PROFITABILITY AND LABOR USE EFFICIENCY OF DIFFERENT RICE VARIETIES WITH DIFFERENT CROP ESTABLISHMENT METHODS IN MAUBIN AND DAIK U TOWNSHIPS

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CHAN MYAE LWIN

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The thesis attached here to, entitled **"Profitability and Labor Use Efficiency of Different Rice Varieties with Different Crop Establishment Methods in Maubin and Daik U Townships"** was prepared and submitted by Chan Myae Lwin under the direction of the chairperson of the candidate supervisory committee and has been approved by all members of that committee and the board of examiners as a partial fulfillment of the requirements for the degree of **Master of Agricultural Science (Agricultural Economics).**

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This thesis represents the original work of the author, except where otherwise stated. It has not been submitted previously for a degree at any other University.

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DEDICATED TO MY BELOVED PARENTS,

U THEIN LWIN AND DAW HLA THIN

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ABSTRACT

Rural population is as huge as 86 percent of total in Ayeyarwady region and in Bago, it is 78 percent and their livelihoods mainly rely on agriculture particularly in rice cultivation. Profitability of rice farming is essential for better livelihoods of rural farm households. Rice yields and profits vary according to the variety, method of sowing and its market price. Paddy cultivation needs many workers due to special treatment in planting and harvesting processes. Nowadays, labor becomes scarce resource due to labor migration in the rural areas. Thus, it is very important to pay a good attention to the proper and efficient use of labor. Crop establishment method with higher labor use efficiency will be economically more competitive in long term. Therefore, this study was carried out to analyze profitability and labor use efficiency of different rice varieties in different growing seasons and crop establishment methods, to determine the factors that affect profitability of the production of the selected rice varieties and to identify the major constraints in rice production. The survey was conducted from September to November, 2015 in Maubin and Daik U Townships, MyRice project areas. The data were collected from 130 farmers of which 65 farmers each from both Townships by using purposive random sampling method. Descriptive analysis, enterprise budget analysis, labor use efficiency analysis and profit function were used to fulfill the research objectives. Two most widely used monsoon rice varieties (Hnan Kar and Sin Thu Kha in Maubin and Hmawbi-2 and Sin Thu Kha in Daik U) and one summer rice variety of Thee Htat Yin for Maubin and Sin Thu Kha for Daik U) were selected for profitability and labor use efficiency analysis. Having compared BCRs of monsoon rice and summer rice varieties, monsoon rice varieties obtained higher BCRs than summer rice varieties even though yields of summer rice varieties were higher. This might be due to lower paddy price of summer rice varieties. In comparison of BCRs of monsoon rice varieties of Maunin Township, Sin Thu Kha obtained higher BCR (with 1.55 in DSR method and 1.40 in TPR method) than Hnan Kar (with 1.28 in DSR method and 0.98 in TPR method). Having compared BCRs of monsoon rice varieties of Daik U Township, Hmawbi-2 obtained higher BCR (with 1.46 in DSR method and 1.27 in TPR method) than Sin Thu Kha (with 1.43 in DSR method and 1.22 in TPR method). In Maubin Township, Sin Thu Kha obtained higher price than Hnan Kar. Similarly, in Daik U, Hmawbi-2 obtained higher price than Sin Thu Kha even though yield of Sin Thu Kha was higher

than Hmawbi-2. Thus, price is major driver for making good profit. Therefore, utilization of high market-demand variety should be encouraged. Having compared profitability and labor use efficiency of six selected rice varieties by crop establishment methods, BCR, labor productivity and labor use efficiency were better in DSR method than TPR method. In all of the selected rice varieties, paddy yield and total labor used were the influencing factors for profitability of selected rice varieties. Paddy profit was positively affected by yield and negatively affected by total labor used. Major constraints described by sample farmers in Maubin and Daik U Townships were scarcity of labor and extreme weather (flood/drought). DSR method is preferably practicing by sampled farmers in Maubin and Daik U Township at the current time for cost minimization objective since they are small holders with limited capital. High-yield labor saving technologies are to be encouraged. At macro or national level, to obtain maximum production, labor substitution technologies for TPR method are to be encouraged. Combine harvesters become more popular as the farmers become aware of post-harvest losses due to a practice, stacking of rice bundles after harvest, to grow pulses urgently before moisture recedes, in the project areas. Thus, rental charges of combine harvester were relatively very high. Therefore, rental charges of combine harvester should be reasonable and affordable price.

Keywords: DSR, TPR, BCR, Labor use efficiency

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LIST OF ABBREVIATIONS

ACIAR	=	Australian Centre for International Agricultural Research
BCR	=	Benefit-Cost Ratio
cm	=	Centimeter
CSO	=	Central Statistical Organization
DAR	=	Department of Agricultural Research
DoA	=	Department of Agriculture
DoP	=	Department of Population
DSR	=	Direct Seeded Rice
g	=	gram
GDP	=	Gross Domestic Product
ha	=	Hectare
HH	=	Household
IRRI	=	International Rice Research Institute
kg	=	Kilogram
md	=	man-day
mm	=	Millimeter
MADB	=	Myanma Agricultural Development Bank
MMK	=	Myanmar Kyat
MOAI	=	Ministry of Agriculture and Irrigation
MOALI	=	Ministry of Agriculture, Livestock and Irrigation
MT	=	Metric Ton
PU farmers	=	Farmers who conduct with DoA
PR farmers	=	Farmers who carry out Khittayar Hinthar Rice Specialization Company
SPSS	=	Statistical Packages for Social Science
TPR	=	Transplanted Puddled Rice
yr	=	Year

LIST OF CONVERSION FACTORS

1 basket of paddy	=	20.86 kilograms
1 hectare	=	2.471 acres
1 metric ton	=	1000 kilograms

CHAPTER I
INTRODUCTION

Profitability is the primary goal of all business ventures. Utilization of high yielding and adaptable varieties is the most common way for farmers looking forward to increase profit. Myanmar is an agricultural country and agriculture sector is the backbone of its economy. Agriculture sector contributes 20.1% of GDP, 20% of total export earnings and employs 61.2% of the labour force (MoALI 2016). Thus, agriculture sector still plays a vital role in development of Myanmar economy. The country's population is about 51 million with the annual growth rate of 2%, 70% of people lives in rural area and their livelihood mainly relies on agriculture particularly in rice cultivation (DoP 2015). Therefore, productivity and profitability of rice farming is an essential factor in improving farmers' income.

1.1 Rice Production in Myanmar

Rice (paddy) is by far the most important crop, taking up approximately 8 million hectares and 40% of all food production (Baroang 2013). Historically, rice has been categorized under the staple food crop rather than commercial or cash crop. Due to climatic and topographical reasons, most of the wetlands in lower Myanmar which are major rice producing areas have lack alternative for food and cash crop and which makes rice the only source of cash and staple food.

According to DoA (2014), Ayeyarwady, Bago, Yangon, Sagaing Regions and Mon and Shan States are the paddy surplus production areas of the country and Magway, Mandalay Regions and Chin State are the paddy deficit production areas of the country.

Sown areas, yield and production of monsoon rice in Myanmar during the period of 2005-2006 to 2014-2015 were presented in Table 1.1. The total sown area of monsoon rice increased from 6.24 million hectares to 6.80 million hectares between 2005-2006 and 2010-2011. However, the total sown area of monsoon rice was decreased steadily starting from 2011-2012 and only 6.23 million hectares were cultivated in 2014-2015. The average yield of monsoon rice was increasing at a low rate from 3.51 MT/ha to 3.70 MT/ha during the period of 2005-2006 to 2014-2015 with an average annual growth rate of 0.62%. There has been increase in total

Table 1.1 Sown area, yield, production and annual growth rate in the production of monsoon rice in Myanmar from 2005-2006 to 2014-2015

Year	Sown Area (million ha)	Yield (MT/ha)	Annual Growth Rate in Yield (%)	Production (000' MT)	Annual Growth Rate in Production (%)
2005 - 06	6.24	3.51		22,557	
2006 - 07	6.90	3.59	2.28	25,320	12.25
2007 - 08	6.82	3.69	2.79	25,789	1.85
2008 - 09	6.82	3.79	2.71	26,582	3.07
2009 - 10	6.78	3.82	0.79	26,698	0.44
2010 - 11	6.80	3.84	0.52	26,762	0.24
2011 - 12	6.53	3.60	-6.25	24,105	-9.93
2012 - 13	6.30	3.61	0.28	23,287	-3.39
2013 - 14	6.23	3.65	1.11	23,326	0.17
2014 - 15	6.23	3.70	1.37	23,717	1.68
Average	6.57	3.68	0.62	24814	0.71

Source: DoA, MOALI, 2005 - 2015

Table 1.2 Sown area, yield, production and annual growth rate in the production of summer rice in Myanmar from 2005-2006 to 2014-2015

Year	Sown Area (million ha)	Yield (MT/ha)	Annual Growth Rate in Yield (%)	Production (000' MT)	Annual Growth Rate in Production (%)
2005 - 06	1.15	4.31		5,119	
2006 - 07	1.23	4.42	2.55	5,596	9.32
2007 - 08	1.27	4.47	1.134e3rr	5,653	1.02
2008 - 09	1.28	4.54	1.57	5,982	5.82
2009 - 10	1.29	4.51	-0.66	5,975	-0.12
2010 - 11	1.25	4.50	-0.22	5,809	-2.78
2011 - 12	1.06	4.47	-0.67	4,897	-15.70
2012 - 13	0.95	4.51	0.89	4,410	-9.94
2013 - 14	1.06	4.57	1.33	4,989	13.13
2014 - 15	0.94	4.62	1.09	4,469	-10.42
Average	1.15	4.49	0.78	5,290	-1.08

Source: DoA, MOALI, 2005 - 2015

production from 22,557,000 MT in 2005-2006 to 23,717,000 MT in 2014-2015. Annual growth rates of total rice production were fluctuated from 2005-2006 to 2014-2015. The total annual growth rate of total rice production from 2005 to 2015 was 0.71%.

