.0	20	4.25	4.0	4.25
Gat Sha Yang	5	4.25	18	4.0	4.2	4.25
N-gan	4	4.5	22	4.75	4.5	4.75
Nawng Hkyi	3	4.0	20	4.5	4.5	5.0
Gara Yang	4	3.5	15	4.0	4.5	4.5
Ja Pu	6	4.65	23	5.25	6.0	5.5
Awng Mye Tit	3	2.0	18	2.5	2.75	3.0
Mai Sak Pa	5	2.5	23	4.0	4.25	4.25
Lawa Yang	3	3.0	19	4.5	4.5	4.5
Mean	41	3.75	202	4.27	4.47	4.53

The mean yield obtained by farmers who applied the practices on their own fields at the same time with the FFS study-fields in 2001 was found to be 3.75 t/ha; in the following years up to 2004, their mean averages were found to be 4.27 t/ha, 4.47 t/ha and 4.53 t/ha, respectively.

The pattern of rice yields and their stability in category-II FFSs

In the second batch of FFSs, yield stability could be evaluated over a three-year period. In 2002, the first year of FFS, farmers' mean yield was observed to be 3.56 tons/ha **(Table 19)** followed by average yields of 4.08 t/ha and 4.64 t/ha in 2003 and 2004, respectively, which shows a very similar pattern to that seen in the previous batch of FFSs.

Table 19: Farmers' mean SRI yields of rice on own fields, by FFS, after graduation in 2002

FFS	(N)	Yields (tons/ha) in graduation year 2002	(N)	Yields (tons/ha) after graduation year	
				Year 1	Year 2
Hka Wang	2	2.5	20	3.0	3.0
Pung Dung	4	3.0	18	3.5	3.75
Chyara Pati	3	2.0	22	2.25	2.5
Mali Hka	6	3.0	20	3.5	4.5
Mading	2	5.0	22	6.0	6.5
Katsu	4	5.5	20	5.5	6.0
Thing Nan Kawn	3	3.75	18	5.5	6.0
N-myen	5	4.0	20	4.1	4.7
Ding Hkung	3	3.0	18	4.0	4.5
Nalung (lower)	3	3.75	20	3.5	5.0
Mean	35	3.56	198	4.08	4.64

The pattern of rice yields and their stability in category-III FFSs

The pattern of yield increase in the third batch of FFSs, which started in 2003, was also found to be similar to that of the first and the second batches of FFSs. Based on the recorded data over a two-year period - the graduation year and the next year after the graduation - rice yield was found to be stable with an increasing trend in the second year. Farmer's mean yield in the graduation year was found as 4.07 tons/ha, while in the following year, the average increased to 4.76 tons/ha **(Table 20)**.

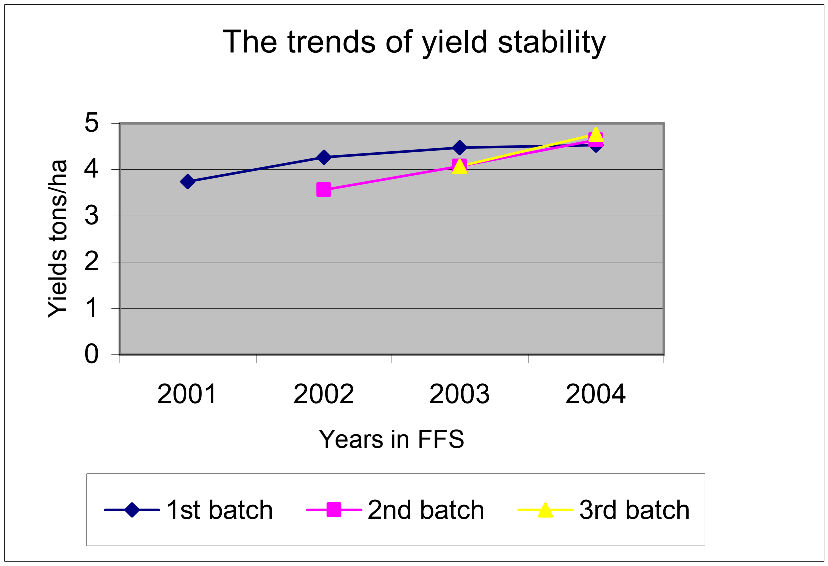
Table 20: Farmers' mean SRI yields of rice on own fields, by FFS, after graduation in 2003

FFS	(N)	Yields (t/ha) in graduation year 2003	(N)	Yields (tons/ha) after graduation year
				Year 1
Lahta Maw Hpang	3	3.5	20	4.2
Khan La	2	3.0	22	3.5
Nam Koi	5	3.0	20	3.5
Nan Nawn Pa	3	2.9	20	3.5
Jam Ga	4	5.5	24	6.5
Nam San	5	5.0	19	6.0
Sam Pai	3	5.0	20	6.0
Gang Dau	2	5.5	25	5.0
Dinga Yang	3	3.5	20	4.75
Daw Hpum	3	3.5	22	4.5
Mean	33	4.07	212	4.76

Overall yield stability

Based on all the figures obtained from 30 selected sites of three batches of FFSs, rice yield across the FFSs was found at least stable and generally increasing **(Figure 5)**. The plotted yield lines presented in the figure below show the upward trends for each batch of FFSs studied, indicating that the yields were not only stable but gradually improved.

Figure 5: The trends of stability of enhanced rice yields in farmer fields



This overall result of yield stability (and improvement) indicates that FFS farmers, even after the withdrawal of FFS support, are confident and able to maintain the rice yields that they acquired on their own fields in the graduation year of FFS. Farmers' confidence is a reflection of the quality of skills and the kind of knowledge that they acquired from their regular participation in FFSs. From this, one can see the longer-term effect of the FFS approach, especially how it is contributing, one can infer, to the development of human quality.

The resulting yield stability within the FFS reveals another important fact about the technologies, especially the practices of SRI, as to how effective they are in maintaining the yield standard without any decline. This is very rarely seen with many traditional and conventional methods/practices.

As the world is moving forward and as science and technologies are advancing faster, the issues regarding environmental decline, deterioration of natural ecosystems or agroecosystems, degradation of soil systems, contamination of water, with their ultimate effects on human health as described in Chapter 1, are becoming more determining factors, affecting whether or not a technology should be considered as sustainable, in addition to its capacity to increase yield. For a particular technology, the overall issue of sustainability is now more important to farmers than just simply ability to increase production. It is not just a matter of whether they can afford the direct costs, but are there other incremental costs to the growing environment, affecting soil, water, pests and diseases which they could no longer afford to carry on.

In all these respects, the SRI practices that farmers have learned within the FFSs can be regarded as highly sustainable in that there was no yield decline noticed in any of the four years of the study at any of the 30 selected sites, with a total of 612 farmers. The practices proved to be low-cost as already seen in the previous sections. They do not include any use of chemicals that can damage the growing environment. The particular characteristics of each of the practices, however, are discussed in the coming sections.

6.5. The use of new technologies and their contribution toward yield increases

During the course of each FFS, farmers were taught a wide range of technologies such as the use of good quality seeds, how to grow better quality seedlings, selection of good rice varieties, the various practices associated with SRI, compost use, preparation and use of indigenous microorganisms (IMOs), preparing fruit juice and plant juice, using green manures, and many practices to control insect and disease infestations. The use of these technologies/practices was left up to the choice and decisions of the farmers based on their perceived needs and capabilities. This meant that there was some variation from one FFS to another in terms of which practices were chosen for use by farmers. All chose to use SRI practices on their farms once they had seen the results at the FFS plot, but which SRI practices they would use was a matter for them to decide. Although farmers generally believed that all the technologies were useful to improve rice production, as the use of all of the technologies could be found in among the graduates of any single FFS, though in a variable rank-order, farmers generally gave priority to the use of certain technologies/practices. The three most popular innovations were SRI, the selection of better quality seeds, and choosing a good rice variety.

A large percentage of farmers in each FFS were found to use all three of these technologies, which they believed to be the most effective ones to improve rice yields. This study, therefore, focuses on these three specific technologies and tried to find out their adoptions and respective contributions to improving rice yields. To study the scale of adoption and the percent of contribution of the selected technologies within the FFSs in three consecutive years from 2002 to 2004, in each year two FFS were selected for intensive study. This was done because studying all 612 farmers in the overall sample in such detail was not feasible; this 20% sub sample covered 124 farmers, which is quite a substantial number to track. The data presented below are the averages from those 6 FFS, 2 from each year.

6.5.1. The use of new technologies and farmers' subsequent yield increase

In the first batch of FFS of category-I FFSs

According to the data available from the 2 FFSs in 2002, 22 farmers on average were found to be practicing 1 to 3 technologies at a time in each FFS **(Table 21)**. Among them, 9 were found to be using better quality seeds and SRI, 4 used higher quality seeds and a better variety, and 1 using better variety and SRI, with 2 using all 3 practices. The rest of the farmers were found using a single practice, either higher quality seeds, better variety, or SRI.

Table 21: Number of farmers using the new practices and their percentage of yield increases from 2002 to 2004

Practice	(N)	02	AF	(N)	03	AF	(N)	04	AF	(N)	02-04	AF
Better quality seed only	6	30	3	6	25	3	6	28	3	18	$28±1^{e}$	3
Better variety only	2	20	1	2	15	1	2	20	1	6	$18±1^{f}$	1
SRI only	4	150	2	6	150	3	6	130	3	16	$143±3^{c}$	3
Higher quality seed + better variety	8	70	4	4	65	2	6	70	3	18	$69±1^{d}$	3
Higher quality seed + SRI	18	200	9	14	190	7	12	170	6	44	$189±2^{b}$	8
Better variety + SRI	2	200	1	4	180	2	4	180	2	10	$184±3^{b}$	2
Higher quality seed + better variety + SRI	4	250	2	4	270	2	4	240	2	12	$253±4^{a}$	2
Total	44		22	40		20	40		21	124		21

AF = Average number of farmers per FFS, (N) = total number of farmers from 2 FFS, 02 = % of yield increase in year 2002, 03 = % of yield increase in 2003, and 04 = % of yield increase in 2004. $^{a, b, c, d, e, f}$ = level of significance according to Duncan's multiple range test.

All the technologies, used either singly or in combination with others, were found to provide significant contribution to yield increase, ranging from 20 to 250% based on their types and numbers used together. Among the farmers, 12 were found with more than 200% yield increase, while only one had just a 20% increase. The contribution of yield increases was found to be higher when all three technologies were applied together. Among the technologies, SRI was found to provide the greatest yield benefits, and such benefits went up further when SRI was applied with other technologies.

In the second batch of FFS or category II FFSs

In 2003, the use and contribution of new technologies was found to be very similar to that in 2002. In the selected FFSs from 2003, 20 farmers on average were found using the technologies, and they experienced 15 to 270% yield increases **(Table 21)**. Among them, 2 farmers used three technologies and experienced 270% yield increase. Out of 22, 14 farmers were able to make more than 150% yield improvement, and similar to 2002 most of this yield increase came from the use of SRI. 7 farmers were found using a single practice. Among them, only the improvement of 4 farmers was found to be low compared with the other farmers in the FFS.

In the third batch of FFS or category-I FFSs

In 2004, 21 farmers on average were found to be using the new technologies on their own fields, concurrently with their FFS exercises, making 20 to 240% yield increases on their farms. Among them, 10 were able to make more than a 170% yield increase, and from the rest, 3 were found to be making 130% increase **(Table 21)**. The yield increases for other 8 were between 20% and 70%. 13 farmers were found to be using more than 2 technologies. As with other farmers, most yield improvement came through the use of SRI, and the next best contributing practice was better quality seed**.**

The mean from three years

The picture drawn from the 6 FFSs in 3 consecutive years indicates great consistency both in terms of adoption of the technologies by the farmers as well as their particular contributions to yield increase. The small percentage of variation observed in each year can be attributed to the local conditions such as the quality of soils, rice varieties, and some persistence with the usual management practices of rice. Farmers across these 6 FFS were found to use more than 10 different rice varieties.

