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Geographical analysis on the variation in agricultural technology diffusion among the farmers near Taungoo University

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Abstract

This paper analyzed the process of agricultural technology SRI (System of Rice Intensification Method) diffusion from Taungoo University to the local farmers based on structured interview conducted to 354 farmers living near Taungoo University. The results reveal that although SRI method diffused from Taungoo University to farmers based on the economic, social and infrastructural factors, many farmers could not adopt it in practice for lack of investment, for not receiving detailed information, varied physical environment (flooding or hilly for water control), unreliable weather, and low education level of farmers. However, majority of these difficulties could be overcome by means of some modifications in SRI method, giving training for new technology, providing investment for farming and guarantee for farm produces. Since SRI method uses less farm input and no chemical fertilizer, it is one of the ways leading to sustainable organic farming. Thus, this technology should be encouraged by means of searching more locally suitable SRI methods and providing farmers with necessary technology and investments.

KeyWords: Technology diffusion, Farmer, System of Rice Intensification

Introduction

Agriculture sector is the backbone of Myanmar economy. It contributes 32 percent of GDP and 17.5 percent of total export earnings. In addition, 61.2 percent of the labour force is engaged in agriculture in 2010 (DAP, 2011). Since majority of farmers are living in rural area agriculture development plays a key role in alleviating poverty of rural farmers. Myanmar used to be the largest rice exporter in the region. Later, Thailand and Vietnam took the leading role in rice export. One of the weak points of Myanmar paddy cultivation is that farmers put too much reliance on traditional cultivation methods (Maung Maung Htwe, 2011).

Ministry of Agriculture and Irrigation sets out five objectives for agriculture development. These strategies are (1) development of new

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agriculture land, (2) provision of sufficient irrigation water, (3) provision and support for agricultural mechanization, (4) application of modern agro-technologies, (5) development and utilization of modern varieties (DAP, 2011). All these strategies aimed to increase paddy production both by means of expanding agriculture land and increasing yield per acre from existing lands. Expansion of agriculture land is carried out by means of agriculture land area expansion and intensification of existing land use (multiple cropping). Increased yield is aimed to gain by using high yield varieties and large amount of farm inputs such as fertilizer, and pesticides.

However, world vision on the paddy cultivation is gradually changing during the last decades. Since the Green Revolution, world paddy yield increased substantially. However, recent trend reveals downturn in production (Spielman and Pandya-Lorch, 2009) due to impact of high-input farming together with mono-cropping, modern varieties, fertilizer and pesticide use. Thus, post-Green Revolution perspective demands innovative strategies that are resources conserving and technologically feasible. In this situation, SRI is considered as a solution for its knowledge-based low-external input technology, promise higher yields with no deleterious impacts on natural resource at affordable costs for poor smaller farmers (Noltze, 2011).

SRI method is not a new technology in Myanmar. Some farmers from Patheingyi Township, Mandalay Region have already practiced modified SRI method in paddy cultivation since the beginning of present century. However, this method was not widely adopted due to too much reliance of farmers on the traditional methods of cultivation (Aung Kyaw, et al, 2007). Under the newly elected government, Myanmar is gradually shifting its strategy to gain high yield by systematically using farm inputs. This strategy was mainly based on the modified SRI method (good agriculture method) and started nationwide since early 2011 (Maung Maung Htwe, 2011). New agricultural methods are usually disseminating to farmer throughout the country by launching large scale demonstration plots and block-wise crop production zones at the entrance and exist of each township (DAP, 2011). However, it takes a long time to diffuse a new agricultural technology from its source to farmers. Thus, for effective and quick diffusion of a new agriculture technology to the farmer, researches related to the process of technology diffusion and constraints that exist between awareness and practice become necessary.

This paper emphasized on the above necessity from the case study of farmers located near Taungoo University. Paddy and matpe cultivations started in Taungoo University with the objectives of getting opportunities for low income university staffs since 2009. However, success in matpe cultivation (highest yield is about 30 baskets per acre) and successful adoption of SRI method in paddy cultivation (in some cases, yield is more than 120 baskets per acre), university widen its objectives and now is aiming to become an agriculture technology dissemination center for local farmers. SRI method was adopted as a pioneer in the farm of Taungoo University in 2010. This is one year before the nationwide motivation for adoption of good agriculture method. Conference on the paddy cultivation by using SRI was also hold at Taungoo University with the participation of regional authority concerns, academicians from Yezin Agriculture University, Taungoo University and other Arts and Science Universities, and 5 farmers from each village tract of the township in December, 2010.

