Sustainable Paddy Cultivation Management: System of Rice Intensification (Sri) for Higher Production

[#1]Nur Badriyah Kamarul Zaman[#1], Jamal Ali[#2], Zakirah Othman[*3]

[#]*School of Economic, Finance and Banking, College of Business, 06010 Sintok, Northern, University of Malaysia*

[1]nurbadriyah87@gmail.com

[2]jamalali@uum.edu

[*]*School of Technology Management and Logistic, College of Business, 06010 Sintok, Northern University of Malaysia*

[3]zakirah@uum.edu.my

***Abstract*— Enhancing farm production through an application of sustainable agriculture innovation to the existing farm system is relevant to face the simultaneous challenge in achieving food security, land protection and soil fertility and improving the wellbeing of farmers especially in rural areas. The System of Rice Intensification (SRI) technique is one of the sustainable rice cultivation techniques that have been introduced with the aim of improving the lives of rural farmers in Malaysia. The study was carried out to examine the differences in the cost of operations, paddy production and profitability of farmers using SRI technique and farmers who use conventional technique. Cost and production analysis among farmers as rice producers are important to be highlighted because farmers are the main actor in rice industry supply chain. In order to improve rice industry supply chain, focus should be given to the farmer's welfare. Profitability analysis using budget technique has been used in this study. The study found that SRI technique is very successful in increasing the productivity of rice production while reducing the cost of production thereby increasing the profitability of farmers. It is important to identify the economic benefits of using SRI technique as it will encourage the adoption of this technique among rural areas farmers.**

***Keywords*—** *Supply chain, SRI practice, Cost and Benefit, SRI Practice, Innovation*

1. Introduction

Rice is the main food crop in Malaysia with an annual production of 2.1 million tonnes a year [16]. The demand for rice is constantly rising in Malaysia with nearly quarter million people being added each year to its population. Malaysia's domestic production can only fulfilled 65 percent of total rice demand and because of this shortfall the country has to import about 35 percent of rice from other countries mainly from Vietnam, Thailand, Pakistan and India to fulfil the shortage [12]. The rice imports increased from 558,100 metric tons in 2004 to 1.13 million metric tons in 2009 due to the world food crisis [12]. The impact of food crisis also affected many south Asian countries and due to that prompted them to increase the domestic production and thus reduce the imports. To cater the food crisis issue, the Malaysian government also take progressive approach by introduced the National Food Security Policy [4]. The implementation of National Food Security Policies have been remarkably success in increasing national rice production with emphasizing external inputs such as pesticides and inorganic fertilizers as the means to increase rice production [4]. The pressure due to the food crisis coupled with improper soil use and management have been caused land degradation and directly contribute to the shortage of food production [23]. One of the main causes of land degradation is intensifying chemical fertilizer and pesticide usage [13], [4], [5]. In addition, policy implemented by government in term of subsidies is one of the encouragement factors for paddy farmers to adopt chemical substance in paddy cultivation techniques.

With the realization of this milieu, in view to fulfil of domestic rice demand and to achieve rice availability by strengthening supply chain several strategies has been made, one of them is the creation of a rice bowl areas such as MADA (Muda Agricultural Development Authority), KADA (Kemubu Agricultural Development Authority),

International Journal of Supply Chain Management
IJSCM, ISSN: 2050-7399 (Online), 2051-3771 (Print)

and IADA (Integrated Agriculture Development Authority).

However, a productivity figure is more meaningful if it does ignore the environmental and economic impact. Therefore, there is growing emphasis on sustainable agriculture in response to concerns about the adverse environmental and economic impact of conventional cultivation techniques [22]. Furthermore, the changes in income, urbanization and concern on health will also shift consumer preferences to high quality rice that produced using less pesticides and artificial fertilizers [1], [9].

One of the innovation management rice cultivation which meets the criteria of sustainability is the SRI technique. This technique is said to meet the criteria of sustainability because it has the potential to enhance rice production without abundance the environment with the uncontrolled use of pesticides and synthetic fertilizers [20], [27]. Puguh (2010) said sustainable agriculture management should be encouraged in agricultural activity since this technique can increase production without compromising the natural environment that can be enjoy by the present generation and future generations.