More than half of the farmers were found to be using more than two technologies at a time of our survey. The use of three technologies provided the highest percent yield increase, while SRI as a single innovation made the highest contribution. This was consistently found over the three years. The yield increases of around two-thirds of the farmers in each FFS were between 143 and 253 percent, with the rest between 19 and 69 percent. Farmers who used either better quality seeds or improved rice variety as a single technology experienced smaller percentages of yield increase than with SRI.

6.5.2. Joint contributions of higher quality seeds, better variety, and SRI to yield increase

Among the three particular technologies adopted by farmers, there has been a great variation observed in terms of their respective contributions to yield increase. The contribution of a particular technology varied from its single use to its combined use with other technologies. For example, the contribution of better quality seed to increased rice yield was found to be higher when it was used with SRI or with a better rice variety, or with both of them, than when used alone. This was also the case with better rice variety and SRI. Here we elaborate on the results presented in the previous section (Table 21). Table 22 gives some quantified comparison of the individual contributions of better quality seeds, better rice variety, and SRI as found in various combinations among themselves as presented below.

Table 22: Levels of significance

Practices	N	Subset for alpha = .05					
		1	2	3	4	5	6
Better variety only	6	18.33					
Higher quality seed only	18		27.66				
Higher quality seed + better variety	18			68.88			
SRI only	16				142.50		
Better variety + SRI	10					184.00	
Higher quality seed + SRI	44					188.64	
Higher quality seed + better variety + SRI	12						253.33
Sig.		1.000	1.000	1.000	1.000	.223	1.000

Contribution of higher quality seeds

Based on its use, either in single or in combination, the contribution of better quality seed to yield increase was found to range from 28 to 69% (Table 23). The highest increase was found when quality seed was used with good rice variety and with SRI. Not surprisingly, good quality seeds contributed more to yield increase when rice was grown with an appropriate variety and using SRI practices. The second highest increase with good quality seed was found when it was used with a good rice variety. The contribution of good quality seed was definitely higher when used with good rice variety and also higher when used with SRI than in use by itself.

Table 23: Contribution of good quality seeds

Contributions of good quality seeds in percent from			
Quality seeds alone	Seeds and variety	Seeds and SRI	Seeds, variety and SRI
28%	50%	46%	69%

The contribution of quality seed alone was found to be 28%, which is less than half of what was obtained in the best combination. This indicates that good quality seed has great synergistic effect when combined with other important yield-contributing practices. One thing needs to be mentioned here; although the contribution of quality seed, when used alone, apparently seems lower, compared with other countries where the baseline yield is already more than 5 tons/ha, a 28 percent yield increase is a very high percentage of contribution to yield increase.

Contribution of better rice varieties

Better rice varieties were found to contribute from 19 to 64 percent to improved rice yields. Like good quality seed, better rice variety was also found to have a synergistic effect when applied with other technologies. The highest percentage of contribution from better variety came when it was grown with good quality seed using SRI management practices as seen in Table 24.

Table 24: Contribution of better rice varieties

Contributions of better variety in percent from			
Variety alone	Variety and seeds	Variety and SRI	Seeds, variety and SRI
19%	41%	41%	64%

The contribution of better variety was found to be very similar when used with either good quality seed or with SRI practices. In the both cases, the combined contribution was found to be much higher than its single use.

Contribution of SRI

Among the three technologies evaluated, the contribution of SRI was found to be the highest, varying from 143 to 184%, and the highest contribution was found when SRI practices were applied with better variety and good quality seed **(Table 25).** The next highest increment came when SRI practices were used separately either with better variety or with good quality seeds. There had not been much differences observed between their use with quality seeds and with good variety in terms of the amount of contribution to yield increase **(Table 22)**.

Table 25: Contribution of SRI

Contributions of SRI in percent from			
SRI alone	SRI and seeds	SRI and variety	Seeds, variety and SRI
143%	161%	165%	184%

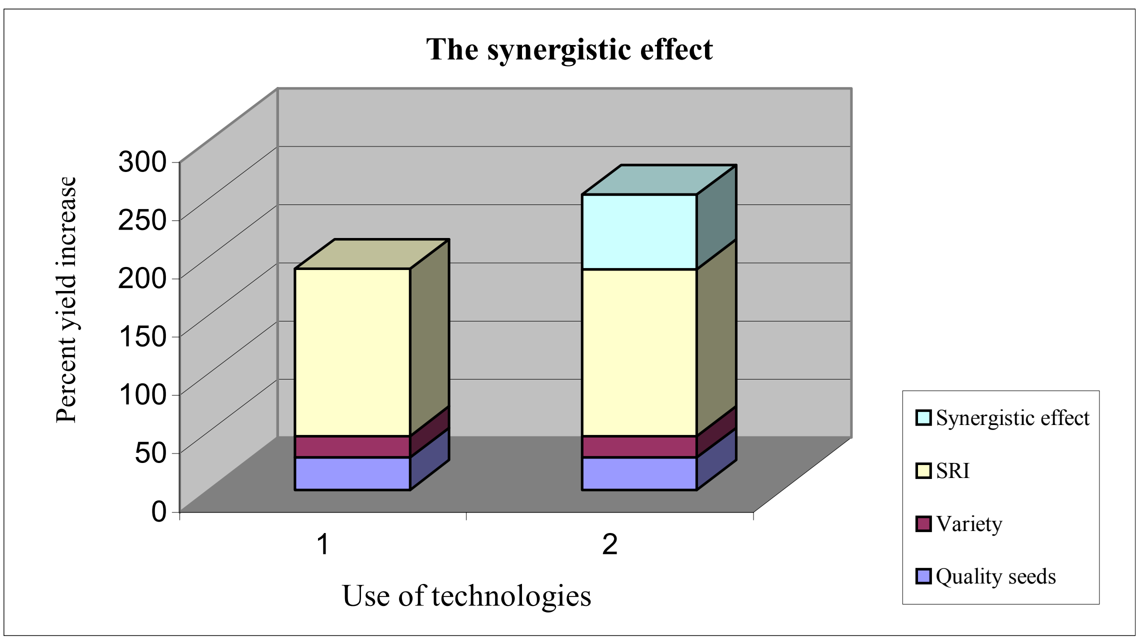
SRI, generally, involves a number of individual practices used together as described in Chapter 4. The most common practices that farmers in the sampled FFSs applied included: 1) use of young seedlings, between 8-16 days old, 2) planting one to two seedlings per hill, 3) wider spacing between plants, from 20 to 40 cm in each direction, 4) use of compost, 5) applying water intermittently to the field, and 6) weeding with rotary weeder. Not all farmers were able to implement all of these practices together because of their diverse field conditions and socio-economic variation.

The number of SRI practices applied varied from 3 to 6. The most common practices that farmers applied under the rubric of SRI were: 1) the use of young seedlings, 2) planting one seedling but in a few cases two seedlings per hill, and 3) wider spacing. Many farmers were not able to use compost and maintain intermittent water application as in the rainy season controlling water is very difficult. This means that there is still productive potential with SRI that is not being fully exploited in the results reported here. If farmers find that there is still additional yield that can be reaped with the full set of practices, assuming that presently unused ones are cost-effective at the margin, we could expect to see even greater agronomic and economic benefits.

Observed synergy

When the combined contributions of certain individual practices are found to be more than the sum of their respective individual contributions, or in other words, when the practices together make a bigger contribution to output when all used together than the sum of their individual separate contributions, we say that these practices have a synergistic effect. The significance of this is seen in the bar graph in Figure 6. The right-hand bar which shows yield when the three most common improved practices are used jointly, compared with the left-hand bar which represents the total of their respective effects when compared with conventional practice.

Figure 6: The synergistic effect in SRI



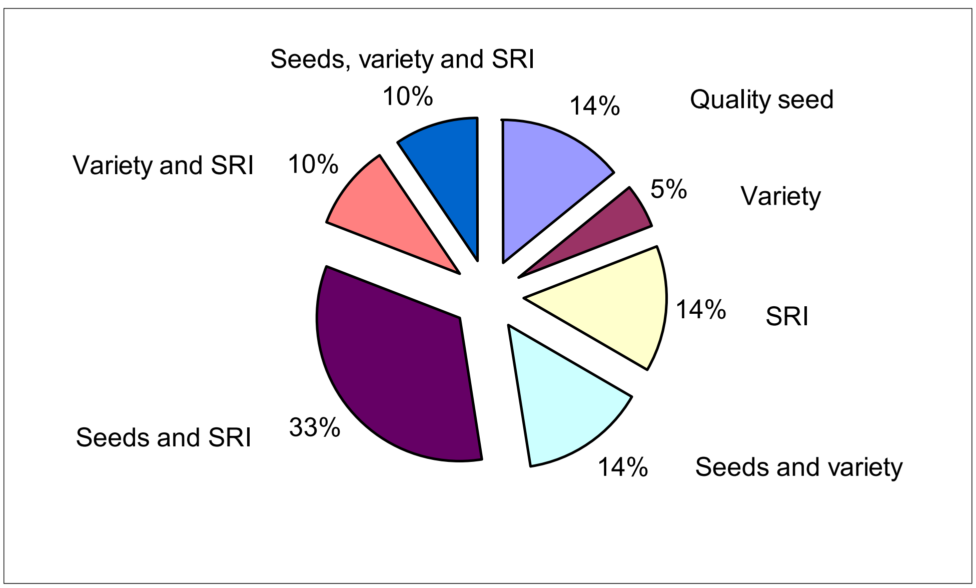
This effect had been consistently observed over the last three years of the study among all the three important technologies that farmers used within the FFS – good quality seed, better variety, and SRI.

When each of these practices was used separately as a single technology, their total cumulative contribution was found to be much less than when they were used together. The contributions of good quality seed, better rice variety and SRI when used separately were found to be 28%, 18% and 143%, respectively, with a total sum of individual contributions coming to 189% (**Table 21)**. But when these improved practices were applied together, the yield increase reached 253%, which is considerably higher than the sum of their individual additions. This extra benefit is the result of synergistic effects, which means that the technologies are supportive to each other, an important sign of sustainability toward their use to improve the yields of rice.

6.6. Percent of farmers using different technologies

The technologies/practices used by FFS graduates were completely a matter of their decisions. The data presented below regarding the percentage of farmers using different technologies on their fields were calculated based on the total number found in the first year after graduation of an FFS cohort, from 6 of the 30 FFSs studied (2 FFSs from each of the three years evaluated). The primary reason for taking only 2 FFS from each year's FFS program was to have a sample (20%) that would be reasonably representative of the whole program's experience but would at the same time be of a size that we could interview each of the farmers (N=124) on an individual basis as discussed earlier.

Figure 7: Percent of farmers using different technologies



According to the observations of the study, 67% of farmers were using SRI methods by themselves or with some combination of other improved practices. 33% farmers from each FFS - almost one third of the total number -- were found to be using SRI practices with better quality seed, while 10% were found to be using SRI with better variety. The percentage of farmers using SRI with both quality seeds and good rice varieties was found to be another 10%. Better rice varieties were used with good quality seeds, but not SRI, by 14% of farmers. As a single technology, either quality seed or good variety or SRI was found to be used by 14%, 5%, and 14% farmers, respectively. This means a total of 33% farmers were found to be using a single technology. Two technologies together were being used by 57% of farmers, and only 10% of farmers were using all 3 technologies together. Grouping the respective categories, 71% farmers were found to be using better quality seed, 39% used a better rice variety, and as noted above, 67% were using SRI by itself or in various combinations.