Research Questions

This paper tried to examine the process of SRI technology diffusion with the following research questions.

(1) What is the situation of currently practicing farming technology?

(2) What is the situation of agricultural technology diffusion from Taungoo University to farmers living near the university?

(3) What are the major controlling factors for agricultural technology diffusion?

(4) Do farmers like to adopt new technology? What are the factors that constrain in adoption of new technology?

Study area

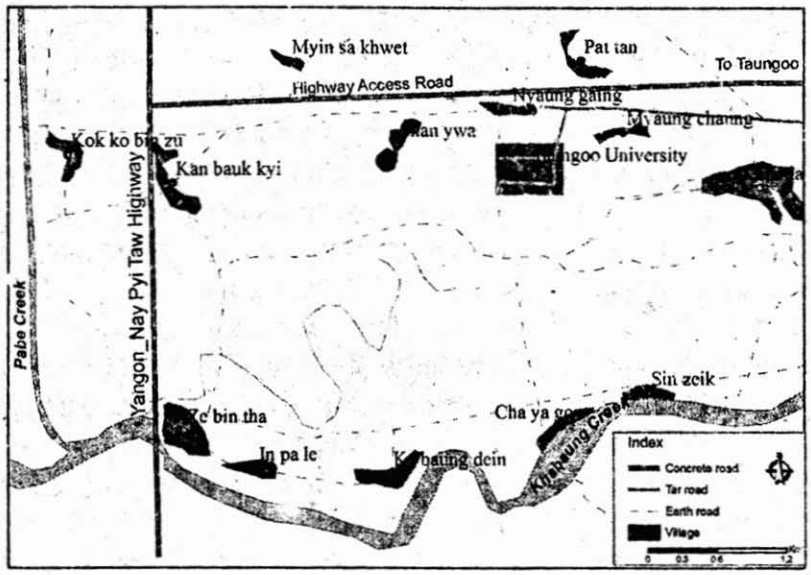

Figure (1) Location of study area (12 Villages)

Source: 1:50000 scale UTM Map No. 1896-05

The study area, Taungoo University is located about 4 miles away in the west of Taungoo City. Newly constructed road that connect Taungoo and Yangon-Nay Pyi Taw Highway is passing near the university (Fig. 1). It is located in Nyaung gaing Village of Sin zeik Village Tract, Taungoo Township, Bago Region. There are 12 villages included in Sin zeik Village Tract. Farmers from these 12 villages were selected to study the technology diffusion.

Data and method

To answer the above research questions, structured interviews were conducted to 354 farmers living 12 villages included in Sin zeik Village Tract in June 2011. Since there were 409 farmers in these villages the sample cover about (86.55) percent of study area. Derived data were analyzed by using Microsoft Excel. Then, Discriminant Analysis was conducted by using SPSS Version 16, to find out the factors controlling the diffusion of technology to the farmers.

Previous Studies and Theoretical Framework

Diffusion refers to the spread of a phenomenon over space and through time (Johnston, et. al, 1995). Information diffuses from the source and passing through the area of individual socioeconomic conditions before accepting and finally practices (Aung Kyaw, et al, 2009). Thus, the diffusion and adoption processes of a new agricultural technology could be explained as shown in Figure (2). The main source of SRI method is Taungoo University. From its source, information of SRI method diffuses to the nearby villages. Since there is no distinguished physical barrier between the university and surrounding villages, distance measure and media (mode) of diffusion could be considered. Then, when people get the information, they have to decide whether they should adopt the new technology or not. In that case, existing infrastructure that facilitate diffusion, and policy that facilitates or constraint the practicing of derived information are involved. In addition, individual's socioeconomic conditions and traditions follow by both individual people and/or the whole village control the actual practice. The process passing through the farmer's internal and external conditions is the most important part in adoption of a new technology. If majority of information and technology were diffused to farmers, they know whether it is good or bad to practice. In many cases, although farmers accept the information as practicable one and the result will benefit to them, they could not do in practice due the above mentioned farmer's internal and external constraints. If farmer decide to adopt or practice their derived technology, strong information exchange occurs between the farmer and source of technology both directly and indirectly.