Based on previous studies conducted in many rice growing areas in India, Indonesia, and Timor Leste, SRI technique have shown significant success in increasing rice production as well as reduced use of agriculture inputs such as, fertilizer, pesticides, rice seed, thus reducing production costs [27], [28]. Farmers using SRI technique reported only using 6 kilograms of seeds for every hectare of land compared to conventional technique that required 60 to 80 kilograms of seeds per hectare [27]. This means SRI technique have the potential to reducing quantity of seeds up to 90 per cent per hectare. In addition, this technique encourages farmers to use local input because it only uses organic materials such as fertilizers and pest deterrents that are readily available around them such as spinach, raw fish, and fruits. This means, SRI technique makes farmers itself as the main actor along the supply chain for rice production. As Bagheri (2008) quoted, sustainable agriculture technique is to make better use of internal resources by minimizing the external input used by regenerating internal resources more effectively, or by combination of both.

In Malaysia, rice farming sector has starting using SRI technique in paddy planting activities and paddy field outside the granary area since 1999 [2]. SRI technique has gaining attention among farmers, development agencies, and researchers. As a new paddy cultivation technique, it is not widely used which is only small number of farmers applied this practice on small scale paddy field. The reason why small numbers of paddy farmers are applying this technique on small scale is because SRI technique is still new and in the period of trial stage. As according to Rogers (2003), any new innovation that being introduced to target group it is very difficult being accepted by the target group instantly even when it has obvious advantage. Based on information provided by SRI Mas, a non-profit association that focused on SRI technique adoption among farmers in Peninsular Malaysia, in total there were only 18 rice farmers who applied SRI technique basically in Peninsular Malaysia.

However, until now there is no study conducted to identify the effectiveness of this practice in improving profitability, production and production costs. Therefore, cost and benefit study of farmers using SRI technique is important to be done and documented for future reference directly or indirectly parties who involve in this sector.

The results of this research are expected to demonstrate the great potential of SRI technique in strengthen supply chain in rice production, improving rice productivity, to all parties, especially for the development agencies and the farmers. In addition, the primary motivation for farmer's adoption of innovation is the improved economic benefits accrued by means of enhanced productivity [19]. A cost benefit analysis will enlighten all parties on benefits of SRI technique in term of paddy productivity gains, reduction in cost of production and thus achieve a rise on profit margin.

This study describes the SRI technique and its opportunities to increase food supply in Malaysia. It further assesses the production efficiency of SRI farming as an alternative to rice production in rice farming which has a limited water supply. We hypothesise that SRI farming can make better use of available inputs and that it can provide socioeconomic benefits to the households of farmers and, more broadly, food security in Malaysia. We test this by assessing productivity efficiency of SRI through an analysis of production and cost of production.

2. Motivation of Study

The program implemented for the purpose to increase the rice yield as one of the effort to overcome the insufficiency of rice supply for domestic need was mostly focused on main granary areas such as Muda areas in Kedah and Perlis States under MADA agencies and IADA (Integrated Agriculture Development Area). This is because more emphasize is given to the already existing areas equip with good and established irrigation system. However, due to the limitations of the land in granary areas and the increment of idle land areas, the use of agricultural practice innovation such as SRI technique coincides to address this issue. This is because SRI technique is suitable to be implemented in areas that do not have a good irrigation system as this technique does not require the use of water as much as conventional cultivation technique. Therefore, the SRI technique is a new development in the rice industry to boost the country's rice production. Thus, the effectiveness of SRI technique in terms of cost and production should be studied.

In line with the government effort through the Ministry of Agriculture that emphasized on the transformation of the agricultural sector through three main strategies, namely Transformation of Traditional Farmers, Technology Transfer Program on farms to modified field operation to become more efficient and economically viable and to shift private sector investment to the food sector industries. In addition, the most promising alternative to increase the productivity of rice is through innovation and policy implementation [3]. Therefore, SRI technique is an alternative way to make all the strategies developed by government realize.