The above picture, according to the data collected, represents how farmers are using the practices in their first year after graduation from a FFS. This number in the following years, due to the spread effects of FFSs, gradually increased. A detailed presentation is made in the following section on how the spread effect influenced other farmers in the communities, and how many of them were influenced by this effect to adopt the practices on their fields in the following years. There are reasons worth considering for why in the first year not all FFS farmers were able to adopt SRI on their fields. The two-thirds of farmers who adopted SRI practices on their fields and experienced a tremendous yield increase in the first year were generally the more advanced farmers in the community. The others who did not decide to apply SRI practices, while interested in them, were more impressed by the simplicity of moving to use good quality seeds and/or better rice varieties, and thus were happy to start just with these innovations in their first year after FFS training. Nevertheless, in the following years, the activities and success of other farmers influenced them to apply SRI practices on their own fields.

6.7. Spread effects of FFS in terms of yield increase by non-FFS farmers through adoption of new technologies

The trends of spread effect over 3 years in terms of farmers' participation

The spread effect was studied in terms of the benefits accessed by farmers who had not participated in FFSs. This benefit was measured by the number of farmers using the methods and their associated yield gains. In the next year after graduation from a FFS in 2002 at the 10 selected sites, it was seen that along with FFS farmers, who had directly participated in the regular activities of a FFS, there were an equal or higher number of non-FFS farmers who also benefited indirectly from the FFS. The mean number of farmers participating in each FFS was found to be 20 **(Table 26),** while along with them, within the same community, there were around 24 other farmers who had not participated in the FFS but who were also benefiting from the new practices.

Table 26: Number of non-FFS farmers associated with Category-I FFSs and their production increases (in percentage) from 2002 to 2004

	FFS farmers		Non-FFS Farmers					
	(N)	**2002**	**(N)**	**2002**	**(N)**	**2003**	**(N)**	**2004**
Nawng Hkying	24	82%	20	50%	32	45%	46	43%
10 Miles	20	95%	25	39%	35	42%	42	40%
Gat Sha Yang	18	102%	15	40%	22	45%	30	42%
N-gan	22	147%	23	60%	28	49%	32	50%
Nawng Hkyi	20	59%	30	45%	38	%	48	52%
Gara Yang	15	87%	26	45%	39	45%	51	43%
Ja Pu	23	74%	32	34%	38	37%	49	38%
Awng Mye Tit	18	100%	26	61%	35	56%	47	51%
Mai Sak Pa	23	76%	23	45%	32	48%	43	50%
Lawa Yang	19	105%	18	68%	29	65%	38	63%
Mean	20	90%	24	49%	33	48%	43	47%
Total	218		252		361		419	

The spread effect in the second and third years after graduation of a FFS cohort (2003 and 2004) was found to be even higher than in the first year after the graduation (2002). The mean numbers of non-FFS farmers who were using different technologies were found to be around 33 in the second year and 43 in the third year, compared with 24 in the first year after graduation, and 20 in the graduation year, which was also the beginning year of FFS. This brought the total number of farmers using improved practices in a FFS community to 63, three times the number trained. It should be mentioned here that 63 is the average number of persons who are engaged in farming in these communities where FFSs were undertaken. This means within a four-year period the benefits of SRI/FFS reached all farmers in the communities through a spread effect. The overall trends of farmer's participation within the FFS framework were seen to increase at the rate of 118%, 162% and 211% in the 1st, 2nd and 3rd years after the graduation of a FFS cohort, respectively, compared with the initial number of participants in the first year of FFS (**Table 27**). This indicates that the overall trend of spread effect is very stable, and this is also a good sign that the impact of FFS is large and extensive, and that the external intervention is having sustainable impact.

Table 27: Mean trend of increase of farmer participation in the following years of an FFS

Year in FFS		Total no. of participants	Associated non-FFS participants	% increase in non-FFS participants
Graduated year	2001	20		
1st year after graduation	2002	44	24	118
2nd year after graduation	2003	53	33	162
3rd year after graduation	2004	63	43	211

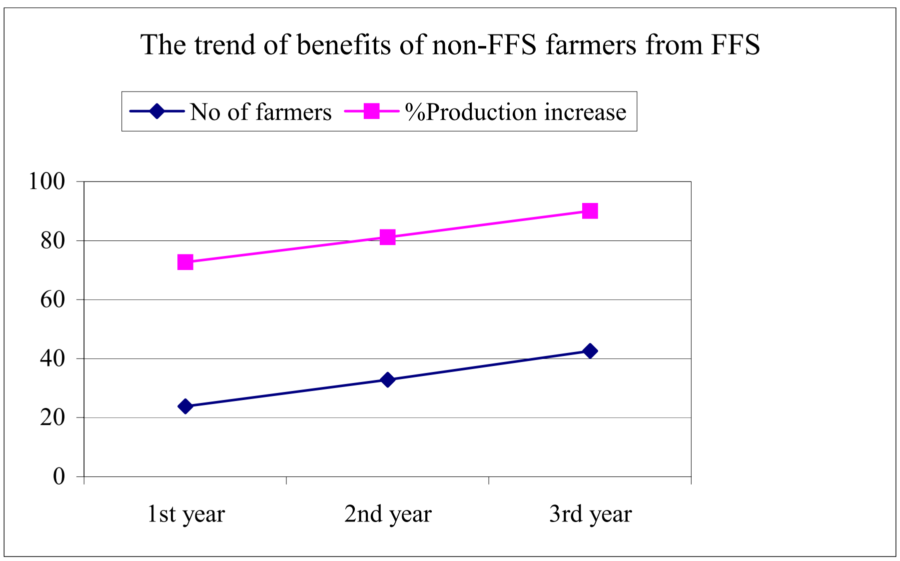
The trends of spread effect over 3 years in terms of farmers' production increase

The spread effect in terms of production increases among non-FFS farmers was found to be very significant and stable, with no decreasing trend in any of the three years of the study. In the first year after graduation of a FFS cohort, on average, 24 non-FFS farmers were able to achieve a 49% production increase **(Table 26)**. While in the following years, the number of such farmers increased, they maintained a similar percentage of production increase (**Figure 8)**. The production increase in the second and third years by non-FFS farmers was recorded as 48% and 47%, respectively (**Table 26),** while the number of such farmers increased at the rate of 162% and 211% **(Table 27)**. This indicates a two-way rolling effect - both vertically by providing an increase in production, and horizontally by bringing the technologies/practices to a larger number of farmers in the community on a continuous basis.

Table 28: Percent of mean increase of production by non-FFS farmers from FFS

Year after graduation of FFS	Average number of non-FFS farmers benefited from a FFS	% increase in production
1st year	24	49
2nd year	33	48
3rd year	43	47

Figure 8: The trend of participation and benefits of non-FFS farmers from FFS



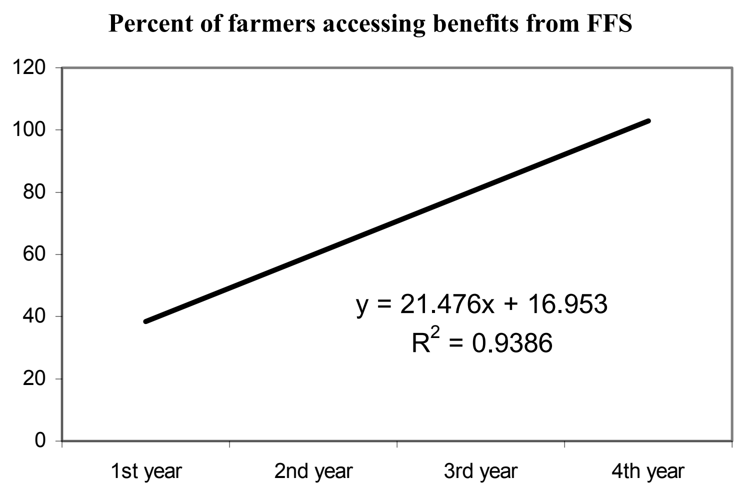
A number of factors could have contributed to this highly successful 'roll-on' effect. Among them, of course, the informal sharing of information and experience from FFS farmers played a crucial role, but there was also a sharing mechanism, more specifically a learning and sharing environment created, within the FFS group that made a large contribution. FFS study-fields served as large demonstrations for the other farmers in the community, and the FFS field-days, where all community farmers were invited together, provided an effective opportunity to share the learning of FFS farmers with non-FFS farmer neighbors. How much contribution the FFS study-fields and the field-days made is a matter for another analysis, the results of which are presented in following sections.

In addition to field-days and study-fields, the nature of the technologies that were used within the FFS played a role. The contribution and effectiveness of each of the technologies to large-scale yield increase could be considered as another reason why the practices were disseminated so quickly and so extensively. The best attribution could be made to the combined effect of both the learning and sharing process of FFS and the effectiveness of the technologies that were used within the FFS. It is reasonable to argue that both the technologies and the processes that were used within the FFS were supportive of each other in an effort to enhance farmers' skills and their ability to increase rice production. With such a combination, a large-scale 'roll-on' effect took place spontaneously.

6.8. Percent of farmers in a community accessing the yield benefits from FFS

Based on the results presented in the previous section, it was evident that within a period of four years, the benefits of FFS can reach almost all farmers in a community. According to the mean figure, an FFS usually started with 32% of the farmers in a community participating in this mode of experimental and experiential training. With the rolling effect, starting from the next year, within a four-year period, the benefits of FFS training reached practically all farmers, as seen in **Figure 9**.

Figure 9: The trend of participation of the community in terms of accessing benefits from FFS



The mean benefits of FFS were found to be disseminated within the community at the rate of 32%, 69%, 83% and 99% in the first, second, third and fourth years of FFS programming, respectively **(Table 29)**. In such dissemination, among all the selected FFSs, great consistency was observed. Reaching the benefits to all farmers in the community in such a short period is undoubtedly a remarkable achievement.

It is likely that the nature of the technologies/ practices and of the processes that were used within the FFSs contributed to the outcomes observed. The nature of these practices is that they do not entail added costs for farmers to apply on their fields as seen in the cost and return analysis section (Chapter 2). Because rice is a self-pollinated crop, farmers can produce their own seed once they have a variety most suitable for their conditions, and using better seed is just a matter of selection of the best seeds through an easily-teachable practice of putting one's seed supply into a bucket of water and then discarding those that float, as they are not as dense (heavy) as the others. The denser seeds contain a larger-sized endosperm – the stored starch inside the seed which is the source of food and energy for the embryo at the initial stage of germination and growth -- and thus they can support the production of stronger seedlings than can the lighter seeds. So the practices being presented to farmers through the FFS methodology are unusually attractive and adoptable.

Table 29: Percent of farmers in a community benefiting from FFS

	Percentage of farmers of a community benefiting from FFS			
FFS	**1st year**	**2nd year**	**3rd year**	**4th year**
Nawng Hkying	34	63	80	100
10 Miles	31	69	85	95
Gat Sha Yang	36	66	80	96
N-gan	40	82	91	98
Nawng Hkyi	29	74	85	100
Gara Yang	23	62	82	100
Ja Pu	32	76	85	100
Awng Mye Tit	27	66	79	97
Mai Sak Pa	35	70	83	100
Lawa Yang	33	64	83	98
Mean	32	69	83	98

On top of this,, FFS processes, with their regular and participatory learning activities, provided farmers with all the knowledge needed on how to produce and use quality seeds, how to select better rice varieties, and how to adopt practically the specific practices of SRI on their fields. Therefore, the farmers could master this new knowledge easily, and in turn it was easy for them to share the technologies with other farmers in the community.