Average yield per hectare of summer rice was increased from 4.31 metric ton to 4.62 metric ton. However, the total sown area of summer rice in Myanmar has decreased from 1.15 million hectares to 0.94 million hectares and the total production also decreased from 5,119,000 metric ton to 4,469,000 metric ton between 2005-2006 and 2014-2015. Total summer rice sown area, yield and production in 10 years period from 2005-2006 to 2014-2015 was shown in Table 1.2.

This study was carried out in two Townships namely Maubin and Daik U, in Ayeyarwady and Bago regions, those represents about 50% of the union rice production, and adaptive research are being carried out by the "Diversification and Intensification of Rice-based Cropping Systems in Lower Myanmar (MyRice)" project of IRRI, DAR and DoA.

1.2 Rice Production in Maubin Township

Maubin Township, one of the Townships in Ayeyarwady Region, is one of the main rice surplus areas where ecological environment is favorable for rice production and mainly supplies not only to the domestic but also to the international markets. Rice production area of Maubin Township contributed about 4.52% of the total rice production area of Ayeyarwady Region in 2014-2015 (CSO 2015). In this Township, total monsoon rice sown areas were increased from 56,628 hectares in 2005-2006 to 57,325 hectares in 2014-2015. However, yield per hectare decreased from 3.77 MT/ha in 2005-2006 to 3.62 MT/ha in 2014-2015. Therefore, paddy production decreased from 214,000 tons in 2005-2006 to 207,000 tons in 2014-2015 (Table 1.3).

In the case of summer rice production, total sown areas were increased from 32,782 hectares in 2005-2006 to 33,734 hectares in 2014-2015. Yield per hectare was also increased from 4.56 MT/ha in 2005-2006 to 4.95 MT/ha in 2014-2015. Thus, paddy production increased from 150,000 MT in 2005-2006 to 167,000 MT in 2014-2015. The annual growth rates on summer rice yield in Maubin Township from 2005 to 2015 were fluctuated. The average annual growth rate of summer rice yield during the ten years period was 0.93%. The average annual growth rate of summer rice production in Maubin Township from 2005 to 2015 was 1.59% (Table 1.4).

Table 1.3 Sown area, yield, production and annual growth rate in the production of monsoon rice in Maubin Township from 2005-2006 to 2014-2015

Year	Sown area (ha)	Yield (MT/ ha)	Annual growth rate in average yield (%)	Production (000' MT)	Annual growth rate in production (%)	Share in total production (%)
2005 - 06	56,628	3.77		214		0.95
2006 - 07	57,575	3.77	0.08	217	1.40	0.86
2007 - 08	58,390	3.91	3.71	228	5.07	0.88
2008 - 09	58,439	3.96	1.28	231	1.32	0.87
2009 - 10	58,446	3.97	0.25	232	0.43	0.87
2010 - 11	58,449	3.97	0.10	232	0.00	0.87
2011 - 12	56,260	3.36	-15.37	189	-18.53	0.78
2012 - 13	56,301	3.36	0.00	189	0.00	0.81
2013 - 14	57,103	3.36	0.10	192	1.59	0.82
2014 - 15	57,325	3.62	7.74	207	7.81	0.87
Average	57,492	3.71	-0.23	213	-0.10	0.86

Source: DoA, Maubin Township, 2005 - 2015

Table 1.4 Sown area, yield, production and annual growth rate in the production of summer rice in Maubin Township from 2005-2006 to 2014-2015

Year	Sown area (ha)	Yield (MT/ ha)	Annual growth rate in average yield (%)	Production (000' MT)	Annual growth rate in production (%)	Share in total production (%)
2005 - 06	32,782	4.56		150		2.92
2006 - 07	37,588	4.74	3.95	178	18.67	3.18
2007 - 08	38,204	4.66	-1.69	176	-1.12	3.11
2008 - 09	38,336	4.73	1.50	182	3.41	3.03
2009 - 10	38,483	4.74	0.00	182	0.50	3.05
2010 - 11	38,336	4.74	0.00	182	-0.40	3.13
2011 - 12	33,098	4.56	-3.80	151	-17.03	3.08
2012 - 13	33,715	4.56	0.00	154	1.99	3.48
2013 - 14	33,734	4.66	2.19	157	1.95	3.15
2014 - 15	33,734	4.95	6.22	167	6.37	3.74
Average	35,801	4.69	0.93	168	1.59	3.19

Source: DoA, Maubin Township, 2005 - 2015

In general, most farmers cultivate the improved high yielding varieties. Hnan Kar, Manaw Thu Kha, Sin Thu Kha, Paw Sann Hmwe, Kyaw Zeya, Sit Pwar, Paw Sann Yin, Thee Htat Yin, Shwe War Tun, Vietnam, Pale Thwe, and others varieties were observed in Maubin Township (DoA 2015).

1.3 Rice Production in Daik U Township

Daik U Township in Bago Region is also one of the main rice surplus areas. Rice production area of Daik U Township contributed about 11.045% of the total rice production area of Bago Region in 2014-2015 (CSO 2015). In this Township, total monsoon rice sown areas were increased from 63,931 hectares in 2005-2006 to 75,704 hectares in 2014-2015. Yield per hectare was also increased from 3.97 MT/ha in 2005-2006 to 4.05 MT/ha in 2014-2015. Thus, paddy production increased from about 254,000 MT in 2005-2006 to 307,000 MT in 2014-2015. The annual growth rates of rice production in Daik U Township from 2005 to 2010 were fluctuated and average annual growth rate of rice production in Daik U Township from 2005 to 2010 was 2.40% (Table 1.5).

The total sown area of summer rice in Daik U Township was increased significantly during the ten years period from 26,725 hectares in 2005 to 59,567 hectares in 2015. Average yield of the paddy was increasing at a low rate from 4.07 MT per hectare to 4.12 MT per hectare during the period of 2005-2006 to 2014-2015. The average annual growth rate of paddy yield from 2005 to 2015 was 0.19%. There has been tremendous increase in summer rice production from 109 MT in 2005-2006 to 245 MT in 2014-2015 (Table 1.6).

According to DoA (2015), Kyaw Zeya, Hmawbi-2, Manaw Thu Kha, Ta-taung Po, Sin Thukha, Yadanar Toe, Sin Thwe Latt, Ayar Min, Vienam, Paw Sann Yin, Kauk Hyinn, Pale Thwe and Yay Myoke Kan-2, Yadanar Aung, and other rice varieties were observed in Daik U Township.

Table 1.5 Sown area, yield, production and annual growth rate in yield and production of monsoon rice in Daik U Township from 2005-2006 to 2014-2015

Year	Sown area (ha)	Yield (MT/ ha)	Annual growth rate in average yield (%)	Production (MT)	Annual growth rate in production (%)	Share in total production (%)
2005 - 06	63,931	3.97		254		1.12
2006 - 07	74,495	3.99	0.50	297	16.93	1.17
2007 - 08	76,113	4.07	2.01	310	4.38	1.2
2008 - 09	76,316	4.17	2.46	318	2.58	1.2
2009 - 10	76,321	4.17	0.00	318	0.00	1.19
2010 - 11	76,321	4.17	0.00	318	0.00	1.19
2011 - 12	76,110	3.63	-12.95	276	-13.21	1.15
2012 - 13	75,843	3.99	9.92	302	9.42	1.3
2013 - 14	75,704	4.03	1.00	305	0.99	1.31
2014 - 15	75,704	4.05	0.50	307	0.50	1.29
Average	74,686	4.02	0.38	301	2.40	1.21

Source: DoA, Daik U Township, 2005 - 2015

Table 1.6 Sown area, yield, production and annual growth rate in yield and production of summer rice in Daik U Township from 2005-2006 to 2014-2015