3. Literature Review

Basically, sustainable development means development that meets the needs of the present generation without compromising the needs of future generations [6]. Although the definition of the Brundtland (1987) received various opposition and criticism, it still accepted and adopted by many scholars as a basis for the definition of sustainable development in general. In fact there are 386 basic definition of sustainability ever since he got the attention of many scholars [23]. This is due to the basic definition of sustainability produced by the different perspectives. However, the discussion on the idea of sustainable development cannot be separated with the original concept of sustainability in general. In fact, sustainable agriculture is a branch under the concept of sustainable development [21]. Therefore, the notion of sustainable agriculture can be interpreted as the ability to maintain agricultural activity and a strong production without compromising the natural environment that can be enjoyed by the present generation and future generations.

The topic of sustainability or more specifically sustainable agriculture cannot be ignored and has always been the main concept of the new ideas for research in the agricultural sector. Sustainable agriculture research aimed to ensure the continuity of food supply and food security while not adversely affect the environment [26]. In addition, sustainable agriculture seeks to increase farmers' profits by reducing input costs. In fact, the acceptance of farmers to practice sustainable agriculture is aimed for continuous profit increment from sustainable agricultural practices.

However, sustainable agriculture is a system that not only emphasize from an economic return in term of production, which specifically aims for profit maximization only. Sustainable agricultural management also emphasize on environmental protection and social needs [3], [11], [20]. This statement is supported by Ghazali and Othman (2011) which stated the main objective of sustainable agricultural management is the preservation of natural environment in the agricultural activity area to achieve economic viability of farms, retention socio-cultural system in a rural farming community, while preserving the stock of natural resources and environmental quality. Therefore, it can be concluded the sustainable agricultural management includes three main aspects namely, ecological, social, and economic [8].

SRI technique is a system formed by the combination of rice cultivation practice result of innovation and creativity of rice farmers [16]. This statement is in line with Uphoff (2005) who argues SRI technique is practice of agricultural innovations invented by the farmers outside the norm where this practice has the advantage of increasing the productivity of land, labour, water, and capital simultaneously. SRI technique was also agreed as a methodology and not technology [7].

According to Uphoff (2005), the practice of SRI technique involves changes in land management, namely management of soil, water, and nutrients.

Through these changes in land management 50 to 100 per cent increase in paddy yield is achieved. Even though there are standard six principles to be complied with SRI technique, Henri de Laulaníe the pioneer of this practice states that this technique is not a conclusive idea and can be adjustable according to the appropriateness of the cultivation area.

Therefore, based on the standards six principles of the SRI paddy cultivation technique, currently it has been practiced in rainfed area which is depend entirely on rain including in Malaysia, Cambodia [2], Indonesia [15], and Timor Leste [18]. Those areas examples is an adaptation of using SRI technique in paddy cultivation combine with original idea proposed by Henri de Laulaníe although at first, the idea of SRI technique come from paddy field under irrigated condition which the water can be controlled on a regular basis to ensure the paddy soil not flooded with water.

4. Methodology

4.1 Instrument of the Survey

To obtain primary data for this study, the main research instrument used was survey questionnaire. The respondents were made up of rice farmers who practice SRI and conventional technique in their farming activities. The survey questionnaire was designed in such a way as to be able to obtain demographic information regarding the background of the farmers (such as experience, level of education, age, and marital status), and their production from farming activities.

A pilot study was carried out in April 2015 on a small, diverse group of 45 rice farmers to confirm the appropriateness of the questions in the questionnaire. After the pilot study, changes were made to the sequence and the wordings of the questions to make them simpler. The actual survey was conducted between May 2015 and June 2015. A total number of 18 farmers who implement SRI technique in Kedah, Johor, Kelantan, and Selangor were involved in this survey. The farmers in every selected state were identified and invited to participate in this study by the Farmers Associations or Institutions that involved with rice production such as Muda Agricultural Development Authority (MADA), the Kemubu Agricultural Development Authority (KADA), and Federal Land Consolidation and Rehabilitation Authority (FELCRA) of Seberang Perak.