6.9. Factors influencing the adoption of practices by farmers

The results presented in the earlier sections have shown how many farmers on average from each community participated in FFS; how many of them using the practices that were taught and used within the study-fields of FFS; how many were using which practices, how much benefit they received by using those practices in terms of increase in rice yields and production; and which practices provided how much contribution to the overall yield and production increases of farmers. Then in later sections, it was shown how many other farmers from the same community who did not participate in the FFS were using those practices; and how much yield and production benefits they had received by the use of those practices.

With all this, the sections above have presented the trends of overall adoption of SRI practices along with other practices facilitated under FFS by farmers on their own fields. The following sections present how this adoption has actually taken place, especially, which factors provided how much influence to this adoption process. During the study, there are two sets of factors found to be influencing the overall adoption of SRI, one set particularly related to the adoption process of FFS farmers, with another related to the adoption of non-FFS farmers.

6.9.1. Factors influencing the adoption process of FFS farmers

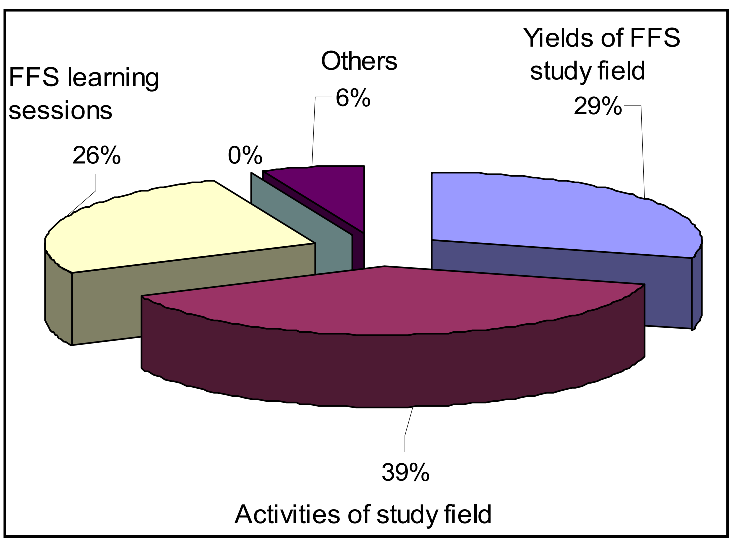
To study the adoption process of FFS farmers, specifically which factors influenced them to apply certain SRI practices on their own fields, a set of open-ended questionnaires was prepared and used to facilitate open discussions among the farmers in each FFS. The discussions were organized in three consecutive years from 2002 to 2004, with each year all the 10 sampled FFSs trained in that particular year being surveyed. During the discussions through the selected questionnaire, farmers in large groups were asked why and how they became interested to apply the practices on their fields.

According to their answers and the responses given, five types of factors were found to be mainly responsible for their adoption of SRI. These were: a) the rice yields of the FFS study-field, b) activities related to the FFS study-field, c) the regular learning sessions of the FFS, d) the field-day activities, and e) some other supplementary activities, which were not very regular in FFS. No one of these factors stood out the single most influential factor for the overall adoption of SRI by any farmers, and there was impressive consistency in farmers' answers across the three years. It appears that the combined effect of all the factors influenced farmers to adopt practices according to their needs. However, there were sharp differences observed among the factors in terms of their degree of influence on farmers **(Table 30)**.

Table 30: Factors influencing the adoption of SRI by FFS farmers, 2002-2004, and average for the three years

Factors	(N)	2002 Response	(N)	2003 Response	(N)	2004 Response	(N)	2002-2004 Ave.
Yields of FFS study-field	202	27%	198	29%	212	30%	612	28%
Activities of study-field	202	38%	198	39%	212	38%	612	38%
FFS learning sessions	202	25%	198	27%	212	26%	612	26%
Field-day activities	202	1%	198	0%	212	0%	612	0%
Others	202	8%	198	5%	212	6%	612	6%

Figure 10: Factors influencing FFS farmers adoption



To understand the importance of each factor in terms of its influence on the adoption process, each FFS farmer was asked to score each factor, on a scale of 1 to 100 points, based on its degree of influence to his/her adoption of SRI. According to the overall scores provided by all the FFS farmers from 30 different FFSs for the three-year period, 2002 to 2004, the factors compare as follows in terms of their influence

a. Activities in study-fields – factor number 1

Based on the mean scores of 612 FFS farmers from 30 sampled FFS over the three-year period from 2002 to 2004 **(Table 30)**, the activities undertaken in study-fields appeared to be the most impressive factor or reason why farmers felt encouraged to adopt the practices on their own fields. This was consistently reported by the FFS farmers in each of the three cohorts.

Among the first graduated batch in 2002, FFS farmers provided the highest score **(38)** to the activities in their FFS study-fields **(Table 30).** In the other years, a similar response was received from the second and third graduated batches of FFS, as farmers' respective scores for study-field activities were 39 and 38 **(same table)**. Farmers who participated in the FFS gained direct experience in growing rice with the new methods on the study-field of the FFS. In addition, they conducted various experiments and established comparative trials on the study-field, based on their particular interests and problems encountered during the study.

Table 31: FFS farmers mean scores across FFSs in 2002 for factors that they felt influenced their adoption

FFS	(N)	Yields of FFS study-field	Activities in study-field	FFS learning sessions	Field-day activities	Others
Nawng Hkying	24	25	43	20	0	12
10 Miles	20	35	35	25	0	5
Gat Sha Yang	18	20	39	30	3	8
N-gan	22	30	25	30	5	10
Nawng Hkyi	20	19	40	26	0	15
Gara Yang	15	35	42	17	0	6
Ja Pu	23	31	35	23	3	8
Awng Mye Tit	18	28	40	17	0	15
Mai Sak Pa	23	25	43	32	0	0
Lawa Yang	19	28	36	32	0?	4
Mean	202	28	38	25	1	8

Interestingly, both of these activities provided a real and very systematic opportunity to learn how to grow rice using SRI practices. By growing rice themselves and by conducting various comparative studies within the study-field area of FFSs, they could see there was no risk when using the SRI practices, and furthermore, given the performance of the trials and studies, they could see which combinations of practices (i.e., spacing, number of seedlings, etc.) worked better. As a result, they became more confident about the possible outcome of SRI, and did not feel it involved significant risk, unlike other farmers in general situations who had to make decisions to use the practices on their fields without such experience.

Table 32: FFS farmers' overall scores across FFSs in 2003 for factors that they felt influenced their adoption

FFS	(N)	Yields of FFS study-field	Activities in study-field	FFS learning sessions	Field-day activities	Others
Hka Wang	20	35	34	20	0	11
Pung Dung	18	30	35	30	0	5
Chyara Pati	22	34	40	20	0	6
Mali Hka	20	28	40	22	0	10
Mading	22	32	38	25	0	5
Katsu	20	17	45	30	0	8
Thing Nan Kawn	18	29	40	28	3	0
N myen	20	24	38	34	0	4
Ding Hkung	18	30	38	30	2	0
Nalung (lower)	20	30	39	28	0	3
Mean	198	29	39	27	0	5

b. Yields of FFS study-field – factor number 2

The second most influential factor for the adoption of SRI by FFS farmers was the higher yields obtained from the FFS study-fields. According to the average scores provided by farmers from three years of the study, higher yields of rice within the FFS study-field received 28 points as against 38 assigned to the activities of FFS study-field **(Table 30 and Figure 10)**. The reasons of considering this as the second most influential factor is that while many farmers made their decision to use the practices on their own field simultaneously with their involvement with the FFS study-field, they were already impressed with the initial growth of the SRI seedlings and young plants on the study-field. Still there were a large number of farmers who were not fully convinced about the practices and therefore decided to wait until they could see the actual harvest. For those farmers, the massive yields of the FFS study-field served as a reinforcing factor to make the decision to adopt the practices on their own fields. The scores provided by farmers for this factor in each of the three years of the study were found to be very similar and consistent (**Tables 30, 31, 32 and 33).**

Table 33: FFS farmers' overall scores by FFS in 2004 for factors that they felt influenced their adoption

FFS	(N)	Yields of FFS study-field	Activities of study-field	FFS learning sessions	Field-day activities	Others
L Maw Hpang	20	35	40	20	0	5
Khan La	22	37	32	31	0	0
Nam Koi	20	25	41	30	0	4
Nan Nawn Pa	20	31	38	26	0	5
Jam Ga	24	25	39	30	0	6
Nam San	19	31	38	21	0	10
Sam Pai	20	29	41	25	0	5
Gang Dau	25	31	37	20	0	12
Dinga Yang	20	28	39	28	0	5
Daw Hpum	22	29	35	31	0	5
Mean	212	30	38	26	0	6

c. FFS learning sessions – factor number 3

The third most important factor influencing the adoption of new practices by FFS farmers was found to be the FFS learning sessions, regularly facilitated during the FFS period. During the learning sessions, the general principles of SRI were explained to farmers, especially why and how rice grown with SRI methods performs better, and how, based on those principles, the practices should be developed and modified to tackle the particular conditions of individual farmers. In addition, there were many practical sessions, followed by interactive and lively discussions among the farmers facilitated by the FFS facilitator on various aspects of rice production. These practical sessions provided them with further opportunities for learning the details of SRI, specifically how to produce and transfer young seedlings to the main field, how to produce and apply compost as needed for SRI, and how to cultivate the soil or use the weeder as recommended for weeding and aerating the soil

The combined effect of all those sessions supported by some additional subject-specific sessions, which were very regular to FFS, enriched the general knowledge and overall understanding of FFS farmers about rice cultivation. As a result, they came up with a better understanding than the average farmers about crop improvement. Then it became easy for them to use the practices effectively on their fields.

d. Other activities – factor number 4

The fourth factor considered includes a number of activities that were not very regular in FFS such as providing quality seeds to FFS farmers, supplying new rice varieties to the FFS, organizing cross-visits among farmers' fields within the FFS and outside the FFS, supplying some farmers with new rice weeders or other materials, distribution of printed materials about FFS and SRI, etc. As compared to the other factors, the influence of these non-regular activities of FFS was very low in the overall adoption of SRI. Nevertheless, they could be considered as supportive activities because they boost the morale and interest of some farmers. The distribution of quality seeds made some farmers instantly interested to try SRI practices on some part of their land, while some farmers said the distribution of the printed material guided them on how to adopt the practices to their field conditions. The three-year mean score for all these supplementary activities of FFS was found to be 6 as compared with 26, 28, and 38 as the mean scores of FFS learning sessions, the yield obtained from the FFS study-field, and the activities on FFS study-fields, respectively **(Table 30).**

e. Field-day activities

While field-day activities raised the confidence of FFS farmers in terms of their ability to organize the communities and share with them their learning from FFS activities, field-day activities in general had virtually no effect on the overall adoption of SRI by FFS farmers. Nevertheless, the activities were important to the adoption of SRI by non-FFS farmers, as discussed below.

6.9.2. Factors influencing the adoption process of non-FFS farmers

A. Adoption in the first year after the graduation of FFS

To study the adoption process of SRI by non-FFS farmers, similar methodologies were used as were used in prior data gathering with FFS farmers. Meetings and group discussions were organized with non-FFS farmers who started using the practices in the first year after the graduation of the FFS. To understand the importance of each factor in terms of its influence on their adoption process, each non-FFS farmer was asked to score various factors on a scale from 1 to 100 points, based on its degree of influence on his/her adoption of SRI. The corresponding score given against each factor was considered as the degree of influence of that factor on farmers' decision-making for adoption of SRI on their own fields.