Year	Sown area (ha)	Yield (MT/ ha)	Annual growth rate in average yield (%)	Production (MT)	Annual growth rate in production (%)	Share in total production (%)
2005 - 06	26,725	4.07		109		2.13
2006 - 07	69,264	4.28	5.16	297	172.48	5.30
2007 - 08	79,040	4.14	-3.27	327	10.10	5.78
2008 - 09	79,549	4.19	1.21	334	2.14	5.58
2009 - 10	87,080	4.18	-0.30	364	8.98	6.09
2010 - 11	55,372	4.17	-0.30	231	-36.54	3.97
2011 - 12	54,666	3.87	-7.19	211	-8.66	4.32
2012 - 13	59,512	4.12	6.46	245	16.11	5.56
2013 - 14	59,532	4.13	0.10	246	0.20	4.92
2014 - 15	59,567	4.12	-0.14	246	0.00	5.49
Average	63,031	4.13	0.19	261	18.31	4.91

Source: DoA, Daik U Township, 2005 - 2015

1.4 Rationale of the Study

Rural communities are home to the majority of Myanmar's population, the majority of its are many ethnic groups, and 70 percent of its are poor. Poverty in Myanmar is concentrated in rural areas, where poor people rely on agricultural and casual employment for their livelihoods (World Bank 2016). Development in rural areas is constrained by low productive agriculture and significantly lower levels of public service delivery and human development outcomes relative to urban areas (Myint *et al.* 2016). Rural population is as huge as 86% of total in Ayeyarwady Region and 78% of it in Bago Region and their livelihoods mainly rely on agriculture (DoP 2014).

Myanmar has total cultivated area of 21.37 million hectares. Out of this 34% of total cultivated area are devoted to rice. Rice production of Ayeyarwady Region contributes 28% of the total rice growing area and 17% of it in Bago Region. In 2015, rice sown area of Ayeyarwady and Bago Regions are 2.02 and 1.23 million hectares which occupy over two-thirds of the available agricultural land of these Regions (CSO 2015). Incomes of farmers of Ayeyarwady and Bago Regions mainly depend on productivity of rice. Thus, profitability of rice farming is essential for better livelihoods of rural farm households. Their incomes will be increased and more profit will be obtained if more rice can be produced with less cost of production. If living standards and job opportunities of rural people increased, rural economy and the country economy will be improved.

Ayeyarwady and Bago Regions are growing not only the traditional rice varieties but also the improved high yielding varieties and supply not only for the domestic but also for the international markets. The production costs and product prices are not the same for different rice varieties. Costs and returns of rice productions are the important factors to select the suitable varieties for farmers.

Among crop establishment methods of rice in Myanmar, transplanting (TPR) and direct seedling (DSR) method are most common. Even though transplanting is beneficial to the plant and results in higher yields than direct seedling method, it requires much higher labour. Nowadays, labor becomes scarce resource due to labor migration in the rural areas. It is very important to make proper and efficient use of labor. Crop establishment method with higher labor use efficiency will be economically more competitive in long term.

Therefore, it is important to analyze profitability based on different rice varieties and crop establishment methods in different location. It is also important for farmers how to allocate their resources efficiently to maximize profit and to find out constraints to increase the welfare of rice farmers. Therefore, this research was carried out to examine the constraints faced by rice farmers to maximize their profits and the factors influencing on profitability of rice production.

1.5 Objectives of the Study

The overall objective of the study was to determine the profitability of rice producers in Maubin and Daik U Townships and factors correlated with rice profit. The specific objectives of the study were as follows:

1. to analyze the profitability and labor use efficiency of different rice varieties in different growing seasons and crop establishment methods which were largely grown in the study areas;
2. to determine the variables that affect profitability of the selected rice varieties production in the study areas; and
3. to identify the major constraints in rice production.

CHAPTER II
LITERATURE REVIEW

2.1 Myanmar Rice Sector Overview

Myanmar stood as a major rice exporter with its export amount of about 3 million Tons between 1921 and 1941, in colonial period. In 1977-1978, pilot project for paddy high yielding program was launched at Shwebo and Teikkyi with the support in technology and inputs distribution. Summer paddy programme was introduced in 1992. By using short-duration high yielding varieties together with proper irrigation system, 0.3 million hectare of summer paddy were grown. Therefore, total paddy sown area reached at 5.7 million hectare and rice export was increased to 1 million tons in 1994-1995. Among the Regions and States, Ayeyarwady, Sagaing, Bago, Mandalay and Yangon are major rice growing areas (MOALI 2016).

According to the National Planning Targets, the total area of paddy was 7.63 million hectare, comprising 6.45 million hectare under monsoon paddy and 1.18 million hectare under summer paddy and average yield 4.17 MT/ha in 2014-2015. Actual paddy sown area in the year 2014-2015 was 7.17 million hectare and production reached at 28.19 million metric ton. Measures have been undertaken to increase paddy production by using high yielding varieties including introduction of hybrid rice varieties, adoption of Good Agricultural Practices, utilization of good quality high-yielding seeds, application of agricultural inputs such as irrigation water, agro-chemicals and natural fertilizers and promotion of farm machineries utilization as technology intervention (MOALI 2016).

Based on their cultivated area in Myanmar, top-ten monsoon paddy varieties were Manaw Thu Kha, Sin Thu Kha, Ayarmin, Paw Sann Yin, Shwe Wah Htun, Sin Thwe Latt, Sin Akayi, Ngasein, Mee done and Hnan Kar. The cultivated area of ten most common summer paddy varieties were; Thee Htat Yin, Shwe Thwe Yin, Sin Thu Kha, Manaw Thu Kha, Yadanar Toe, 90-days, Pale Thwe, IR-747, Yadanar Aung and Shwe Yin Aye. Ten most widely growing monsoon and summer paddy varieties with their sown hectare were shown in Table 2.1.

As shown in Table 2.2, utilization of farm machinery and equipment for various activities of agricultural production has been increased in both State and private sectors in attempts to boost the agricultural production.

Table 2.1 Cultivated Area of Ten Most Growing Monsoon and Summer Paddy Varieties in Myanmar

No.	Monsoon rice varieties	Sown hectare	No.	Summer rice varieties	Sown hectare
1.	Manaw Thu Kha	1,124,974	1.	Thee Htat Yin	447,940
2.	Sin Thu Kha	550,758	2.	Shwe Thwe Yin	121,665
3.	Ayarmin	329,322	3.	Sin Thu Kha	95,479
4.	Paw Sann Yin	300,131	4.	Manaw Thu Kha	94,078
5.	Shwe Wah Htun	289,501	5.	Yadanar Toe	63,372
6.	Sin Thwe Latt	255,375	6.	90-days	29,008
7.	Sin Akayi	248,837	7.	Pale Thwe	22,712
8.	Ngasein	240,962	8.	IR-747	19,332
9.	Mee done	230,799	9.	Yadanar Aung	11,839
10.	Hnan Kar	225,217	10.	Shwe Yin Aye	7,022

Source: DoP, MOALI (2016)

Table 2.2 Utilization of Machineries and Farm implements in Myanmar

Type of Machinery	**2013-14**	**2014-15**
Tractor	11,839	14,265
Mini Tractor	1,506	2,113
Powertiller	257,971	286,097
Cultivating Roller Boat	5,403	6,065
Threshing machine	55,104	61,793
Combine Harvester	668	1,680
Transplant machine	122	169

Source: DoP, MOAI (2015)

2.2 History of Rice Variety Introduction to Myanmar

The introduction of new hybrid strains was initiated in Myanmar since the prewar days, but gathered significant momentum in 1966-67. Paddy research was resumed in earnest, but the scarcity of suitable parent strains, to produce hybrids was an inhabitant and Myanmar was compelled to rely on the domestic strains. Myanmar local varieties, however, had long life spans, long and soft stems, weak in multiplication of strains and poor in its response to fertilizer applications. Hence, yields remained low. Additionally as Myanmar's rice were season fixed, double cropping wasn't possible. Then with the Green Revolution in 1966, the use of high yielding material, the application of fertilizer and the need for switching to high yielding techniques was realized and accepted. Research activities were initiated in Myanmar prior to its independence and with the establishment of the central agricultural research institute in 1954, research activities were stepped up year by year. Myanmar research released many high yielding, high quality and pest resistance strains were suitable for the different regions and climatic condition of Myanmar (MOAI 2004).

In addition measures for the adoption of modern scientific cultivation were dispensing through talks, booklets and pamphlets. For high yielding rice varieties, breeder seed was produced from Department of Agricultural Research and foundation seed were multiplied from DAR and satellite farms and Myanma Agriculture Service, now DoA (Department of Agriculture) and seed farms. Registered seed and certified seed were distributed through MAS, seed farms and seed grower farmers. Nowadays, there were 97 released high yielding rice varieties and farmers can choose the most profitable rice variety for their farm plan and production by using decision making tools. Department of Agricultural Research (DAR), which maintains contact with International Rice Research Institute (IRRI), is producing new improved high yielding varieties. DAR was systematically conduct research activities that would suit to the needs of all stakeholders which include producers, distributers and consumers in developing and dissemination of regionally adapted crop varieties and crop production technologies (DAR 2009).