Each respondent was questioned during a face-to-face interview, where the enumerator asked questions and marked a '/' on a scale on a separate answer sheet. Before asking questions related to the cost of production, yields and profits, basic information on the background of respondent's, such as address, age, gender, experience, and aspects of households were completed by the respondents. This background information was used to group respondents for the statistical analysis. The interviews were held at a comfortable and convenient location for all farmers. Normally the interviews were held after farmers doing their work in the paddy field; this has been normally in the morning, from 10.00am to 11.00am. The duration of interviews was between 20 to 30 minutes for each farmer. Each farmer completed their questionnaires independently. However, in cases where farmers could not read or write, the enumerators assisted them in answering the questionnaire.

4.1 Sample Size

The increase in paddy production and a reduction in agricultural inputs use is a major cause of increasing farmers' income. Therefore, to achieve the accuracy of the information, this study will only focus on rice production data, production costs and profits for farmers harvesting rice in the main season paddy cultivation in 2015 only to be taken. The definitions of the main season according to the Department of Agriculture is the period when paddy is planted in which the commence date of planting falls on 1st August until last day of February next year.

This is a descriptive study using primary data. In conducting this study, two sets of questionnaires were distributed to farmers who are practicing SRI and farmers under Paddy Estate project, MADA who practicing conventional methods. This study was conducted to rice farmers applying SRI practice in Peninsular Malaysia which covers the states of Kedah, Johor, Kelantan, and Selangor. Census approach will be used, which all farmers using SRI practice will be chosen as the unit of analysis.

Based on information from the MADA representative, there are 6,973 farmers under Paddy Estate Project. A simple random approach is used as the sampling method after researchers identified the study areas. Based on the total population, the

sample size was determined based on table of sample determination proposed by Sekaran (2000). Therefore, the sample size is 364 farmers. A total of 400 sets of questionnaires were distributed to 400 farmers, a total of 264 survey questionnaires were returned.

The comparison group was selected from rice farmers under Paddy Estate Project of MADA as MADA runs most rice yield development programs. In addition, Paddy Estate Project, MADA is designed to reduce the cost of rice production and manage by government agency. Therefore, the comparison of profitability, cost of production and yield of rice will be carried out most effectively in Paddy Estate Project, MADA.

5. Findings and Discussion

5.1 Socio-demographic Profile of Farmers

This study involved 264 farmers under Paddy Estate Project and 18 farmers using SRI practice. The average age of farmers planting rice using SRI practice is 40 years old, while farmers under Paddy Estate Project is 61 years old. While the average area of land cultivated by farmers using SRI practice is 0.71 hectares while farmers under Paddy Estate Project is 1.31 hectares. SRI technique of paddy cultivation practice is newly introduced in Malaysia, so farmers still in trial period and was applied on a small plot of land. Most of the farmers planting rice using SRI practice (94.8 per cent) have been involved in paddy farming using SRI technique between 1 to 5 years. As already mentioned, the farmers who practice SRI technique are among the earliest farmers using this paddy cultivation technique. Contrary to farmers under Paddy Estate Project, the majority of them (52.7 per cent) have been involved in paddy farming between 25 to 44 years. For the detail information on socio-economics profile, refer to the Table 1.

Table 1: Socio-economic profile of farmers

	Paddy Management Techniques	
Profile	SRI technique (n=18)	Paddy Estate Project (conventional techniques) (n=264)
Age		
Mean	40	61
Min	17	34
Max	55	95
Standard deviation	11.45	11.54
Land Size (ha)		
Mean	0.71	1.31
Min	0.02	0.07
Max	4.00	6.00
Standard deviation	0.92	0.96
Years of experience		
Mean	4	31
Min	1	1
Max	8	60
Standard deviation	2	12
Main income (RM)		
Mean	1,522	2,046
Min	500	212
Max	5000	14,576
Standard deviation	1,218	1,423

5.2 Yield

Rice yields for the two groups of farmers who practice SRI technique and farmers under Paddy Estate Project, MADA practicing conventional technique is shown in Table 2. The yield of paddy rice is obtained by summing the rice yield of all farmers in each group of analysis divided by the total area of their fields for both groups.