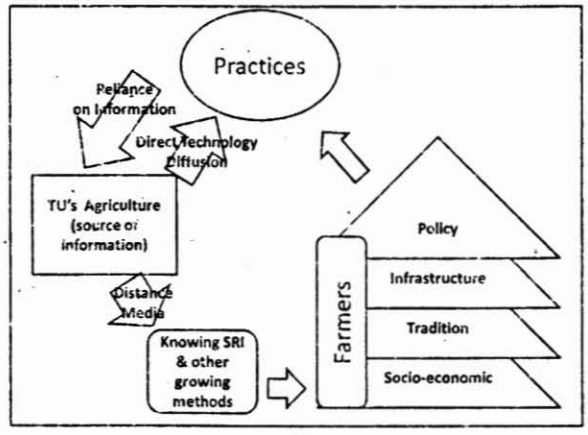

Figure (2) Process of technology diffusion and practices Modified from (Aung Kyaw, et al, 2009).

System of Rice Intensification and Traditional Rice Cultivation Method

Before considering the technology diffusion, it is necessary to understand the differences between the traditional agriculture practicing in the region for nearly 4 decades and more advance method (SRI) practicing in some other regions of the world. The concept of SRI was developed by Fr. Henri de Laulanié, a French missionary priest in the mid-1980s in Madagascar (McDonald, et al, 2005). It was originally aimed to enable small-scale farmers increase rice yields by using less water and seed. SRI is mainly concerned with the practice of farmer in managing plants, soil, water, and nutrients. It is a complex agricultural production system, leading to high agroecological and biological productivity without necessarily increasing external key inputs such as mineral fertilizer and pesticides, labour or capital (Noltze, et al, 2011).

There are major differences between traditional paddy cultivation method and SRI method. First, the seed used in SRI should be carefully selected because only one seedling is used in one plot thus quality of every seeds used in cultivation are strongly related to yield. Major paddy seed distributer is Yezin Agricultural University in Myanmar. Newly developed hybrid high yield seeds are directly distributed to key farmers. Then, second generation seeds are further distributed to respective regions from those key farmers. According to interviews it is observed that only second or third generation seeds are suitable for high yield because mixing of paddy species could effect on yield by means of variation in harvesting time.

Second point of difference is method of nursery for seedlings. In traditional method, an acre of paddy cultivation needs to use 3 to 4 baskets of paddy seed and 0.122 hectare (0.25 acre) of nursery (plowing) for sowing. In case of SRI method only 0.22 baskets of seed and 0.0037 hectare (0.0092 acre) (soil nursery block) of land is necessary. Thus, SRI method could save large amount of seed and labor in land preparation. In addition, soil nursery blocks could be constructed at the nearest location within the farms, thus, transportation cost of seedling could be greatly reduced.

Third point is nursery period. In traditional method, young seedlings were transplanted to the field within 25 and 30 days. In case of SRI method, however, nursery period is only 8 to 10 days. By means of reducing the nursery period branching rate of paddy plant will increase nearly two times.

Fourth factor is related to the nature of planting. Instead of planting 3 to 5 seedlings in each planting SRI uses only one seeding in each planting. In

addition, SRI method uses wider inter-plant and inter-row distances of each plot. By means of reducing amount of seedling and increasing distance between plants, SRI method facilitates paddy plant to be able to take nutrients more freely than traditional method. This point contributes to the well development of branching rate. It is also observed that the quality of seed bearing from the branches is better than the one bearing from main stem. Thus, even the yield rate is equal, the quality of paddy is better in case of SRI method.

Fifth point is, intermittent flooding of paddy-field in SRI method, instead of continuously flooding in traditional method. Thus, SRI method could save water compared to traditional method. In addition, dry and wet alternation of soil promotes better aeration and encourages development of roots. Subsequently it contributes to the more branching and healthy plants.

Sixth point is related to sustainability of agriculture. In traditional paddy cultivation method, farm-inputs such as fertilizer and pesticide are essential. However, SRI method uses plant compost and silts instead of chemical fertilizer. Thus, this new technology is more environmental friendly and leading to the organic farming. Incorporation of organic manure into the soil supports root activities by stimulating growth promoting bacteria (Mishra, et al, 2007).