2.3 Classification of Rice Varieties of Myanmar

Beale (1927) divided the varieties of Myanmar into five groups according to length and breadth of the grain and the ratio of length to breadth, as shown in Table

2.3. These are Group A (Emata), Group B (Letywezin), Group C (Ngasein), Group D (Medon) and Group E (Byat). The rice varieties sown in Myanmar were further divided into Ngasein, Medone, Emata and Ngakywe. Among these varieties, Medone and Ngakywe varieties are known as quality rice variety and it receives the highest price while Ngasein is the cheapest variety in the markets. The production costs and product prices are not equal between varieties, qualities and also among regions. There are many differences between productions of Medone and Emata rice varieties regarding with capital investment, use of labor, use of fertilizer, water and weed management, insect and pest control, etc. Regarding with domestic rice marketing, Emata has strong and high domestic and international demand at reasonable price while Medone has favorable demand at high price in both domestic and international markets. Although Paw Sann is denoted as quality rice and high-priced rice, its production and export are fewer than Emata variety.

2.4 Varietal Characteristics of Selected Rice Varieties

Varietal characteristics of the selected rice varieties are shown in Table 2.4.

2.4.1 Hnan Kar

The variety is photosensitive and usually sown in mid-June. It was released from Myaungmya Central Farm in 1934. It is still widely grown in Ayeyarwady and Bago divisions. The variety is well known as Zeera rice in the international market. It is resistant to Ufra disease caused by Nematode and Rice blast disease and Rice stem borer.

2.4.2 Sin Thu Kha

The variety was obtained by breeding of Manaw Thu Kha rice variety with IR BB-21 which contains bacterial leaf blight resistant genes. It is released in 2010 by the approval of National Seed Committee (NSC). It is resistant to bacterial leaf blight. Yield per acre and grain quality of this variety is same with Manaw Thu Kha variety but eating quality is better than Manaw Thu Kha.

2.4.3 Thee Htat Yin

The variety is a selection of IR-108-2-2-3 which was introduced from IRRI (Philippines) and was released in 1991 as Thee Htat Yin. It is a short lived

Emata variety. Grain appearance is translucent. Rice yield and milling recovery are good. It is widely grown in rice double cropping areas.

2.4.4 Hmawbi-2

The variety is a selection of IR-21836-90-3 which was introduced from IRRI (Philippines). It was released in the name of Hmawbi-2 in 1984. It is an Emata variety with translucent grain appearance. Milling recovery and eating quality are good. Response to fertilizer application is also good, and hence high yield is obtained. It is still widely grown in lower Myanmar.

2.5 Advantages and Disadvantages of Transplanting and Direct Seeding

2.5.1 Advantages and disadvantages of transplanting

The advantages of the transplanted puddled rice (TPR) system of sowing include increased nutrient availability (e.g. iron, zinc, phosphorus), weed suppression (Singh *et al.* 2001), easy seedling establishment and creating anaerobic conditions to enhance nutrient availability (Sanchez 1973).

Repeated puddling adversely affects soil physical properties by dismantling soil aggregates, reducing permeability in subsurface layers and forming hard-pans at shallow depths (Sharma *et al.* 2003), all of which can negatively affect the following non-rice upland crop in rotation (Tripathi *et al*. 2005). The transplanted puddled rice (TPR), leads to higher losses of water through puddling, surface evaporation and percolation (Farooq *et al.* 2011). Furthermore, need of ponded water for customary practice of puddling delays rice transplanting by one to three weeks (Ladha *et al.* 2009). Huge water inputs, labour costs and labour requirements for TPR have reduced gross margins (Pandey and Velasco 2005).

2.5.2 Advantages and disadvantages of direct seeding

Direct-seeding of rice has the potential to provide several benefits to farmers and the environment over transplanting. Direct seeding helps reduce water consumption by about 30% (0.9 million liters acre^{-1}) as it eliminates raising of seedlings in a nursery, puddling, transplanting under puddled soil and maintaining 4-5 inches of water at the base of the transplanted seedlings. Direct seeding (both wet and dry), on the other hand, avoids nursery raising, seedling uprooting, puddling and

Table 2.3 Classification of paddy into five types according to size

Group	Group name	Dimensions of grain			
		With husk		Husked	
		Length (mm)	Length/breadth	Length (mm)	Length/breadth
A	Emata	Over 9.4	Over 3.3	Over 7.0	Over 3.0
B	Letywezin	8.4 - 9.8	2.8 - 3.3	6.0 - 7.0	2.4 - 3.0
C	Ngasein	7.75 - 9.0	2.4 - 2.8	5.6 - 6.4	2.0 - 2.4
D	Medon	7.35 - 8.6	2.0 - 2.4	5.0 - 6.0	1.6 - 2.0
E	Byat	9.0 and more	2.25 - 3.0	6.4 - 7.35	2.1 - 2.5

Source: MOAI (2004)

Table 2.4 Varietal Characteristics of selected rice varieties

Variety Name	Hnan Kar	Sin Thu Kha	Thee Htat Yin	Hmawbi-2
Breeding Number	B 34-1	IRYn-1068-7-1	IR 13240-108-2-2-3	IR 21836-90-3
Grain type	Letywezin	Letywezin	Emata	Emata
Life days/ flowering date	152-158	140	110	140
Response to photoperiod	Sensitive	Insensitive	Insensitive	Insensitive
Plant height (cm)	153	107	90	105
Ear bearing tillers	5-7	10-12	8-10	10-12
Grains per panicle	155	178-220	105	141
1,000 grain weight (gm)	21.0	20.6	24.0	25.5
Grain appearance	Large white belly present	Translucent	Translucent/ Trace white belly present	Translucent
Grain measurement				
1. Length (mm)	9.42	8.53	8.80	10.60
2. Breath (mm)	2.65	2.10	2.35	2.30
3. L/B ratio	3.55	4.06	3.74	4.60
Amylose content (%)	25.7	23.7	30.4	18.20
Eating quality	Good	Fairly good	Fairly good/hard	Good/Palatable
Yield per acre (basket)	40-60	90-135	100-120	80-100

Source: MOAI (2004)

transplanting, and thus reduces the labour requirement (Pepsico International 2011). Transplanting shock can be avoided in direct seeded rice than transplanting. This results in growth delays and hastens physiological maturity and reduces vulnerability to late-season drought (Tuong 2008). DSR have less methane emissions (Wassmann *et al.* 2004) and hence offer an opportunity for farmers to earn from carbon credits than TPR system (Balasubramanian and Hill 2002).

In direct seeding, the seeds are exposed to birds, rats and snails. Plants tend to lodge more because there is less root anchorage. More seeds are required, eighty to one hundred kilograms per hectare compared with thirty-five to sixty-five kilograms per hectare required for transplanting. High weed infestation is a major constraint for broader adoption of DSR (Rao *et al.* 2007). Likewise, micronutrient deficiencies such as Zn and Fe, due to imbalanced N fertilization and high infiltration rates in DSR, are of major concern (Gao *et al.* 2006). Yield in DSR is often lower than TPR principally due to poor crop stand, high percentage of panicle sterility, higher weed and root knot nematode infestation (Singh *et al.* 2005). Moreover, cost for weed control is usually higher than TPR.

There are two techniques of direct seeding on a wet field; broadcasting and drilling or line sowing. Major advantages of broadcasting method are; it is quickest and cheapest method, skilled labour and implement are not required and followed in moist condition. Disadvantages of this method are; seed requirement is more and crop stand is not uniform.

Advantages of drilling or line sowing method are seeds are placed at proper and uniform depths, uniform row to row spacing is maintained and seed requirement is less than broadcasting. Disadvantages are this method require implement for sowing, plant to plant spacing is not maintained and skilled person is required for crop sowing.

2.6 Review of Empirical Studies on Economic Comparison of Direct Seeded and Transplanted Rice

Yee Mon Aung (2012) conducted a study to analyze the profitability of rice production for different rice varieties and cultivation methods in Waw Township, Bago (East) Region. The results showed that yield and gross return of different rice varieties sown by broadcasting method was lower than that of varieties sown by transplanting method. Among rice varieties, the highest yield was received from

Manaw Thu Kha rice variety grown by transplanting method and the lowest yield was obtained from Shwe Ta Soke rice variety grown by broadcasting method. The benefit cost ratio (BCR) of Shwe War Tun in broadcasting and transplanting methods were 1.69 and 1.79 respectively. BCR of Manaw Thu Kha rice variety was 1.89 and 1.95 respectively in broadcasting and transplanting method. BCR of Shwe Ta Soke rice variety grown by using broadcasting method was 1.61. The BCR of other rice varieties (Sin Thiri, Thu Kha Tun and Bay Kyar Lay) was 1.66 and 1.81 in broadcasting and transplanting methods. Most of the farmers obtained the highest profit from Manaw Thu Kha rice variety. This study also highlighted that more than half of the sampled farmers grew with low yielding local varieties.