SRI technique had the higher average yield (7.75 tons/ha) compared to the conventional practice (6.21 tons/ha) under Paddy Estate Project, MADA. Comparative average yield between the two techniques showed better results for the SRI cultivation techniques.

Table 2: Comparison of paddy production between SRI practice and conventional technique under Paddy Estate Project, MADA

	SRI technique (n=18)			**Paddy Estate Project (n = 264)**		
	Production (ton/ha)	Deduction (%)	Nett production (ton/ha)	Production (ton/ha)	Deduction (%)	Nett production (ton/ha)
Mean	7.75	22	6.0	6.21	22	4.8
Min	2.5			2.10		
Max	8.75			9.50		
Std	1.77			1.24		

5.3 Production Cost

The difference between the cost of production of paddy grown using SRI technique and paddy grown using conventional technique under Paddy Estate Project, MADA is displayed in Table 3. The total cost of rice production is obtained by summing all costs incurred in rice cultivation activities under both paddy cultivation techniques. The activities involve in rice cultivation are post-harvest management, land preparation, seedling stage, plant care and harvesting.

The findings showed that rice cultivation using SRI technique have average cost per hectare lower than conventional technique under Paddy Estate Project, MADA. The cost of production of rice by using SRI is RM 1,968 and the cost of rice production using conventional technique under Paddy Estate Project, MADA is RM 2,485. Referring to Table 3, post-harvest management recorded higher costs in SRI technique compared to the conventional technique. Post-harvest management showed higher costs at SRI technique is due to straw on the soil is not burnt as conventional rice cultivation technique, but this straw be composted. Composting will certainly involve additional costs. According to practitioners of SRI technique, this activity is complicated and the labour costs rate is higher compared to conventional technique.

Table 3: Comparison of production cost between SRI technique and conventional technique under Paddy Estate Project, MADA

Items	SRI technique (RM)	Conventional technique (RM)
Post-harvest	21.42	21.72
Land preparation	705.26	798.65
Seedling	208.13	317.17
Plant care	497.82	846.93
Harvesting	535.52	500.98
Total	**1,968.15**	**2,485.45**

5.4 Profitability

According to Table 4, the net profit for SRI technique and conventional technique under Paddy Estate Project, MADA is obtained by summing sales revenue and price support subsidy minus production costs. According to MADA representative, the rate of deduction for each state throughout Peninsular Malaysia is between 20 per cent and 23 per cent. Therefore, for the profit calculation, the rate of deduction estimation is 22 per cent (Table 4). Therefore the weight of rice after deduction for SRI technique is 6 ton/ha, while for conventional technique under Paddy Estate Project, MADA is 4.8 ton/ha. The findings show that profits earned by farmers who practice SRI technique is RM 69,306 while the profits for farmers under Paddy Estate Project, MADA who practice conventional technique is RM 1,903. This suggests that farmers adopt SRI technique obtain higher profits than farmers who practice conventional technique under Paddy Estate Project, MADA.

Table 4: Profit comparison between SRI technique and conventional technique under Paddy Estate Project, MADA

Items	SRI technique (n=18)	Paddy Estate Project (n=264)
Yield after 22 per cent deduction (ton/ha)	6.0	4.8
Sales of revenue (RM) = RM 1200/ton	7,200	5,760
Price support subsidy (1 ton = RM248.10) (for conventional technique only)	-	1,190
Production cost (RM/ha)	1,968	2,485
Profit (RM) = (Sales of revenue + Price support subsidy) – (Production cost)	**5,231**	**4,465**

6. Conclusion

Based on the findings of this study, it can be conclude that SRI technique recorded higher paddy production compared to conventional technique under Paddy Estate Project, MADA. In addition, the cost of production by using SRI technique is lower conventional technique under Paddy Estate Project, MADA and thus higher profits recorded for SRI technique compared to the conventional technique under Paddy Estate Project, MADA. Although SRI technique is still new and not widely

practiced among the farmers, this practice has the potential to be applied in order to help farmers deal with problems of rising rice production costs. Since the primary motivation of farmers to adopt agricultural innovation by financial benefit, SRI technique has the potential to be adopted in wide range of farmers in the future. In addition, this practice is not only able to reduce production costs, it also has the potential to increase rice production. It shows rice production can be increased at low production costs and thus can increase farmers' profits. This coincides with the government's efforts to intervene in the country's rice farming sector to increase rice production and at the same time improve the living standards of the farmers.