In terms of cost, SRI method saves cost of seed, labour (although it is more expensive in the very first year under traditional environment), for pulling out and carrying young seedling, and transplanting. However, it is necessary to train female labourer in transplanting. In case of Taungoo University, labour requirement of the transplanting an acre of land was 24 workers in the first year. It is nearly double the amount of traditional cultivation method. In the second year, however, labour requirement could be reduced up to 10 and can save 1 to 3 labour per acres than traditional method.

Results

In the first section we posted four research questions. The first research question is "What is the situation of currently practicing farming technology?" To understand the first question, knowledge about the generation of cultivating seed, inter plant and row ranges, number of seedling planted in each plot, nursery period and condition of water control are considered. Figure (3) shows the source of paddy seed planting in their farm in last year. More than 80 percent of farmers use the seed having from

previous harvest. Only 18 percent purchase from other named places of high yield. Actually, about 82.7 percent (n=341) do not even know the generation of paddy seed they are growing.

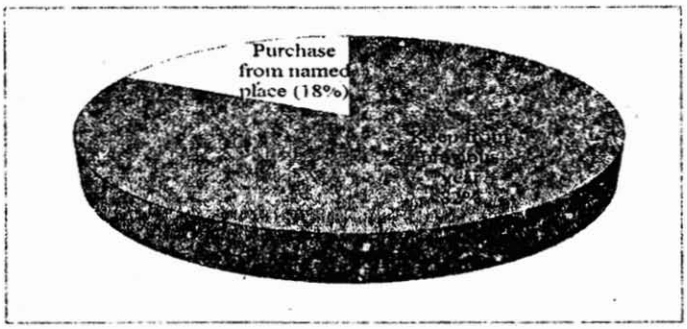

Figure (3) Source of paddy seed for nursery (n= 341)

Source: Structured interview (June, 2011).

Table (1) describes the frequency distribution of inter-plant and inter-row distances currently practicing by farmer in the study area. Majority of farmers are practicing 6 inches × 6 inches distance.

In addition, farmers plant different number of seedlings in one plot. In average 4 seedlings is used for one plot. Some farmers even use up to eight seedlings in one plot (Fig. 4). The reason for using large amount of seedling in one plot is that farmers could not use large amount of fertilizer and could not control the water, then, small amount of paddy yield from each plant in the plot makes total yield higher since there are comparatively many plants in an acre of paddy.

Table (1) Inter-plant and inter-row ranges of current farming

Length (inches)	Width (inches)	No. of respondent
4	4	1
4	5	3
4	6	4
4	9	1
5	5	7
5	6	7
5	7	1

Length (inches)	Width (inches)	No. of respondent
6	6	168
6	7	47
6	8	23
6	9	8
7	7	55
8	8	13
8	10	2
9	9	6
Total		346

Source: Structured Interview (June 2011)

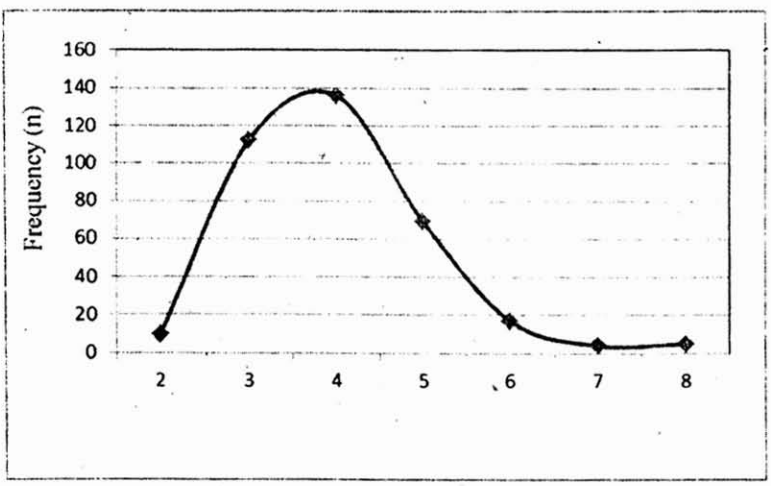

Figure (4) Frequency distribution of number of seedling plant in each plot

Source: Structured Interview (June 2011).

Frequency distribution of nursery period is shows in Figure (5). It is very clear that all farmers use seedlings that are last for 25 to 31 days. It is revealing tradition of paddy cultivation in Myanmar.