Younas *et al*. (2015) reported about economic comparison of direct seeded and transplanted rice: evidences from adaptive research area of Punjab Pakistan. The study was conducted in three of the four districts of Adaptive Research Zone, Sheikhupura; which contains Sheikhupura, Lahore and Kasur districts for economic comparison of direct seeded (DSR) and transplanted super basmati rice during Kharif-2014. Average yield, cost of production, net economic benefits and benefit cost ratio for DSR and transplanted rice was calculated. Extent of area under DSR technology was also determined. The results revealed that DSR technology was adopted on 22.8% of rice area on surveyed farms and farmers gained profit from practicing DSR technology and born loss from transplanted rice crop in the year 2014. This study also revealed that weeds infestation was a major problem in DSR technology that can be overcome through a combination of cultural as well chemical control methods. Thus, it concluded that DSR is a promising technology subject to weeds management.

2.7 Review of Empirical Studies on Profitability Analyses

Htet Htet Htun (2013) conducted a study to analyze the factors affecting groundnut profit at farm level in Magway Township. To determine the factors affecting the groundnut profit, log linear regression function was employed. The specific profit functions of groundnut farmers were estimated by using 7 independent variables; farm experience, sown area, yield, total labor cost on the farm, total material cost on the farm, price of groundnut and access to credit. According to the groundnut profit regression estimates, groundnut profit was positively and significantly influenced by yield at 1 percent level and negatively influenced by total material cost at 5 percent level.

Olubanjo and Oyebanjo (2008) attempted to identify the determinants of profitability in rain-fed paddy rice production in Nigeria. The Cobb-Douglas type unit-output-price (UOP) profit function was fitted to the study. The results revealed that the elasticity of the profit function increased with the quantity of fertilizer applied and the size of the farmland cultivated, while there was a decline with respect to increased use of hired labour and rice seeds. This study suggested that fertilizer should be made available and affordable to rice farmers in the Ikenne Agricultural Zone since this enhance farm productivity and ensure increased profitability of rain-fed paddy rice production. This study recommended that extension activities should be intensified and focused on introducing labor-saving devices such as tractorisation and at enhancing farmers' access to improved seeds.

Hoque and Haque (2014) reported about socio-economic factors influencing profitability of rice seed production in selected areas of Bangladesh. This study was carried out in three districts namely Jamalpur, Gazipur and Manikganj to identify the socio-economic dimensions of the government seed production project beneficiaries persuading profitability of rice seed production. To examine the profitability of rice seed production, the gross margin and cost benefit analysis were carried out. Co-efficient of correlation and multiple stepwise regressions were employed to find out the determinants of profitability in rice seed production. The results of the study examined that rice seed production was not found to be so profitable as investment in rice seed cultivation can produce average BCR of only up to 1.44, where highest BCR was found in Jamalpur (1.58) compared to Manikganj (1.48) and Gazipur (1.26).The results revealed that socio-economic factors have a profound influence on profitability of rice seed production as these factors combined explained 54.9 percent variation. Sown area, contact with information sources, knowledge on quality rice production and age of the respondents were identified as significant contributors in profitability of rice seed production, whereas contact with information sources was the single most influential factor (24.6%).

2.8 Review of Empirical Studies on Major Constraints of Rice Production in Myanmar

Yee Mon Aung (2012) had an attempt to assess the constraints of rice production in Waw Township, Bago (East) Region. This study revealed general

constraints of sample farm households which were insufficient fertilizer application and higher fertilizer prices, low technology, insufficient capital investment, problem of flooding in rice fields, low farm-gate price of paddy, lack of contact with extension workers, seed impurity, lack of market information, and high transportation cost. The most serious problems of sample farm households were high fertilizer price, low technology for production and low farm gate price of paddy for marketing.

Myo Htwe (2014) conducted a joint research program, undertaken with Oxfam GB and the Department of Agriculture. The purpose was to assess and compare the profitability and technical efficiency of Oxfam's beneficiary farmers and non-beneficiary farmers in 6 villages of Thazi Township. The data were collected through personal interview using a questionnaire answered by a random sample of 30 beneficiary farmers and 88 non-beneficiary farmers. This study examined there were some problems and constraints in rice production in Thazi Township. These were insufficient water, inadequate credit, capital requirement, labor scarcity, inadequate fertilizer, infestation of pest and disease, seed impurity and need extension services. Only labor scarcity was their serious problem for the beneficiary farmers. Inadequate credit and capital requirement problems were more serious in the non-beneficiary farmers.

Mon Mon Ohnn (2012) attempted to identify the main constraints of rice production of sampled farmers by the public and private services in Pyay Township, Bago Region. Main constraints for farmers who carry out Khittayar Hinthar Rice Specialtion Company (PR farmers) in the study area were poor soil (20%), insufficient irrigated water (45%), high price of fertilizer (33%), unavailability of machine (10%), unavailability of high yield seed (40%), lack of access to technology (57%) and limited capital (43%) in their rice production. Main constraints for farmers who conduct with DoA (PU farmers) in the study area were poor soil (13%), insufficient irrigated water (50%), high price of fertilizer (73%), unavailability of machine (30%), unavailability of high yield seed (63%), lack of access to technology (67%) and limited capital (97%) in their rice production. Main constraints for PU+PR contact farmers in the study area were poor soil (10%), irrigated water (40%), high price of fertilizer (73%), unavailability of machine (13%), high yield seed (60%), technology (83%) and limited money (83%) in their rice production.

According to these researches, poor soil, inadequate credit, capital requirement, seed impurity, high price of fertilizer, inadequate fertilizer, lack of

market information, low farm-gate price of paddy, low technology, lack of contact with extension workers, problem of flooding in rice fields, insufficient irrigated water, high transportation cost, labor scarcity, infestation of pest and disease and unavailability of machine were observed as common constraints for rice producing farmers in Myanmar. According to the results of Aung (2012) and Ohnn (2012), labor scarcity was not yet mentioned as a constraint. However, in 2014, labor scarcity became a big issue besides production constraints.

2.9 Review of Research Methodology

2.9.1 Enterprise budget analysis or decision making tool for farmers

Enterprise budget analysis is important decision making tool. They can help individual producer determines the most profitable crops to grow, develop marketing strategies, obtain financing necessary to implement production plans, and make other farm business decisions (Olson 2009).

An enterprise budget projects the costs and returns of growing and selling a particular crop or livestock over a period of time. It comprises of a simple listing of income and expenses, based on a set of assumptions (Afeworki *et al.* 2015). Enterprise budgets estimate profitability for agricultural enterprises while documenting management practices and the resources and technology used (Smith *et al.* 2013).

An enterprise budget is an estimate of the costs and returns associated with the production of a product or products-referred to as an enterprise. An enterprise, or profit center one, is a distinct part of the farm or ranch business that can be analyzed separately. An enterprise is usually based on some production input unit- an acre of land for most crop enterprise budgets, or an individual animal unit for livestock enterprise budgets. In some cases, two enterprises may be merged into one, such as grazing wheat pasture and growing wheat for harvest. Enterprise budgets estimate costs and returns based on a specific complement of machinery, land, labor and technology (Smith *et al.* 2013).

Doye and Sahs (2015) reported that enterprise budgets project costs and returns for an activity such as raising livestock, producing grain, or growing vegetables for a production period. Each budget specifies a system of production, inputs required, and the annual sequence of operations, as well as summarizes the costs and returns associated with the process. Most budgets are based on one year. For

enterprises where production spans more than one year (for example, pecans or cow-calf), a budget generally includes income and expenses for a representative one-year period.

An enterprise budget is a physical and financial plan for raising and selling a particular crop or livestock commodity. It is a physical plan because it indicates the type and quantity of production inputs and the output, or yield, per unit. It is also a financial plan, because it assigns costs to all the inputs used in producing the commodity (Richard 2008)

Greaser and Harper (1994) stated that enterprise budget represents estimates of receipts (income), costs, and profits associated with the production of agricultural products. The information contained in the enterprise budgets can be used by agricultural producers, extension specialists, financial institutions, governmental agencies, and other advisers making decisions in the food and fiber industry. Enterprise budgets contained several cost components. Determining the costs of production practices can be difficult. Individuals often disagreed over which costs to include and how they should be measured. Understandably, these differences arise because production costs are unique to each resource situation. An important financial distinction was the concept of variable and fixed costs.

In economic terms, enterprise budgets help to allocate land, labor and capital, which are limited, to the most appropriate use (Chase 2017). Enterprise budgets require less data than the whole farm budget, and when realistic and accurate cost allocations can be made by enterprise, the comparative profitability of enterprises can be measured. Enterprise budgets also can be used to derive breakeven prices and break-even yields (Smith *et al.* 2013).