In addition, SRI technique also has the potential to be applied on idle land that does not has proper irrigation infrastructure system. This is because these techniques that use less water coincide to solve the problem of idle agriculture land.

Farm management practices in a systematic and timely manner during the period of plant growth is indispensable, especially for strategic commodities in the country. Therefore, SRI technique is one of the potential techniques to spread and develop to boost the development of the country's rice sector.

Acknowledgement

Appreciation goes to the Northern University of Malaysia for the channelling funds for Ph.D student.

References

[1] Alavanja, M. C. R., Ross, M. K., & Bonner, M. R. (2013). *Increased cancer burden among pesticide applicators and others due to pesticide exposure: Pesticides Exposure and Cancer*. CA: A Cancer Journal for Clinicians, 63(2), 120–142. http://doi.org/10.3322/caac.21170

[2] Anthofer, J. (2004). *The Potential of the System of Rice Intensification (SRI) for Poverty Reduction in Cambodia*. Conference on International Agricultural Research for Development, Berlin, 5-7 October 2003.

[3] Azima, A. M., Choy, E. A., Saad, S., Selvadurai, S., Lyndon, N. & Husain, M. Y. (2013). *Keterlibatan penduduk lokal dalam pembangunan pertanian : kajian kes di daerah Kuala Pilah , Negeri Sembilan*. Malaysia Journal of Society and Space, 9 Issue 1 (24 - 33) © 2013, 1(1), 24–33.

[4] Bala, B. K., Alias, E. F., Fatimah, M. A., Noh, K. M. & Hadi, A. H. A. (2014). *Modelling of Food Security in Malaysia*. Simulation Modelling Practice and Theory, 47 (2014) 152-164.

[5] Bagheri, A., Shabanali Fami, H., Rezvanfar, A., Asadi, A. & Yazdani, S. (2008). *Perception of Paddy Farmers towards Sustainable Agricultural Technologies: Case of Haraz Catchments Area in Mazandaran Province of Iran.* American Journal of Applied Sciences, 5(10): 1384-1391, 2008.

[6] Brundtland, G. H. (1987). *Report of the World Commission on Environment and Development: Our Common Future*. Published as an Annex to U.N. General Assembly document A/42/427. New York, NY: The United Nations.

[7] Budi I. S., Satyanto K. S., Hanhan A. S. & Gardjito. (2011). *Wireless Automatic Irrigation To Enhance Water*. In Regional Symposium on Engineering & Technology (pp. 1–16).

[8] Buttimer, A. (2001). (ed) *Sustainable landscapes and lifeways*. Cork University Press, Ireland.

[9] El-Wakeil, N., Sallam, A., Abdou, G., & Shalaby, S. (2013). *Pesticide-Residue Relationship and Its Adverse Effects on Occupational Workers*. INTECH Open Access Publisher. Retrieved from http://www.researchgate.net/profile/Nabil_El-Wakeil/publication/235340536_Pesticide-Residue_Relationship_and_Its_Adverse_Effectson_Occupational_Workers/links/09e41511113004ae22000000.pdf

[10] Ghazali, R. & Othman, F. (2011). *Pembangunan Indikator Untuk Penilaian Kelestarian Sektor Padi Indicator Development for Sustainable Padi Sector Evaluation.* Prosiding PERKEM VI, JILID 1 (2011) 331 – 347 ISSN: 2231-962X Pembangunan, 1, 331–347.

[11] Horna, J.D. and Smale, M. 2005. *Farmer willingness to pay for seed-related information: rice varieties in Nigeria and Benin.* Journal of Environment & Development Economics 12 (6): 799-825. Internet: The FAO rice prices update 2012.