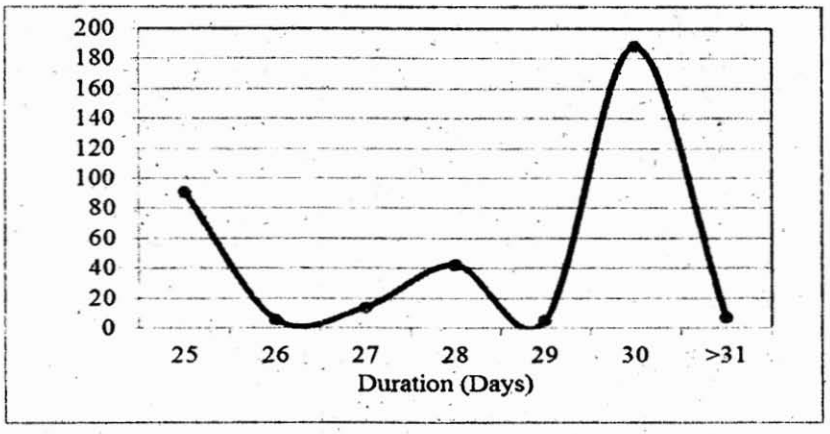

Figure (5) Frequency distribution of nursery period

Source: Structured Interview (June 2011).

The last point that needs to be examined in current cultivation is water control during the growing period. About 88 percent of farmers control water very well by means of irrigation and pumping out of water. Another (4) percent and (2) percent of famers control draining out and draining in water only. About 6 percent of farmers do not control the water during cultivation period. This situation is highly related to the nature of rainfall and local topography in the area. Since the study area is located in the flat plain and early rainfall is not reliable and irrigation the early period and pumping out of excess water from the paddy field is essential even in the traditional method.

Current situation of paddy and matpe cultivation is shown in Table (2). Average area of farm land owned by a farmer is about 6.7 acres. Of them, about 6.3 acres (2.55 hectares) of matpe is grown as second cropping after paddy. Usage of fertilizer in one acre of paddy is about 1.7 (50 Kg) bags. It is below the amount of fertilizer need in an acre of paddy land. Some farmers could not even use fertilizer. However, matpe is relatively more profitable crop for a farmer. Thus, they use large amount of fertilizers and pesticides. Paddy yield per acre is 83.2 baskets per acre and it is higher than national average of (78.14) baskets in 2010. Average matpe yield is about 14 baskets per acre.

Table (2) Some facts about the current situation of agriculture in Taungoo University

	Average farm size			Use of fertilizer/ pesticide (per acre)			Yield		
	Acre	Std.	N	Amount	Std.	n	Basket	Std.	n
Matpe	6.3	4.2	251	19802 Kyats	13561	346	13.9	4.64	351
Paddy	6.7	4.4	336	1.36 Bags	1.5	298	83.2	19.47	76

Source: Structured Interview (June 2011).

From the above mentioned tables and figures, the first question of this paper could be answered as farmers still using traditional method of paddy cultivation in practice. Average farm size is about 7 acres and yield is relatively higher although use of chemical fertilizer is limited.

The second question is, "What is the situation of agricultural technology diffusion from Taungoo University to farmers living near the University?" To answer this question farmer are asked whether or not they know the paddy and matpe cultivations of Taungoo University. The responds from 354 farmers revealed that 263 (74.3 percent) farmers know it. The rest of the farmers 91 (25.7 percent) do not know. Then, further question emphasized on whether they know SRI method or not. Chi-squared Test result shows that "there is significantly difference between the farmers who know the Taungoo University's agriculture and those who do not know, in terms of knowing SRI" (Table 3). It can be interpreted as most of the farmers know SRI through Taungoo University.

Table (3) Relationship between knowing of Taungoo University's agriculture and knowing of SRI

	Know SRI	Do not know SRI	Total
Know Tg U's Agriculture	66	197	263
Do not know Tg U's Agriculture	7	84	91
Total	73	281	354

Source: Structured Interview (May, 2011).

Notes: Chi-squared Test Significant at 0.001level.

Again it is tested that whether farmers actually know the basic concepts of SRI method or not. The result is shown in Table (4). Except from "permanent existence of water on the paddy filed could affect the yield" and "successively using of same seed effect on yield", farmer have knowledge of SRI method. Even for these two factors more than 60 percent of the people have information. In case of other 3 factors more than 90 percent of farmers have the right information.