According to the assessments of farmers who did not participate in FFS programs, across three years, the mean scores of influential factors are shown in **Table 34** which were thought to be mainly responsible in influencing their adoption of SRI. While these are similar to those influencing FFS farmers, no single factor could be singled out as the main influencing factor; none of the factors was found to be responsible primarily for influencing the adoption of SRI by any single non-FFS farmer. However, field-day activities, which were not important for FFS farmers' adoption turned out to be the most important factor identified. Overall, adoption was seen to be influenced by the combined effect of factors.

Table 34: Factors influencing the adoption of SRI by non-FFS farmers, 2002-2004, and three-year average

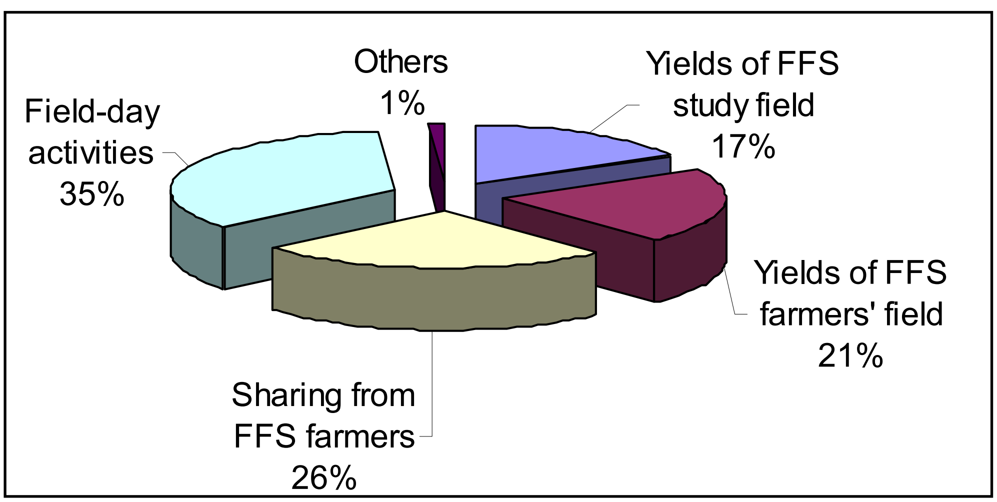
Factors	(N)	2002 Responses	(N)	2003 Responses	(N)	2004 Responses	(N)	2002-2004 Ave.
Yields of FFS study-field	238	19	232	14	221	17	691	17
Yields of FFS farmers' fields	238	23	232	22	221	19	691	21
Sharing of experience by FFS farmers	238	25	232	27	221	26	691	26
Field-day activities	238	32	232	36	221	37	691	35
Others	238	2	232	1	221	1	691	1

a. SRI yields on FFS study-fields

The FFS study-field was usually the first thing that non-FFS farmers noticed from an FFS. It is actually the planting activities by the FFS farmers working together within the study-field area that first attracted non-FFS farmers. The attraction becomes bigger when they see massive yields of rice from the study-field area. During the discussions, a great number of non-FFS farmers mentioned they were fully aware of this new method (SRI) for growing rice from seeing the study-field during the growing season, and they had keenly watched its performance. The study-field, therefore, served as an effective demonstration plot for non-FFS farmers, unlike the FFS farmers who used it as a learning field for themselves.

Non-FFS farmers had their initial motivation for adopting the practices on their own fields when they observed higher yields of rice on the FFS study-fields, which in most cases were 100-200 percent higher than the yields they were accustomed to seeing and getting, as mentioned in Chapter 6.1. However, in making their final decision, other factors were more influential as seen below. According to the scores given by non-FFS farmers, the influence of higher yields of rice on the FFS study-field on their decision-making for adopting SRI was given only 17 points, and hence, compared with other factors, it appeared to be only the fourth most influential factor to the adoption process **(Table 34 and Figure 11)**.

Figure 11: Ranking of the factors that influenced Non-FFS farmer's adoption



b. SRI yields on FFS farmers' fields

Based on the three-year mean score, the higher yields of SRI rice on FFS farmers' fields were the third most influential factor affecting adoption of SRI by non-FFS farmers. According to the data presented in **Table 18 (**Section 6.4), 15-20 percent of farmers from each FFS, on average, were found to apply SRI practices on their own fields at the same time as they were experimenting on the FFS study-field. The higher yields of these FFS farmers provided confirmation to non-FFS farmers for what they were seeing on the FFS study-field. As a result, their level of confidence about the effectiveness of the new practices rose higher than before. They saw that there was a consistency in higher yields both on the FFS study-fields and on FFS farmers' own fields. Therefore, they become more confident that such yields would also be possible on their own fields. The degree of influence of FFS farmers' higher yields on the overall decision-making of non-FFS farmers to adopt SRI practices on their fields was found to be 21% **(Table 34)**.

Table 35: Mean scores of non-FFS farmers across FFSs in 2002 for the factors that they felt influenced their adoption

FFS	(N)	Yields on FFS study-field	Yields on FFS farmers' field	Sharing from FFS farmers	Field-day activities	Others
Nawng Hkying	20	15	15	36	34	0
10 Miles	25	19	32	19	25	5
Gat Sha Yang	15	21	23	21	32	3
N-gan	23	21	22	24	28	5
Nawng Hkyi	30	19	21	26	32	2
Gara Yang	26	23	22	16	39	0
Ja Pu	32	21	17	27	35	0
Awng Mye Tit	26	16	29	30	25	0
Mai Sak Pa	23	12	26	19	38	5
Lawa Yang	18	18	21	28	31	2
Mean	238	19	23	25	32	2

c. Sharing of experience by FFS farmers

The influence of sharing by FFS farmers in the overall decision-making of non-FFS farmers for adoption of SRI was found to be much higher than other factors. According to the scores given, the sharing from FFS farmers made a 26% contribution to the decision-making of non-FFS farmers **(Table 34)**. This sharing covered mostly informal discussions and chats between FFS farmers and non-FFS farmers and their families. According to the selection criteria, FFS farmers were those in the community who were interested and had enough time to participate in the regular activities of FFS. 'Non-FFS' farmers were usually friends or relatives of FFS farmer families. While FFS participants performed any activity such as production and transplanting of seedlings, preparation of compost, etc., this usually produced curiosity in the minds of non-FFS farmers. As a result, they used to have frequent or at least occasional discussions regarding those new activities or practices. In many cases, due to the closer proximity of their lands, one could see what the other was doing.

Table 36: Mean scores of non-FFS farmers across FFSs in 2003 for factors that they felt influenced their adoption

FFS	(N)	Yields on FFS study-field	Yields on FFS farmers' fields	Sharing of experience by FFS farmers	Field-day activities	Others
Hka Wang	23	16	25	23	34	2
Pung Dung	21	10	18	38	34	0
Chyara Pati	28	19	15	36	30	0
Mali Hka	25	17	26	25	27	5
Mading	21	20	16	34	28	2
Katsu	16	12	22	21	43	2
Thing N Kawn	23	12	31	23	34	0
N Myen	25	10	22	24	43	1
Ding Hkung	22	16	18	23	43	0
Nalung (lower)	28	12	25	20	41	2
Mean	232	14	22	27	36	1

Sharing was also stimulated by the observation of superior growth of SRI rice plants and their better yield both on FFS study-fields and on the fields of FFS farmers. Many non-FFS farmers, after being impressed by the superior growth and yields of SRI, made spontaneous visits to FFS farmers who explained to them (the non-FFS farmers) the details of the practices which were attracting their attention.

Table 37: Mean scores of non-FFS farmers by FFS in 2004 for factors that they felt influenced their adoption

FFS	(N)	Yields on FFS study-field	Yields on FFS farmers' fields	Sharing of experience by FFS farmers	Field-day activities	Others
Lahta M Hpang	18	18	22	28	32	0
Khan La	13	12	22	23	41	2
Nam Koi	26	21	21	22	34	2
Nan Nawn Pa	26	15	19	24	38	4
Jam Ga	29	22	16	28	33	1
Nam San	19	12	14	37	37	0
Sam Pai	19	21	16	25	38	0
Gang Dau	21	17	13	29	40	1
Dinga Yang	23	21	25	18	35	1
Daw Hpum	27	13	18	27	41	1
Mean	221	17	19	26	37	1

d. Field-day activities

Based on the percent of influence as shown in **Figure 11,** field-day activities were found to be the most important factor influencing the overall decision-making process of non-FFS farmers to use SRI practices on their fields. The scores provided for the field-day activities by non-FFS farmers in different years of the study were found to be much higher than those for other decision-making factors and also consistent across FFS groups **(Tables 35 to 37).** The three-year mean score for field-day activities was found to be 35 as compared to 26, 21 and 17 as the respective mean scores for the other activities like sharing of experience by FFS farmers, yields on FFS farmers' fields, and the yields of the FFS study-field.

As the field-day was a more formal system of sharing between FFS farmers and non-FFS farmers, unlike the other activities of the FFS, it provided non-FFS farmers a more organized opportunity for interaction with FFS farmers and their FFS facilitators. Field-days, which were usually organized at the end of the rice season or during the harvesting period, also served as a display of various kinds of information about SRI and FFS, followed by systematic presentations of the entire activities of the FFS, with particular focus on the practices that were used in growing rice. Furthermore, it provided non-FFS farmers with an opportunity to see the actual yields of rice, as usually during a field-day, rice yields were measured and calculated, either through crop-cuts or through total harvest. All these activities provided non-FFS farmers with more convincing reasons to believe that the SRI methods had more potential than their usual methods. As a result, non-FFS farmers gave the highest score to field-day activities as the most influential factor for their decision-making to use the new practices on their fields.

e. Other activities

The influence of other activities was found to be minimal, with around 1% influence on the overall decision-making of non-FFS farmers as compared with the other factors described earlier. 'Other activities' generally included what some non-FFS farmers heard about SRI from relatives from other villages, or what some of their church leaders advised them to apply the practices on their fields. As mentioned in Chapter 5, there were two church-based organizations actively involved in the implementation of FFS and SRI. Some of their leaders with an interest in agriculture, while visiting the communities, encouraged their communities to use the practices.

B. Adoption in the second and following year after the graduation of an FFS

Although in this study there had been no formal discussions or meetings organized with farmers who started adopting the practices the second year after the graduation of an FFS, or later, to know how their adoption took place, it could be that in those years, or since the graduation of the FFS, there had been no FFS activities, and the only way that other farmers could know about or be influenced by the use of SRI practices was either by considering the yields of those farmers who were using the practices at the time, or by what could be directly learned from them. Therefore, the overall adoption of SRI by these categories of farmers could largely be attributed to the yields and experiences of FFS farmers, with non-FFS farmers starting to use the practices since the first year after the graduation of an FFS. According to the data provided in **Table 29**, by the end of the second year after an FFS (after the FFS year and the first year after the graduation of an FFS), 69% of the farmers in each community were found to already adopting the practices. By the next two years (the second and third year after the graduation of an FFS), the yields and experiences of these farmers encouraged the rest of the farmers in the community to adopt the practices on their fields.

6.10.The effect of field studies and farmer experimentation process

This section reports the results of the effect of farmers' own experimentation process on the overall adoption of SRI practices by farmers and their corresponding production gains. As mentioned in Chapter 4, farmers' experimentation is the usual process of learning in an FFS. During this experimentation process, farmers in growing rice established many experiments or season-long field studies: 1) to compare the performance of various methods that are used in rice production; 2) to study the particular aspects of crop growth and production; and 3) to explore options for finding solutions to the unanticipated problems that they encountered while growing rice.