2.9.2 Log linear regression analysis

Regression analysis is a statistical technique that attempts to “explain” movements in one variable, the dependent variable, as a function of movements in set of other variables, called the independent (or explanatory) variables, through the quantification of a single equation. The double-log form is the most common functional form that is nonlinear in the variables while still being linear in the coefficients. In a double-log functional form, the natural log of Y is the dependent variable and the natural log of X is the independent variable:

$LnY_i = \beta_0 + \beta_i LnX_i + e_i$

Where LnY refers to the natural log of Y and LnX_i refers to natural log of X_i.

The double-log form, sometimes called the log-log form, often is used because a researcher has specified that the elasticities of the model are constant and the slopes are not. This is in contrast to the liner model, in which the slopes are constant but the elasticities are not. The way to interpret β_i in a double-log equation is that if X_i increases by 1 percent while the other Xs are held constant, then Y will change by k percent. Since elasticities are constant, the slopes are now no longer constant. Before using a double-log model, make sure that there are no negative or zero observations in the data set. Dummy variables, which can take on the value of zero, should not be logged but still can be used in a double-log equation.

An intercept dummy variable is a dummy variable that changes the constant or intercept term, depending on whether the qualitative condition is met. These take the general form,

$Y_i = \beta_0 + \beta_i X_i + d_i D_i + e_i$

Where

$$D_i = \begin{cases} 1 \text{ if the } i^{th} \text{ observation meets a particular condition} \\ 0 \text{ otherwise} \end{cases}$$

The intercept dummy does indeed change the intercept depending on the value of D, but the slopes remain constant no matter what value D takes. Only one dummy variable is used even though there were two conditions. This is because one fewer dummy variable is constructed than conditions. This event not explicitly represented by a dummy variable, the omitted condition, forms the basis against which the included conditions are compared. Thus, for dual situations only one dummy variable is entered as an independent variable; the coefficient is interpreted as the effect of the included condition relative to the omitted condition (Studenmund 2005).

CHAPTER III
RESEARCH METHODOLOGY

3.1 Data Source and Data Collection

The study utilized both primary and secondary data. The survey was carried out by using purposive random sampling method during September to November 2015. Primary data were obtained from purposively selected different locations, Maubin and Daik U Townships, because of being IRRI and ACIAR joint project areas. Four villages were purposively chosen from each Township because they were the project's villages. Simple random selections of 130 sample farmers were personally interviewed in which 65 farmers from each Township with a set of structured questionnaire.

The questionnaire was constructed in details on all information about rice production. Demographic characteristics of the sample farmers such as age, education level, and household head's experience in rice production, family size and family labor were collected. And also farming practices such as land ownership, rice production area, method of cultivation, varieties used, seed rate per acre, cropping patterns, utilization of fertilizer, seed, pesticide, herbicide and their prices were collected. Detail costs (material cost, labor cost and farm power cost), yields and returns of rice production, constraints of rice farmers were also composed in the questionnaire.

Secondary data were gathered from published and official records of Ministry of Agriculture, Livestock, and Irrigation (MOALI), the Department of Population (DoP), Department of Agriculture, Maubin and Daik U Township Offices, the various other government organizations and the other related publications.

3.2 General Description of the Study Area

The study was carried out in Maubin and Daik U Townships. They are the Townships of rice surplus areas in lower Myanmar.

3.2.1 Maubin Township

It is located in the Ayeyarwady Region, the heart of Myanmar's rice bowl, with a total population of 314,093 according to Myanmar census report 2014. It is situated between latitude 16˚ 30' north and east longitudes 95˚ 24'. There are 442

villages and 76 village tracts in Maubin Township. The area of Maubin Township was 133,540 hectares and the cultivated area was 86,538 hectares, 67.71 % of total area. The area of paddy land (Le) was about 57,348 hectares and dry land (Yar) was about 33,747 hectares. Pann Pin Su, Nga Gyi Ghayat, Tar Pat and Alang villages were selected as study areas of Maubin Township. A map of the Maubin Township with selected sample villages was shown in Appendix 1.

3.2.2 Daik U Township

Daik U Township is one of the largest rice surplus areas in Bago Region with a total population of 202,530 according to Myanmar census report 2014. Bago region is the second largest rice cultivated area after Ayeyarwady Region. It is situated between latitude 87˚ 50' north and east longitudes 97˚ 48'. There are 178 villages and 44 village tracts in Daik U Township. The area of Daik U Township was 90,236 hectares and the cultivated area was 80,820 hectares, 89.57 % of total area. The area of paddy land (Le) was about 77,984 hectares and dry land (Yar) was about 897 hectares. The study was conducted in four villages such as Pyin Ma-lwin, Kadoke Phayar Gyi, Pha-aung Wae and Oat Shit Kone. A map of the Daik U Township with selected sample villages was shown in Appendix 2.

3.3 Data Analysis Methods

Collected data were tabulated in the Microsoft Excel program. The analysis was employed with demographical approach, descriptive method and regression model using Excel Software and Statistical Packages for Social Science (SPSS) version 16. The analytical techniques included descriptive statistics analysis, enterprise budget analysis, labor use efficiency analysis and profit function for rice production.

3.3.1 Descriptive statistics analysis

Descriptive analysis was used to know farmer social characteristics. Mean, percentages and frequency counts were included in descriptive measurement. Also the problems and constraints faced by the farmers were described by descriptive statistics methods.

3.3.2 Enterprise budget analysis

The evaluation and focus on the economic and technical performance of an individual farm enterprise is called an enterprise budget which is used to examine the profitability of specific farm enterprise and to compare the profitability of existing and proposed enterprises. Enterprise budget enables to evaluate the cost and return of production process. The purpose of enterprise budgeting was to show the differences in net benefits under several resources situations in such a way as to help one make management decision (Olson 2009).

Enterprise budget analysis was used to assess the profitability of rice production in the study area on an average basis. In this analysis, the variable cost of the rice production was divided into two categories, Cash cost and Opportunity cost.

Cash cost includes

(1) Cash items for material cost;
(2) Hired labor cost and
(3) Payment for custom-hired machineries and working animals.

Opportunity cost included

(1) Non-cash items for material cost such as owned seeds, owned FYM and so on;
(2) Family labor cost;
(3) Owned farm power cost and
(4) Interest on cash cost.

Opportunity cost is an economic concept, not a cost that can be found in an accountant's ledger or on an income tax return. However, it is an important and basic concept that needs to be considered when making managerial decisions. Opportunity cost is based on the fact that once an input has been acquired, it may have one or more alternative uses. Once an input is committed to a particular use, it is no longer available for any other alternative use, and the income from the alternative must be foregone.

Opportunity cost can be defined in one of two ways:

1. The income that could have been earned by selling or renting the input to someone else, or
2. The additional income that would have been received if the input had been used in its most profitable alternative use.

Opportunity costs are widely used in economic analysis. For example, the opportunity costs of a farm operator's labor, management, and capital are used in several types of budgets used for analyzing farm profitability. The opportunity cost of farm family labors would be what that labor would earn in its next best alternative use. That alternative use could be nonfarm employment, but depending on skills, training, and experience, it might also be employment in another farm or ranch enterprise. Some operators state that their own time is "free", but it should be given a value at least as high as the value that they put on leisure time (Kay *et al.* 2011).

The interest was normally charged on cash expense for early in the growing season. This reflects that cash invested has an opportunity cost. Using the money to grow this crop precludes investment elsewhere (Olson 2009). In this study, the counted interest rate was 10% for cropping period of 4 months.

In order to estimate total gross returns for crop, average yield and average output price were used. Enterprise budget of rice production by DSR method were computed for 28 Hnan Kar monsoon rice growers, 3 Sin Thu Kha monsoon rice growers and 28 Thee Htat Yin summer rice growers in Maubin Township and 10 Hmawbi-2 monsoon rice growers, 10 Sin Thu Kha monsoon rice growers, and 9 Sin Thu Kha summer rice growers in Daik U Township. Enterprise budget of rice production by TPR method were also computed for 5 Hnan Kar monsoon rice growers, 27 Sin Thu Kha monsoon rice growers and 2 Thee Htat Yin summer rice growers in Maubin Township and 30 Hmawbi-2 monsoon rice growers, 22 Sin Thu Kha monsoon rice growers, and 3 Sin Thu Kha summer rice growers in Daik U Township.

To compare the profitability of different rice varieties with different crop establishment methods, the concept of enterprise budget was used. Profitable measures were estimated by using the following formulae:

1. Gross margin per unit of land = Total Gross Benefit-Total Variable Cost
   GM = GB-TVC
2. Benefit Cost Ratio = Total Gross Benefit/ Total Variable Cost
   BCR = GB / TVC
3. Return from capital invested = Total Gross Benefit/Total Cash Cost

Other measurements used in economic analysis are as follows;

Total variable cost = Total opportunity cost + Total Cash Cost

Total opportunity cost = Total material cost (non-cash items) + Total family labor cost + Total farm power cost (own) + Interest on cash cost

Total cash cost = Total material cost (cash items) + Total hired labor cost + Total farm power cost (hired)

3.3.3 Labor use efficiency analysis

Paddy cultivation needs many workers due to special treatment in planting and harvesting processes. Productivity is commonly defined as a measure relating a quantity of output to the inputs required to produce it. Thus it is an average measure of the efficiency of production. Among other productivity measures such as multi-factor productivity or capital productivity, labor productivity is particularly important. Labor productivity is an output per unit of labor measure. It is computed by dividing the value of farm production by the number of labors.