[12] Jamal, K., Kamaruzzaman, N. H., Abdullah, A. M., Ismail, M. M. and Hashim, M. (2013). *Farmers acceptance towards fragrant rice farming: the case of non-granary areas in the East Coast, Malaysia*. International Food Research Journal. 20 (5): 2895-2899.

[13] Jean, C. B., Paul, B. M., Jan, D. G and Alfons, O. L. (2015). *Potential Impact of Alternative Agricultural Technologies to Ensure Food Security and Raise Income of Farm Households in Rwanda*. Forum for Development Studies. Vol. 42, No. 1, 133-157.

[14] Li, D., Liu, M. and Deng, G. 2010.*Willingness and determinants of farmers' adoption of new rice varieties.* China Agricultural Economic Review 2 (4): 456-471.

[15] Luh, P. S. & Bambang, J. (2012). *Implementation of SRI (System of Rice Itensification) for Increasing Paddy Production and Smallholder Self-Sufficiency*. Proceedings ICAM, ISSN: 978-602-9030-09-9

[16] Mati, B. M. & Nyamai, M. (2009). Promoting the System of Rice Intensification in Kenya: Growing More with Less Water (Brochure).

[17] Ministry of Agriculture and Agro-based Industry Malaysia (MOA). (2012). *Perangkaan Agro Makanan 2010.* Putrajaya: MOA.

[18] Noltze, M., Schwarze, S., & Qaim, M. (2011). *Understanding the Adoption of Systemic Innovations in Smallholder Agriculture : The System of Rice Intensification (SRI) in Timor Leste*. EAAE 2011 Congress Change and Uncertainty, August – September 2011.

[19] Oluwaseun, K. & Trudy, H. (2014). *Impact of Cooperative Membership on Farmer's Uptake of Technological Innovations in Southwest Nigeria.* Development Studies Research, Vol. 1, No. 1 340-353.

[20] Othman, Z., Othman, S. N., & Ab Hamid, K. (2013). *Pengurusan Pertanian Lestari di Luar Bandar : Kes Projek Agropolitan di Kawasan Terbiar*. Prosiding PERKEM VIII, JILID 2 (2013) 790 - 795 ISSN: 2231-962X Pengurusan, 2, 790–795.

[21] Puguh, K. (2010). *Factors Affecting the Adoption of Sustainable Upland Agriculture at Lawu Mountain, Indonesia*. Ph.D Thesis (unpublished). Pusat Pengajian Undang-undang, Kerajaan dan Pengajian Antarabangsa. Universiti Utara Malaysia.

[22] Rasul, G., & Thapa, G. B. (2003). *Sustainability Analysis Of Ecological And Conventional Agricultural Systems in Bangladesh*. World development,31(10), 1721-1741.

[23] Rigby, D. & Cáceres, D. (2001). *Organic farming and The Sustainability of Agricultural Systems.* Agricultural Systems 68, 21□40.

[24] Rutunga, V., Janssen, B. H., Mantel, S., & Janssens, M. (2007*). Soil use and management strategy for raising food and cash output in Rwanda.* Journal of Food Agriculture and Environment, 5(3/4), 434.

[25] Sekaran, U. (2000). *Research Methods for Business*. New York: John Wiley & Sons.

[26] Shariff, N. N. M., Hamidi Z. S., Muhammad. A. (2013). *Evidence for Generating High Margin Profit by Cost Cutting of Sustainable Agriculture Farming Input.* American-Eurasian J. Agric. & Environ. Sci., 13 (2): 158-161, 201.

[27] Styger, E., Aboubacrine, G., Attaher, M. A., & Uphoff, N. (2011). *The System of Rice Intensification as a Sustainable Agricultural Innovation: Introducing, Adapting and Scaling Up a System of Rice Intensification Practices in the Timbuktu Region of Mali*. International Journal of Agricultural Sustainability, 9(1), 67–75.

[28] Uphoff, N. (2005*). The Development of the System of Rice Intensification*. Vol. 3, 119-125, International Potato Center-UPWARD and International Development Research Centre, Ottawa.