The size of the study-field is an important matter in the process of learning and adopting SRI practices. It serves as a demonstration plot in terms of demonstrating to FFS farmers and to other farmers in the community how much rice they can produce with the new practices. A smaller study-field is easier to manage, but sometimes it does not provide much persuasion because some people think it is easy to produce a higher yield on small plot. Small study-fields often give a wrong perception as there are many possibilities of errors about yields, costs and returns when calculated from a smaller area but expressed in larger units like tons per hectare. Therefore, even after seeing very attractive yields, farmers may not feel confident to use the practices on their own fields, because they feel the practices are applicable only in smaller areas. Since the new practices are intensive in nature, farmers feeling this way are likely to believe that SRI is only suitable to use in smaller areas.

A larger study-field, on the other hand, is more likely to provide a realistic picture of the applicability of new technologies or new practices, as it demonstrates more reality in terms of the yields, costs, returns, and other factors, and there are fewer or no chances of error. It is, however, difficult to manage a larger size field, especially when just starting out with new practices. Since two types of study-fields, smaller and larger, were used in the program, it was interesting to see whether the size of the study-field had any impact on the overall adoption of SRI practices by the farmers. The following section presents the results as to whether there was any relationship between the size of the study-field and the adoption of SRI practices by farmers. The overall results are presented in terms of the effect of study-field size on: 1) the scale of adoption of the practices by individual farmers, and 2) the number of farmers who adopted the practices on their own fields.

6.10.1. The effect of size of study-field on the scale of adoption by individual farmers

The effect of the size of the study-field on the scale of adoption by individual farmers was analyzed in terms of the production increase gained by the individual FFS families from using SRI practices on their fields. The amount of production increase, in percent, compared with the baseline condition, is an indicator used to determine on how much area they used the new practices. Two categories of study-fields were found in FFS, first, areas around 2,000 square meters or below, second, areas around 4,000 square meters.

Based on the recorded yield data about the production of FFS farmers in their first year after graduation from an FFS and the total size of the FFS study-field, a positive relationship was observed between the size of study-field and the percent of production increase by individual FFS families. FFSs with larger-sized study-field (4000 square meters) had farmers experiencing a larger percentage of production increase than those FFSs that had smaller-sized study-fields **(Table 38)**.

Table 38: Size of study-field and corresponding percent of production increase by individual FFS farm families

Size	2002 (N)	2002 (%)	2003 (N)	2003 (%)	2004 (N)	2004 (%)	2002-2004 (N)	2002-2004 Ave.
$2000m^2$	125	79%	36	88%	42	82%	203	81%
$4000m^2$	77	114%	162	121%	170	118%?	409	118%

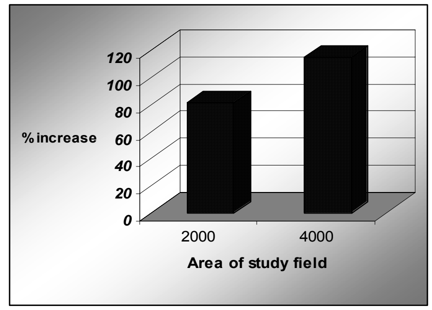
According to the mean average from three years, farmers participating in FFSs with a study-field 2000 square meters or less had an 81% production increase, from their baseline production before participating in FFS, as compared with those in FFSs with a study-field 4000 square meters or above, whose production increase averaged 118%. The results were found very consistent in all the three years of the study **(Tables 39-41)**

Figure 12: Corresponding yield increases

Correlations

		Area	Rice yield
Area	Pearson Correlation	1	.855(**)
	Sig. (2-tailed)	.	.000
	N	30	30
Rice yield	Pearson Correlation	.855(**)	1
	Sig. (2-tailed)	.000	.
	N	30	30

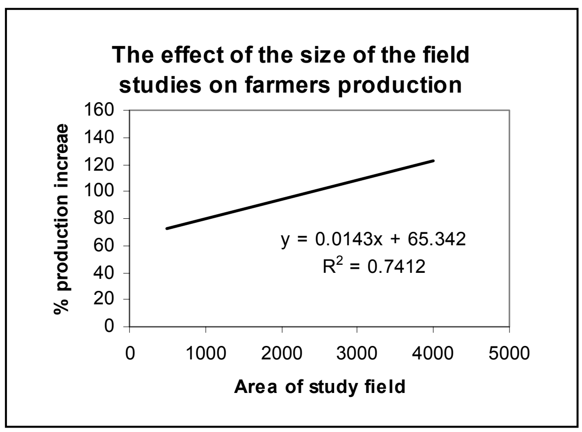
** Correlation is significant at the 0.01 level (2-tailed).



A significantly positive relationship (r = 0.855, n = 30; P>0.01) was found between the study-area and the percent of yield increase by individual farmers.

Table 39: Study-field size and its effect on farmers' production increase in 2002

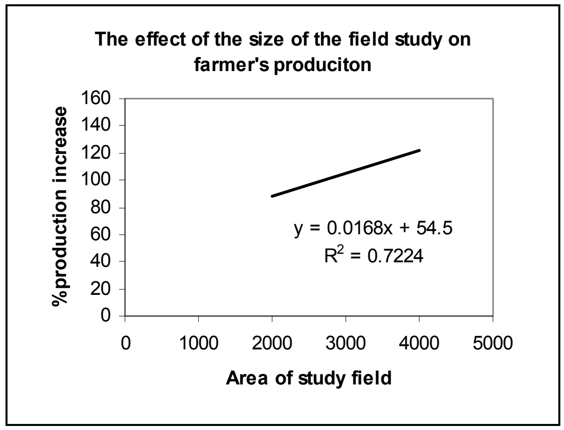
FFS	Area	% increased
Nawng Hkying	1000	82
10 Miles	1500	95
Gat Sha Yang	3000	102
N-gan	4000	147
Nawng Hkyi	500	59
Gara Yang	1000	87
Ja Pu	600	74
Awng Mye Tit	3000	100
Mai Sak Pa	500	76
Lawa Yang	4000	105



In the first batch of FFS, since they were first FFS to be introduced by the program in 2001, a larger variation was noticed in the size of the study-fields. The size of FFS study-field in this particular year ranged from 500 square meters to 4000 square meters with the majority below 2000 square meters.

Table 40: Study-field size and its effect on farmers' production increase in 2003

FFS	Area	% increased
Hka Wang	4000	105
Pung Dung	2000	90
Chyara Pati	4000	121
Mali Hka	4000	122
Mading	4000	129
Katsu	4000	134
Thing Nan Kawn	4000	109
N myen	4000	126
Ding Hkung	2000	86
Nalung (lower)	4000	126

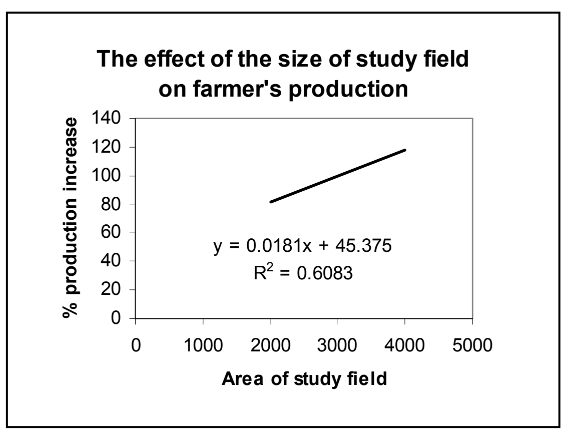


It was interesting to notice that a higher percent increase in production by farmers came from FFSs that had a larger-sized study field, and there had been for the first time a positive relationship observed between the size of the study fields and the percentage of production increase by the associated FFS farmers **(figure under Table 39)**.

Based on such learning, the project in the following years emphasized larger-sized study-fields, except in a few locations (two out of the ten selected sampled FFS in both 2002 and 2003) where due to some social constraints or the facilitator's limited understanding, it was not possible to establish larger-sized study-fields.

Table 41: Study-field size and its effect on farmer's production increase in 2004

FFS	Area	% increased
Lahta Maw Hpang	4000	100
Khan La	2000	90
Nam Koi	4000	100
Nan Nawn Pa	4000	133
Jam Ga	4000	115
Nam San	4000	129
Sam Pai	4000	125
Gang Dau	4000	111
Dinga Yang	2000	73
Daw Hpum	4000	128



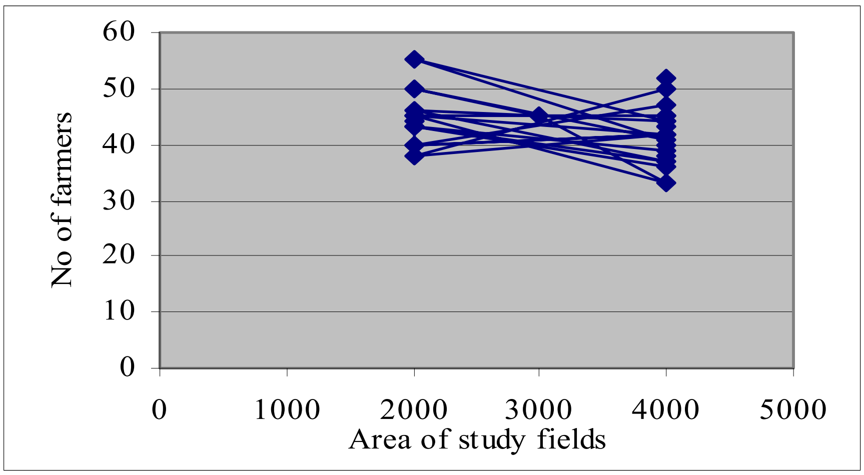
The results in these years were found to be very similar to those in the first year, and again the higher percentage of production increase by farmers came for FFSs that had larger-sized study-fields **(Tables 40 and 41)**.

How the larger-sized study-fields influenced the attainment of higher production increases was that it gave farmers a clearer picture about the adoptability/adaptability of the practices in large areas. Though farmers are generally impressed by the superior yields of SRI, due to the intensity of the practices, many farmers under FFS with smaller size study-field were not confident enough to put more of their own area under SRI. On the other hand, farmers who participated in FFSs with a larger-sized study-field saw for themselves the practicability of using SRI on a larger scale. The use of SRI on around 4000 square meters area – the size of an acre of land, with better yield performance -- was a good demonstration of the methods' capabilities. As a result, these farmers were very confident and put more area under cultivation with SRI methods. They were able to produce more than the other farmers from FFSs with smaller sized study-fields.

6.10.2. The Effect of size of FFS study-field on the number of farmers adopting practices

Based on the data plotted in **Figure 13** regarding the number of farmers, both FFS and non-FFS, who were found using SRI practices on their fields in the first year after their graduation from an FFS, and the size of the study-fields of their FFSs, no concrete relationship was found between the size of the study-field, whether small or large, and the number of farmers using SRI practices.

Figure 13: Effect of the size of FFS study-field on number of farmers adopting SRI



According to the data derived from 30 sampled FFS in a three-year period, under both categories of FFS, with larger as well as smaller-sized study-fields, there were higher as well as lesser numbers of farmers found using SRI practices (Table 42).

Table 42: Mean effect of the size of FFS study-field on the number of farmers adopting SRI practices

Size	2002 (N)	2002	2003 (N)	2003	2004 (N)	2004	2002-2004 (N)	2002-2004
2000m	6	45	2	43	2	42	10	44
4000m	4	40	8	43	8	43	20	42

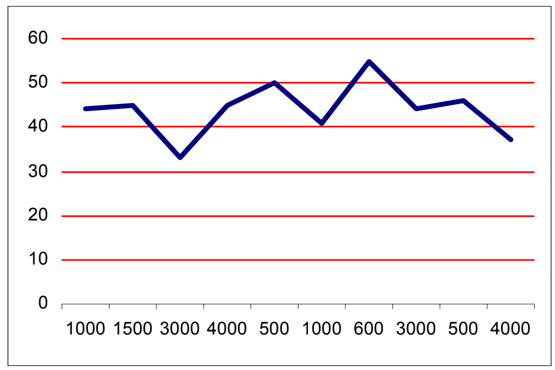
(N) = number of FFS

Among the first batch of FFSs in 2002 -- the first year after the graduation of FFS -- 55 farmers were found as the highest number of farmers using the SRI practices, and they were from a FFS that had a study-field less than 2000 square meters (600 square meters); while against this, 33 farmers was the lowest number of farmers using the SRI practices in a FFS that had a study-field more than 2000 square meters (3000 square meters) **(Table 43)**.