Labor efficiency measures labor costs as a percentage of the value of production of the farm. It is computed by dividing total labor cost (family labor plus hired labor) by the value of farm production.

If labor efficiency is relatively high and labor productivity is relatively low, it is important to evaluate whether the farm has excess labor. A farm that is efficient and productive with respect to labor would have a relatively low labor efficiency measure, a relatively high labor productivity measure, and relatively low machinery investment and cost measures (Langemeier 2015).

In calculating the labor productivity and labor use efficiency of different rice varieties production, the following equations were used. The information of the total labor used (total labor man-day), total labor cost, gross benefit of the selected rice varieties production were taken directly from enterprise budgets.

$$\text{Return from labor (average labor productivity)} = \frac{\text{Gross benefit}}{\text{Total labor used}} \quad \text{(MMK/md)}$$

$$\text{Labor cost share in total cost} = \frac{\text{Total labor cost}}{\text{Total cost}} \times 100$$

$$\text{Labor use efficiency} = \frac{\text{Gross benefit}}{\text{Total labor cost}}$$

3.3.4 Profit function of rice production

The following model was used to examine the determinant factors on paddy profit of the selected farm households in Maubin and Daik U Townships. To determine the factors affecting paddy profit at farm level in the study area, log linear regression function was used. The dependent variable was gross margin received by sample farmers and independent variables were yield, total labor used, total fertilizer cost, sown area of paddy, age of household head, schooling year of household head, seed source, crop establishment method, harvesting practice and income source. The regression function was as follows;

$$\text{Ln GM} = \beta o + \beta_1 LnX_{1i} + \ldots + \beta_6 LnX_{6i} + b_1 D_{1i} + \ldots + b_4 D_{4i} + u_i$$

Where,

Ln	=	Natural logarithm
i	=	i^{th} farm in the sample
GM	=	Gross margin received by sample farmers (MMK/ha)
X_{1i}	=	Yield (kg/ha)
X_{2i}	=	Total labor used on the farm (md/ha)
X_{3i}	=	Total fertilizer cost (MMK/ha)
X_{4i}	=	Sown area of paddy (ha)
X_{5i}	=	Age of household head (yr)
X_{6i}	=	Schooling years of household head (yr)
D_{1i}	=	Seed source (1 = own seed, 0 = otherwise)
D_{2i}	=	Crop establishment method (1 = DSR method, 0 = TPR method)
D_{3i}	=	Harvesting practice (1 = combine harvester, 0 = otherwise)
D_{4i}	=	Income source (1=having non-farm income, 0=otherwise)
β_0	=	Constant
β_i, b_i	=	Estimated coefficients, i = 1,2,3, … etc.
u_i	=	Disturbance term

3.4 Empirical Model for the Factors Influenced the Paddy Profit

The study expected from the independent variables which affected the factors influencing for paddy profit in the study area. A complete decision of the variables specified and types of measures that have been employed was shown in Table 3.2.

Table 3.1 Expected signs of the independent variables in paddy profit

Independent Variables	Unit	Expected Sign
Yield	MMK/ha	(+)
Total labor used on the farm	md/ha	(+/-)
Total fertilizer cost	MMK/ha	(-)
Sown area of paddy	ha	(+/-)
Age of household head	yr	(+/-)
Schooling years of household head	yr	(+)
Seed source (dummy)	-	(-)
Crop establishment method (dummy)	-	(+)
Harvesting practice (dummy)	-	(+)
Income source (dummy)	-	(+)

CHAPTER IV
RESULTS AND DISCUSSION

4.1 Descriptive Statistics on Background Information of the Sample Respondents

4.1.1 The demographic characteristics of the sample farm households

The information of the demographic characteristics of the sample farm households in Maubin and Daik U Townships sourced from the conducted survey in 2014-15 was provided in Table 4.1.

Household head is the primary decision maker on the family farm. Therefore, household head's age and farming experience are the important factors for farm profitability. The age of the household heads of the sample farm households ranged between 29 and 68 years with a mean of 50 years in Maubin Township and ranged between 32 and 74 years with a mean of 51 years in Daik U Township. The average farming experiences of the household heads were 24 and 27 years in Maubin and Daik U Townships.

Education which represents human capital of household's head is generally postulated to have a positive impact on profit. The average schooling year of household heads from Maubin and Daik U Townships was 7 years. According to the result, it can be seen that most of the household heads from both Townships were in middle school education level. In Maubin Township, the highest education level of 13 years and the lowest of 4 years were observed among the selected farm household heads. Similary, the highest of 14 years and the lowest of 4 years were also observed in Daik U Township.

It is expected that households with large farms would spread production costs across a large output leading to economies of scale. The average farm size of the sample farm households in Maubin and Daik U Townships were 3.9 and 8.6 hectare respectively. It ranged between 0.4 to 24.3 hectare in Maubin Township and 2.0 to 18.2 hectare in Daik U Township.

A large household size indicates that a large number of family members can avail their labour to farm activities and thus labour constraints wouldn't be a problem. In addition, a large household size could be an indication of a household's ability to have several information sources thus positively impacting on profits. However, in some instances, despite a large household size, profitability may be negatively impacted upon in that some family members may not take part in the production

activities (Samboko 2011). Therefore, household size and number of family members work on farm are interesting factors for farm profitability. The mean household size of the respondents was 4 and 5 in Maubin and Daik U Townships, and it ranged between 1 to 8 members per household in Maubin Township and 1 to 9 members per household in Daik U Township. In Maubin Township, average family labor force was 3 with maximum of 6 and minimum of 1. Average family labor force of 2 with a range of 1 to 5, was also observed in Daik U Township. Family labor was 75% of family size in Maubin and 40% of it in Daik U Township.

According to the results, it is obvious that most of the respondents from Daik U Township possessed larger farm size than those from Maubin Township. However, number of family labor was higher in Maubin than that of Daik U. Thus, the farm size to labor ratio was quite big in Daik U Township that they have to depend more on hired labor.

4.1.2 Farming assets of the sample farm households

The majority of sample farm households in the study areas possessed a range of farming implements. The data for ownership of farm assets of the sample farm households in Maubin and Daik U Townships were shown in Table 4.2.

In Maubin Township, most of the sample farm households possessed water pump, sprayer and power tiller. However, bullock cattle, buffalo, cart, tractor, thresher, warehouse, plough, harrow, seeder and intercultivator were not possessed by majority of sample farm households.

In Daik U Township, most of the sample farm households possessed sprayer, plough, harrow, cattle and bullock cart. However, buffalo, tractor, power tiller, water pump, thresher, warehouse, seeder and intercultivator were not possessed by majority of sample farm households.

According to the results, it can be seen that most of the sample farm households in Maubin Township possessed farm machineries such as power tiller and water pump meanwhile most of the sample farm households in Daik U Township possessed traditional farming implements such as cattle, plough and harrow. While 27 percent of total respondents in Maubin possessed warehouse, only 15 percent of total respondents in Daik U possessed this. Low percentage of possessing warehouses in Daik U Township pointed out that most farmers from there selling out paddy directly after harvest.

Table 4.1 Demographic characteristics of the sample farm households in Maubin and Daik U Townships

No.	Items	Maubin (N=65)				Daik U (N=65)			
		Avg.	Max.	Min.	SD	Avg.	Max.	Min.	SD
1.	Age of household heads (yr)	50	68	29	11.1	51	74	32	9.9
2.	Farming experience of household heads (yr)	24	48	3	11.9	27	55	3	11.0
3.	Education level of household heads (yr)	7	13	4	2.3	7	14	4	2.9
4.	Farm size (ha)	3.9	24.3	0.4	3.7	8.6	18.2	2.0	6.0
5.	Family size (No.)	4	8	1	1.6	5	9	1	1.7
6.	Family labors (No.)	3	6	1	1.2	2	5	1	1.1

Table 4.2 Farm assets of the sample farm households in the study areas

Items	Maubin Township (N=65)			Daik U Township (N=65)		
	Avg.	Max.	Percent of total respondents	Avg.	Max.	Percent of total respondents
Cattle	0.62	10	21	1.59	15	45
Buffalo	0.17	6	6	1.81	19	26
Cart	0.27	2	25	0.61	2	49
Tractor	0.13	1	13	0.04	1	3
Power tiller	0.48	1	48	0.33	1	35
Water pump	0.60	2	56	0.48	2	40
Thresher	0.21	1	21	0.04	1	3
Warehouse	0.31	2	27	0.19	1	15
Plough	0.40	3	35	1.00	4	75
Harrow	0.40	2	37	1.02	3	75
Drum seeder	0.29	1	17	0.04	1	3
Sprayer	0.71	4	56	0.96	3	82
Intercultivator	0.04	1	4	0.04	1	3

4.2 Rice Varieties Used by Sample Farmers in the Study Areas

In Maubin Township, different rice varieties were grown such as Hnan Kar, Sin Thu Kha, Taung Pyan, Sin Thwe Latt, Thee Htat Yin, Paw Sann, Pyi Taw Yin, Water flood resistance-2, Manaw Thu Kha and Ayarmin in monsoon season and Thee Htat Yin, Yay Anelo-4, Sin Thu Kha, Vietnam, Pyi Taw Yin and Pale Thwe in summer season (Figure 4.1). Among them, the major rice varieties grown in Maubin Township were Hnan Kar and Sin Thu Kha in monsoon season and Thee Htat Yin in summer season.