Then, further question is asked to farmers to give reasons for "how each factor effect on yield". In that case only very small number of farmers could answer this question (Table 4). Again, their giving reasons are also considerably different from what scientists assume. In case of successive growing of same seed, majority of farmers could give right answer. But in case of permanent existence of water in the paddy field, adverse answers are given. They said, for example, that with the continuous existence of water, weed could not thrive and lead to the high yield. This point is also important in case of SRI, weeding is necessary for every 10 days. Traditional paddy cultivation method generally do not need much weeding, because permanent existence of water automatically eliminate weed and large paddy plants also cover the sun light that encourage growing of weed. Anyhow, it is fair to conclude that many farmers have SRI knowledge although there are minor differences among them.

Table (4) SRI knowledge of farmer in study area

SRI related knowledge	Answer		n	Reason	No reason
	No	Yes			
Inter-plant and row distance effect on yield	6.0	94.0	319	38	262
Number of seedling in each plot effects on yield	5.0	95.0	319	21	282
Nursery duration effects on yield	2.7	97.3	338	5	324
Successive growing of same seed reduces yield	35.1	64.9	322	84	125
Permanent existence of water effects on yield	21.4	78.6	323	122	132
Average	14.0	86.0	324		

Source: Structured Interview (May, 2011).

The third research question is "What are the major controlling factors for agricultural technology diffusion?" To answer this questions, discriminate variables such as economic, social, traditional, using technology and infrastructure of each farmer, and grouping variables of whether they know SRI or not and would like to adopt SRI or not are asked to farmers with structured interviews. Economic variable is represented by paddy and matpe cultivation acres while age and education level of farmer are considered as social variable. Traditional aspect is represented by number of seedling planted in each plot and nursery duration. Existing technology is measured by knowing of SRI (in case of knowing SRI this variable is omitted) and average yield of paddy and matpe by each farmer. As infrastructure (spatial aspect), straight distance and route distance from the source of technology are considered. By using above variables, discriminant analyses are conducted.

Results for the variable that discriminating know and do not know of SRI reveals in Table (5). There variables of matpe cultivation area, education level of farmer, and Euclidean distance became the discriminant variables of know and do not know of SRI method. Economically more powerful and more educated farmers living near the source of technology could quickly receive technology compared to other farmers. Thus, economic, social and infrastructure variables are important factors in the distribution of new agriculture technology.

Table (5) Standardized Canonical Discriminant Function Coefficient for diffusion of SRI method of Taungoo University to it environ

Variables	Std. coefficient	Do not know	Know
Matpe growing acre	0.575	6.144	6.322
Education	0.431	4.158	4.170
Euclidean distance	-0.768	2.561	2.510

Note: Percentage of correctly groups = 69.7%; F in= 3.84, F out=2.71); Wilka Lumda Method. n = 320.

The fourth research question is "Do farmers like to adopt new technology?" Structured interview results revealed that about 45 percent of farmers are willing to adopt new technology while the rest (55 percent) are not willing. To understand the main reasons of this difference, economic, social, traditional, and infrastructure variables used in above discriminant analysis are

used again. Of course, grouping variable become whether farmer would like to adopt new technology or not. The result is shown on Table (6).

Table (6) Standardized Canonical Discriminant Function Coefficient for adoption of new technology

Variables	Std. Coefficient	Not willing	Willing
Paddy yield	0.524	73.282	73.441
Nursery Duration	-0.503	28.465	28.458
Route Distance	0.744	3.917	3.935

Explanation Percent= 62.3%; (F in= 3.84, out=2.71); Wilka Lumda Method. n = 310.

Paddy yield, currently practicing nursery duration, and straight distance from the technology centers are the results as discriminating variables of whether farmer would like to adopt new technology or not. Paddy yield is directly related with willingness to adopt new technology. On the other hand, nursery duration that represents current technology of farmer is indirectly related to the adoption of new technology. Route distance that represents infrastructure and nearness to the source of information also directly related to the technology diffusion. This relationship is a contradiction to the point found in case of SRI method diffusion. Instead of easily adopted by nearby farmers, farmers located at a far distance from source of technology are willing to adopt new technology. This is because farmers living very close to the university are quite familiar with the practice of SRI in Taungoo University. They saw the different points: using large amount of labour, large investment in making of soil nursery blocks, controlling of water, larger transplant cost (in the case of first year), making of too much detail, etc. Those points are difficult to carry out in the sense of farmers. But in the case of final paddy production and total cost calculation they are not involved and well informed, thus, many farmers living near the university think that they could not able to adopt new technology.