Table 43: Effect of FFS study-field area on the number of farmers using SRI in 2002

FFS	Area	Farmers
Nawng Hkying	1000	44
10 Miles	1500	45
Gat Sha Yang	3000	33
N-gan	4000	45
Nawng Hkyi	500	50
Gara Yang	1000	41
Ja Pu	600	55
Awng Mye Tit	3000	44
Mai Sak Pa	500	46
Lawa Yang	4000	37

Relationship

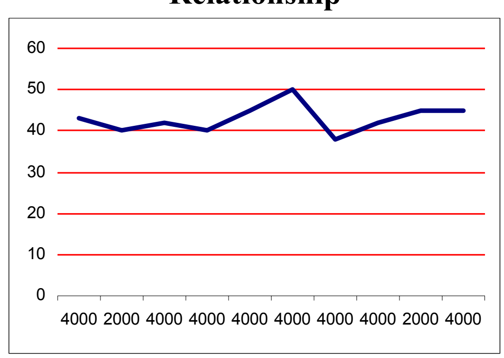


Similar results were observed in 2003 and 2004 among the second and third batch of FFS. The size of the study-field was found to have no impact on the number of farmers using the practices on their fields.

Table 44: Effect of FFS study-field area on the number of farmers using SRI in 2003

FFS	Area	Farmers
Hka Wang	4000	43
Pung Dung	2000	40
Chyara Pati	4000	42
Mali Hka	4000	40
Mading	4000	45
Katsu	4000	50
Thing Nan Kawn	4000	38
N myen	4000	42
Ding Hkung	2000	45
Nalung (lower)	4000	45

Relationship

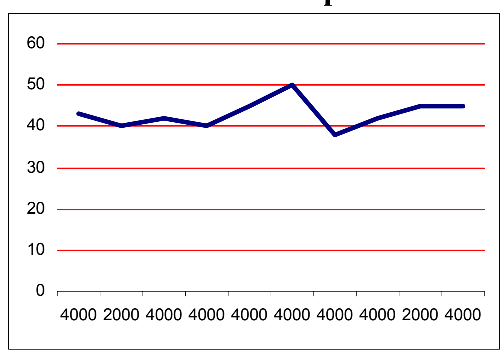


Why there should have been no relationship found between the two variables could be because the primary purpose of the study-field was to provide farmers an opportunity for learning and practicing the methods of SRI and other aspects of rice production. Regardless of the size of study-field, whether small or large, the field was able to provide this opportunity to farmers successfully. Therefore, although the study-field was an important factor in farmers' learning and decision-making about the use of the practices on their fields, its size was not an important factor affecting their success in using the methods since both smaller and larger sizes of study-field were equally successful for that purpose.

Table 45: Effect of FFS study-field area on the number of farmers in 2004

FFS	Area	Farmers
Lahta Hpang	4000	36
Khan La	2000	43
Nam Koi	4000	39
Nan Nawn Pa	4000	44
Jam Ga	4000	52
Nam San	4000	43
Sam Pai	4000	38
Gang Dau	4000	47
Dinga Yang	2000	40
Daw Hpum	4000	42

Relationship



The most important influence that the size of study-field had on the adoption of SRI was that it influenced the scale of adoption by individual farmers, as clearly shown in the previous sections, but not on the total number of farmers. The factors that led to field size having an influence on the number of farmers using the practices are different. Based on the results presented in Section .9.6, it was the entire process and the overall approach to FFS that were mainly responsible for influencing the overall number of farmers adopting the SRI practices.

6.11.The effect of FFS field day

The field day is an important activity in FFS strategy, seeking to share the results and outcomes of FFS experience with the other farmers in the community. Based on the result presented in Section 6.9.2, among the many activities in an FFS, farmer field days were found to be the most important factor in influencing the adoption of SRI by non-FFS farmers. This result presented in the earlier section was based on opinions and discussions with farmers organized in groups. This section provides further validation to the results that a significantly positive relationship exists between the field day and the adoption of SRI by community farmers.

The effect of the field day was studied from 2002 to 2004, based on the number of non-FFS farmers from each community who attended a field day, and the percentage using these practices on their own fields in the following year. According to recorded data, the number of farmers who were found using the SRI practices on their fields, after being influenced by the field day activities, constitutes a significant percentage of the total number of farmers who were using SRI practices in each FFS. From the recorded data among the first batch of FFS graduates, we see that on average, 30 non-FFS farmers from each community were found to attend the field-day, and from among them, 24 were subsequently found to be using the practices on their own fields in the next year **(Table 46)**.

Table 46: Effect of FFS field day on the use of SRI practices in 2002

FFS	Farmers who attended field day	Farmers using the practices		% of total farmers using the practices
		No.	%	
Nawng Hkying	30	20	67	45
10 Miles	35	25	71	56
Gat Sha Yang	25	15	60	45
N-gan	25	23	92	51
Nawng Hkyi	35	30	86	60
Gara Yang	32	26	81	63
Ja Pu	38	32	84	58
Awng Mye Tit	30	26	87	59
Mai Sak Pa	25	23	92	50
Lawa Yang	25	18	72	49
Mean	30	24	80	54

In the 10 selected sites, a total of 300 farmers attended field days, and from among them, 238 were found to be using the practices on their fields. This constitutes 80% of the total farmers who attended the field day, and 54% of the total farmers those using the SRI practices on their fields in the immediate next year after the field day **(Table 49)**. In the second batch of FFSs in 2003, the number of non-FFS farmers who attended the field day of their community's FFS was found to range from 20 to 36, with a mean of 27 per FFS. From among them, 23 were found subsequently using the practices on their fields. This result indicates a little higher percentage of farmers than in the previous year using the practices on their fields **(Table 46)**.

Table 47: Effect of FFS field day on the use of SRI practices in 2003

FFS	Farmers who attended field day	Farmers using SRI practices		%of total farmers using SRI practices
		No.	%	
Hka Wang	25	23	92	53
Pung Dung	28	22	79	55
Chyara Pati	23	20	87	48
Mali Hka	20	20	100	50
Mading	26	23	88	51
Katsu	36	30	83	60
Thing Nan Kawn	30	20	67	53
N myen	26	22	85	52
Ding Hkung	29	27	93	60
Nalung (lower)	30	25	83	56
Mean	27	23	85	54

Table 48: Effect of FFS field day on the use of SRI practices in 2004

FFS	Farmers who attended field day	Farmers using technology		Percent of total farmers using technology
		No.	%	
Lahta Maw Hpang	25	16	64	44
Khan La	26	21	80	49
Nam Koi	22	19	86	49
Nan Nawn Pa	28	24	86	55
Jam Ga	30	28	93	54
Nam San	28	24	86	56
Sam Pai	22	18	82	47
Gang Dau	25	22	88	47

Dinga Yang	24	20	83	50
Daw Hpum	26	20	77	48
Mean	26	21	83	50

he pattern of results found in the third batch of FFS was very similar to the previous two years where on average, 26 farmers were found to have attended the field-day and from among them, 21 were using the practices on their fields **(Table 48)**. This indicates that 83% of the farmers who attended the field-day were using the practices on their fields.

The mean effect of field day exposure

In the three-year period, great consistency was observed in terms of the percentage of farmers who adopted the practices on their fields after attending the FFS field-day **(Table 49)**. According to the average from three years, more than 80% of the farmers who attended a FFS field day were found using the practices on their fields in the next year after the field day. This is a significant number and confirms that the field day is a very effective activity in FFS to disseminate SRI practices among community farmers when there are results as evident and dramatic as those demonstrated by SRI methods

Table 49: Mean effect of FFS field day on the number of farmers adopting SRI practices

Year	No. of non-FFS farmers who attended field day	Farmers those influenced by the field day		
		No.	% of those who attended the field day	% of total farmers using the practices
2002	300	238	79	54
2003	273	232	85	54
2004	256	212	82	50
Mean	829	682	82	53

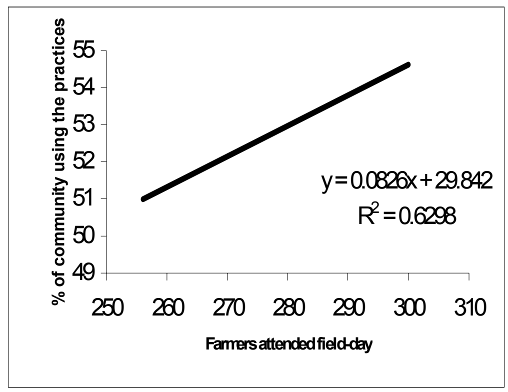
Outcomes cannot be attributed to the field day alone. Farmers were unlikely to be influenced just by the field day to use the demonstrated practices on their fields, as there were some other factors involved in the decision-making of farmers as seen in Section 6.9.2. But it is clear that the field day had a very definite impact given the percentage of farmers in each community who attended and were subsequently using the practices on their fields. According to the Pearson correlation test, the correlation between field-day attendance and adoption of the practices was found significant at 1% level.

The data presented in the first section of this chapter indicated that rice yields within the FFS study-fields, where FFS farmers grow rice together and study various issues of rice production, are much higher than those of their usual yields with standard methods, averaging 158 to 257% higher than the yields they got before participating in FFS, representing a kind of baseline. These higher yields achieved by the farmers are a clear indicator of the effectiveness of their new skills that they obtained from FFSs.

Table 50: Correla

		Attended field-day	Using the practices
Attended field-day	Pearson Correlation	1	.719(**)
	Significance (2-tailed)	.	.000
	N	30	30
Using the practices	Pearson Correlation	.719(**)	1
	Significance (2-tailed)	.000	.
	N	30	30

Trends over three years



Production data presented in the second section indicated how farmers' production per household increased on their own fields when they applied the new practices of growing rice that they learned from FFS. According to the data, application of the new practices on their own fields provided almost all of the farmers who participated in FFS, on average, more than a two-fold increase in their annual production of rice compared to their previous levels before participating in FFS.

In the third section, the comparisons of cost and return analysis using various methods demonstrated that the costs of producing rice using the practices/methods facilitated by FFS are essentially the same as, or possibly somewhat lower than, their conventional methods of growing rice when calculated on a unit-area basis. The returns, however, are found two times higher, or more, than their previous levels. The cost when calculated in terms of unit-volume of rice is just one-third of their traditional cost. Farmers using the practices of SRI can thus now grow three times more rice than before with the same cost.

The results presented in section four showing the trends of yield stability indicate that farmers are capable of maintaining yields in subsequent years as high as or higher than what they achieved on their farms in the first year after FFS training. These trends of yield stability indicate that the new practices used in rice production are highly sustainable.

Then section five presented what types of technologies/practices farmers adopted or adapted for use on their fields, and which practices contributed how much to yield increase. According to the data presented in section six, the majority of FFS farmers are using SRI as their main approach for growing rice, and the use of SRI has provided them maximum yield benefits.

Sections seven and eight demonstrated how SRI practices are spreading to other farmers in the communities, and how these other farmers are benefiting from such spread. The data indicated that SRI practices when facilitated through FFS methods can reach all of the rice farmers within a community within a four-year period if just one-third are trained at the beginning of the period. From such spread, each and every farmer using these practices can make significant production and yield gains.