Table (7) Major difficulties of farmers concerned with introducing of new technology

Factors	Difficulties	
	Frequency	Percent
Investment	90	23.7
Water control	67	17.6

Factors	Difficulties	
	Frequency	Percent
Techniques	66	17.4
Could not do detail	35	9.2
Weather	29	7.6
Labour	20	5.3
Seed	16	4.2
Weed	14	3.7
Soil is infertile	12	3.2
Others	31	8.2
Total	380	100

Source: Structured Interviews (June, 2011). Note: Based on multiple choice.

Table (7) supports the above mentioned point. In this table, three major difficulties that the farmers have to face in adopting new technology are mentioned. Of course, investment (about 24%) is the first constraint for farmers in adoption of new technology. Majority of the farmers possess only small amount of land and rely only on their farm as a sole source of income. Thus, they have money only enough to invest on their farms. If some failure should happen due to bad weather conditions, or destroyed by pest or disease they could not continue farming and have to borrow money from money lenders. Due to large interest rate they could not return to normal situation within one or two years. Water control is second factor that stand as constraint for farmers in adoption of new technology. Since majority of farm lands are located on the low land, it is usually flooded during the rainy season and quickly dried up when monsoon is retreated. Thus, even if they want to adopt new technology it is difficult to practice directly. Some 18 percent reveals that they are lacking in detailed technology while 9.2 percent give reason for too detailed nature of new technology. These points are related to two extreme processes. One process is the weakness of technology dissemination program and another is heritage system of farmers. Majority of farmers are getting old (Structured interview revealed as 50 years in average, ranging from 20 and 84 years). Accordingly, they could not work some detail works. About 7.6% of farmers give reason for unreliable weather. Since Taungoo is located in the transition of Dry Zone and Lower Myanmar, annual rainfall of 1956 mm (77 inches) is not well distributed during the monsoon. Sometime entry of monsoon is late and sometime retreat is faster and farmers face with difficulties. Other minor constraints include availability of good seed, problem

of weeding, and infertile of their farm lands. All these minor difficulties revealing that SRI method could not practices directly and need to make some modification based on local variation of climate, relief, and soil.

Conclusions and Discussion

This paper analyzed the situation of technology diffusion from Taungoo University to farmers of its environment by using data collected from structured interviews. Results reveal that all farmers are still using traditional paddy cultivation method although many of them notice about the SRI methods. Majority of farmers (74.3 percent) know about the SRI methods practicing in Taungoo University. Chi-squared test result revealed that SRI method is diffused from Taungoo University to nearby farmers. Further analysis results show that although majority of farmers know the basic principles of SRI, they could not give sound reasons for the benefits derived from it. Thus, the result points that detailed technology dissemination programs are still necessary in the area.

To understand the controlling factors of technology diffusion, discriminant analysis is conducted. The result shows that know or do not know about SRI method is related to the economic (areas of paddy and matpe cultivation), social (education level), and infrastructure (distance from the source of technology).

Concerning with adoption of new technology, only less than half (45 percent) of farmers want to adopt new technology. Then, discriminant analysis is used again to understand the factors that make difference between willingness and not willingness of adopting new technology. Paddy yield (positive relation) and nursery duration (negative relation) those represented current technology of farmers are related to the adoption of new technology. However, route distance that represents infrastructure and nearness to the source of information is directly (positive) related to the technology diffusion. It is due to the point that farmer living near the technology source learn the initial phase of SRI method that need many labor and detail works compared to traditional method. Then, since they do not have enough capital they are not willing to adopt this new technology.

Therefore it can be concluded that although SRI method is diffused to the farmer from Taungoo University based on the economic, social and infrastructure factor, many farmers could not actualize in practice for lack of investment, for not receiving detailed information, different physical

environment (flooding or hilly for water control), unreliable weather, and lower education level of farmers. However, majority of these difficulties could be overcome by means of some modifications in SRI method itself (it also resistant to flood and drought), giving training for new technology, providing investments and guarantees for production. Since SRI method use less farm input and no chemical fertilizer it is the beginning of sustainable organic farming. Thus, this technology should be encouraged by means of searching more locally suitable SRI method and providing farmer with necessary technology and investments.

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