Section nine presented factors made how much contribution to the overall spread and adoption of SRI by farmers. In this adoption of SRI by FFS farmers, the activities in and the higher yields from FFS study-fields, plus the learning activities of FFS had a significant influence, while the field-day activities, the sharing from FFS farmers, and the higher yields on both FFS-study-fields and FFS farmers' own fields made a large contribution to the adoption of SRI by non-FFS farmers. Sections ten and eleven further confirmed these results with more in-depth study and analysis. These concluding paragraphs can be considered a summary of empirical results reviewed in this chapter above. A more comprehensive conclusion for the overall study is made in the next chapter.

Chapter 7
Conclusions

The primary purpose of this study was to: 1) investigate and assess the adoptability/adaptability of SRI by farmers through and FFS experience, 2) study the interactions and relationships between SRI and FFS, and the particular factors that contribute to the adoption and adaptation process with SRI, and 3) assess the overall contributions and the combined effects of both SRI and FFS to improving the socio-economic conditions, as well as the livelihoods, of resource-poor farmers in Myanmar.

The effect and the contributions

In terms of the contributions to improving the livelihoods and socio-economic conditions of the resource-poor farmers, rice yields and productions are considered as relevant and meaningful indicators. Rice is the main source of income and livelihood for the vast majority of farmers in the region, as stated in the introductory chapter. Based on the results presented in the Sections 6.1 and 6.2, both SRI and FFS are found to be not only effective in increasing rice yields as well as production; their combined use has actually set an example for how effectively they can enhance the livelihoods and socio-economic conditions of resource-poor farmers in Myanmar.

The combined effects of FFS and SRI were found very impressive first in terms of enhancing rice yields on a per unit area basis. As compared with the conditions before, farmers' rice yields after FFS experience were found to be consistently higher, averaging more than 200 percent increase from their baseline conditions. This large yield increase came from the use of the various different practices promoted by the FFS, the major share of this deriving from the core practices of SRI.

A second distinct effect was seen in the area of per household production increase, during and/or after the FFS experience. As seen in Section 6.2, farmers' average production, after starting to use SRI practices, was found to be enormously enhanced, by more than two times the average of their previous production before FFS. With such a huge increase on average, each family was able to produce more than 2 tons of extra rice per hectare. For a family to achieve this with their traditional practices, they would have to put into cultivation, a similar amount of land to that which they cultivate now.

The third effect was that although yields and production had increased so dramatically, there had been no increase in production cost. This overall finding on cost and returns is very astonishing. Contrary to the views of any who think that SRI must involve more cost than the conventional methods due to the intensity of its practices, SRI was found to be far more cost-effective than any other methods of growing rice. With traditional methods, the returns that farmers usually derive from rice cultivation were found to be very low; some farmers were even found losing money from the process, while for the majority it was more or less a break-even operation. In such conditions, the use of SRI has made rice cultivation a profitable venture to the farmers.

As the cost of production is usually calculated on a unit-area basis, this system of cost analysis does not provide the real pictures of cost, since the output is always determined in terms of the volume of rice produced. When cost is calculated on a unit-area basis, such as per hectare, the cost of production of rice using SRI methods was found to be either equal to or little less than with the traditional methods. But if the cost is calculated per unit volume of production, the cost of producing rice with SRI practices was found to be just as one-third of what is needed with the traditional practices.

On the basis of yield per unit area (per hectare), production per household, and production cost both by acreage and by unit volume of product, rice production using SRI practices is definitely highly effective and more profitable than with traditional or conventional methods. SRI practices could also be considered sustainable over a relatively longer period of time (at least three to four years) as there was no sign either of yield or production declining on farmer's fields; neither has there been any increase in production costs. The yields, the production and production costs were all found to be very stable compared with farmers' traditional or conventional methods and were, if anything enhanced over time.

Among the practices used by farmers, the contributions of SRI to yield increase were found to be enormously high, providing a 143% yield increase when used alone, and up to a 253% increase when combined with quality seeds and a good rice variety. Although the use of quality seeds and good rice varieties were not part of the practices considered essential to SRI, they were found very beneficial in enhancing rice yields. SRI provided the maximum yield increase when combined with quality seeds and good rice variety. This means that SRI offers significant synergy when combined with quality seeds and good rice varieties. The contributions of quality seeds and good rice varieties were also found to be higher when they were used together with SRI or with each other than when they were used alone.

The adoption process

Based on the results presented in Sections 6.6 to 6.8, the rate of adoption of SRI along with quality seeds and a better rice variety was found to be significantly high. In the first year of FFS, which was when farmers began to learn about the practices by experimenting and growing rice on the FFS study-field, it was only the FFS farmers who were found simultaneously using the practices on their fields along with the study-fields of FFS. But in this year, 15-20% of them were able and willing to apply the complete practices of SRI on their fields. Others were able to use the practices only partially as they had already missed the time for using many other practices. In the next year, the first year after the graduation from an FFS and the year for applying the practices, all the farmers who participated in the FFS were found to be using the practices on their fields.

In the same year, along with these FFS farmers, in each community a similar number of non-FFS farmers who had not participated in an FFS were also found using the practices on their fields. The number of such non-FFS farmers in the following years continued to increase, and within a three-year period after the graduation of an FFS cohort, practically all of the farmers of each community were found to be using the practices on their fields.

According to the recorded data, 20 farmers on average participated in each FFS. In the first year after the graduation of FFS, along with these 20 farmers, there were 24 additional farmers whom we are calling 'non-FFS farmers' who were using SRI practices to different degrees on their fields. In the second year after the graduation, the number of such non-FFS farmers was found to be 33, and in the third year, this number had risen to 43, making a total of 63 FFS and non-FFS farmers in each community who were using the new practices. In fact, this is the average number of farm families living in a community in this region.

In terms of the percentage of farmers in a community using SRI following the the organization and training of a cohort of local farmers (about 25) in a FFS, in the first year of an FFS, 31% of the farmers were already practicing the new methods on their own fields, parallel to their FFS experiments; in the second year, it was 69% of farmers, while in the third and fourth years, 83% and 99% of the farmers in each community were, respectively, using the practices on their fields.

At the end of four years after FFS initiation (or the third year after graduation), all of the farmers in each community were found to be using the practices facilitated by FFS. They all were experiencing tremendous yield increases from using the practices on their fields as well as being able to maintain such yields and even further improve them. There were, however, variations observed in terms of the percentage of production increase between FFS farmers and non-FFS farmers. FFS farmers, being direct participants, had better understanding and knowledge compared with their non-FFS neighbor farmers who learned the practices from the FFS farmers and were not quite as successful.

This difference in ability between FFS farmers and non-FFS farmers is a natural phenomenon because of differences in the level of study and experience of FFS farmers. Also, FFS participants were a self-selected group, so they may be more energetic and innovative to begin with. This is obviously going to happen in any similar case. There was, however, great consistency observed in the overall ability of non-FFS farmers to successfully maintain the production increase experienced in their first year after using the practices over the considerable period of time.

Production increase was directly related with the number of practices and the amount of areas where these practices were applied. According to the recorded data, the average percentage of production increase by FFS farmers was found to be 90%, as against 49%, 48%, and 47% by non-FFS farmers in the first year, second year and third year after the graduation of the FFS. Although the production increase by the non-FFS families was lower compared with FSS families, nearly a 50% increase in total production on a per-household basis is, of course, a huge increase when compared with what farmers in other communities whose rice production is still traditional are still producing.

The higher percentage of production increase achieved by FFS farmers means that they used the practices in larger areas compared with the non-FFS farmers. It might also be possible that they used a larger number of the SRI practices than were used by non-FFS farmers. Depending on the category, 67% of farmers were found using the core practices of SRI, either with or without quality seeds in various combinations, while the rest were found using only either quality seeds, or good varieties, or both together. This result was found based on the practices applied by farmers in their first years after graduation from a FFS. In the following years as they become more competent and confident, they have applied more practices.

The factors that were found influencing such a higher degree of adoption of SRI and other practices facilitated under FFS have had unique roles in influencing the decision-making of both FFS farmers and non-FFS farmers. Specifically, the FFS study-field and the regular learning sessions of FFSs had significant influence on the adoption of SRI by FFS farmers. Within the study-field, farmers' experimentation and growing rice together on the study-field areas had a significant influence on their decision-making to adopt the SRI on their fields.

For non-FFS farmers, the factors having the most influence on adoption were the field-day activities of FFSs, the sharing of experience of FFS farmers, and the higher yields of rice observed within the FFS-study fields and within the fields of FFS farmers. The latter in particular had a significant influence on decision-making to adopt the practices on their fields.

The interactions and relationships

As seen above, the achievement of significant yield and production increases by farmers, reduction of production costs, and the large-scale adoption of SRI across the communities are the combined effect of FFS and SRI. It is difficult to separate how much of this contribution came from the FFS organization and methodology and how much is attributable to the inherent productivity of SRI concepts and methods. Based on the responses of farmers, and by analyzing the factors that influenced the overall adoption of SRI, both by FFS farmers and non-FFS farmers, a number of conclusions could be drawn about which FFS activities supported the large-scale adoption of SRI, and which activities of SRI strengthened the performance of FFS by providing more opportunities for dissemination of the practices and the knowledge that it facilitated for farmers.

The primary purpose of FFS programs was to provide farmers with adequate knowledge and skills to improve their decision-making so that with this new knowledge and these new skills, they could make better decisions on how to improve the productions and productivity of their rice fields. In doing so, FFS activities provided more emphasis on experimentation to find out methods and practices that are more effective and sustainable in enhancing rice production. SRI, being the most effective and sustainable method of growing rice and enhancing yields, its introduction to the FFS program has made FFSs more effective vehicles for finding the most appropriate methods of growing rice. On the other hand, to be most effective, SRI requires continuous experimentation on how to adapt the methods to local conditions. Hence the regular experimentation process of FFS strengthens the performance of SRI by providing most effective opportunities for experimentation. This is how they supported each other. For the purpose of enhancing production, both have similar goals on how to improve the production and productivity of rice.

In this adoption process, the size of the study-field was an important factor in terms of the scale of adoption of SRI practices; on how much area the practices were applied by the farmers had a bearing on their willingness and skill to use the new methods. The larger the size of the study-field, the higher was the scale of adoption by the individual farmers.

The other factors or activities, that were found instrumental in yield enhancement as well as in the adoption process, were the practices of SRI themselves, which made such high yield possible. The higher yield of rice was found as to be an important factor influencing the adoption process. Therefore, the yield-enhancing activities of the practices, and the resultant higher yield, should be recognized as a crucial contribution of SRI to shape the adoption process.

Other activities that could be given credit as common to both FFS and SRI in the adoption process were: 1) the informal sharing that took place between and among farmers, and 2) the rice fields of the those farmers who used the SRI practices becoming demonstration plots for other farmers in the community. This was discussed in Section 6.9.2 as important factors influencing the adoption of SRI by non-FFS farmers.

Based on all the findings and the conclusions presented above, it could be concluded with confidence that the combined activities and effects of FFS and SRI have resulted within each community in the development of: 1) the skills and confidence of a core group of farmers (FFS farmers), and 2) a learning-cum-sharing process which can drive broader processes of agricultural development and modernization forward. The learning is not limited to FFS participants but is spreading to all the farmers in the communities where FFSs are conducted, with the result that the whole farming sector becomes better able to learn and share how to adopt the practices for desirable yield gains. That was how the adoption of innovations has been taking place in the Kachin State and Shan Sate of Myanmar since 2000. Since this area is considered to be a socio-economically disadvantaged and difficult one, the success of FFS and SRI methods there should give encouragement that similar gains can be achieved elsewhere.