Moreover, in Daik U Township, different rice varieties such as Hmawbi-2, Sin Thu Kha, Manaw Thu Kha, Yadanar Aung, Yadanar Toe, Pale Thwe, Paw Sann Yin, Kauk Nghin, Yar Kyaw, Sin Thwe Latt and Paw Sann Bay Kya were cultivated in monsoon season and Sin Thu Kha, Manaw Thu Kha, Hmawbi-2 and Yadanar Toe were also culivated in summer season (Figure 4.2). The most widely cultivated rice varieties of Daik U Township were Hmawbi-2 and Sin Thu Kha in monsoon season and Sin Thu Kha in summer season.

In Maubin Township, two most widely used monsoon rice varieties of Hnan Kar and Sin Thu Kha and one summer rice variety of Thee Htat Yin were selected for profitability analysis. Similarly, in Daik U Township, two most widely used monsoon rice varieties of Hmawbi-2 and Sin Thu Kha and one summer rice variety of Sin Thu Kha were also selected for profitability analysis.

4.3 Gross Margin Analysis of Rice Production by Different Crop Establishment Methods (DSR and TPR)

4.3.1 Gross margin analysis of Hnan Kar rice production by different crop establishment methods (DSR and TPR) (Maubin Township, 2014 monsoon season)

The gross margin analysis of Hnan Kar rice production by DSR and TPR methods was indicated in Table 4.3. Total cash cost includes cash items for material cost, total hired labor cost, and payment for custom-hired machineries and working animals. Total cash cost was 272,895 MMK per hectare in DSR method and 371,517 MMK per hectare in TPR method. Total opportunity cost includes non-cash items for

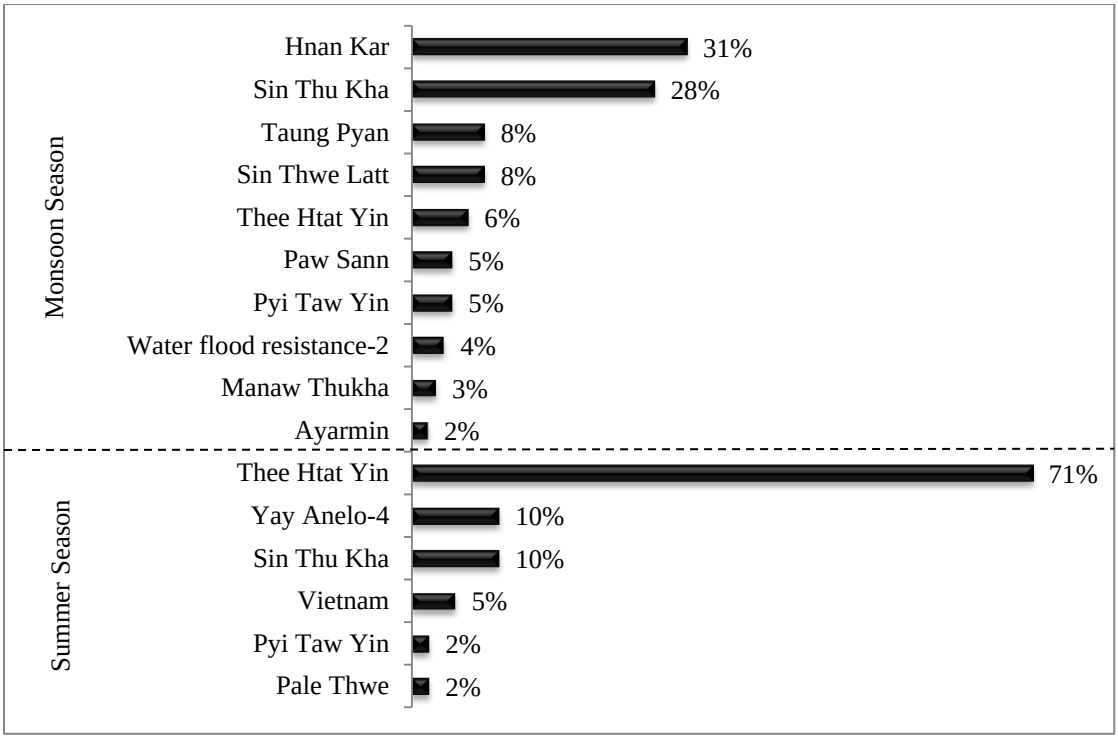

Figure 4.1 Rice varieties used by percentage of sample farmers in Maubin Township

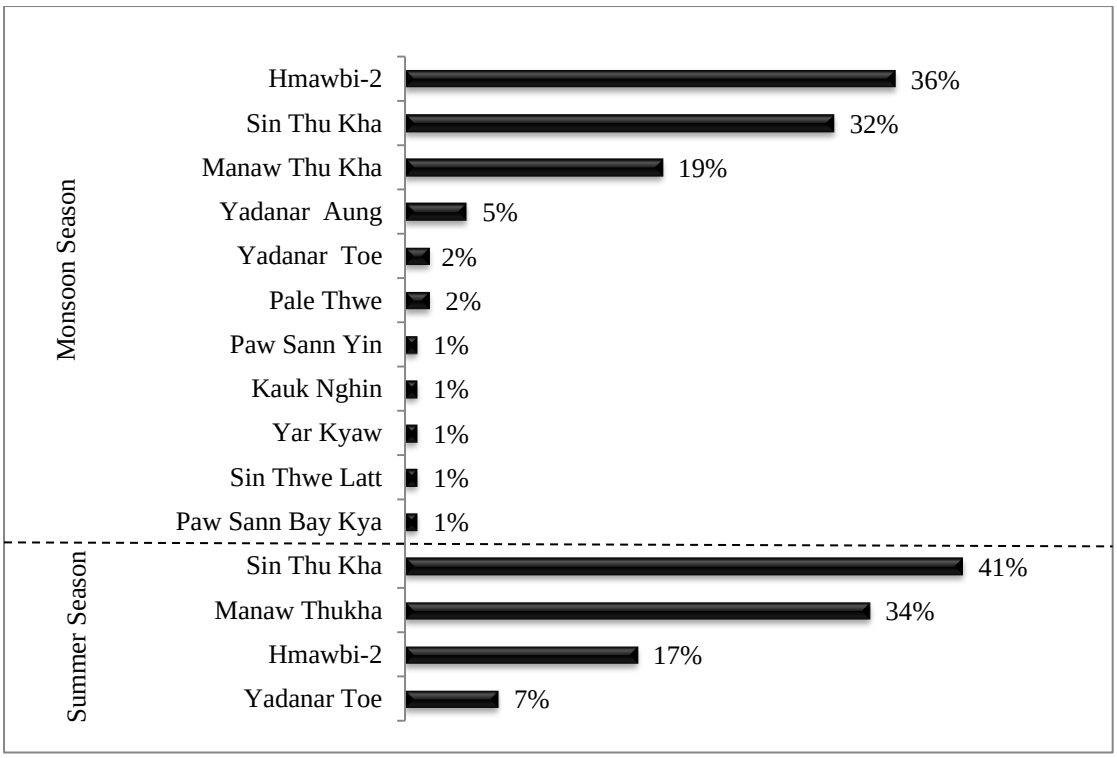

Figure 4.2 Rice varieties used by percentage of sample farmers in Daik U Township

material cost, family labor cost, owned farm power cost and interest on cash cost. In this study, the counted interest rate was 10% for cropping period of 4 months. Total opportunity cost was 104,349 MMK per hectare in DSR method and 93,539 MMK per hectare in TPR method. Total variable cost includes total cash cost and total opportunity cost. DSR method expensed total variable cost of 404,534 MMK/ha and TPR method expensed total variable cost of 502,208 MMK/ha. It was found that DSR method expensed less in total variable cost than TPR method. Moreover, the average yield in DSR method (2,661 kg/ha) was higher than that of TPR method (2,504 kg/ha). Therefore, total gross benefit for DSR method (517,065 MMK per hectare) was higher than that of TPR method (492,172 MMK per hectare). Gross margin per unit of land for DSR and TPR methods were 112,531 MMK per hectare and -10,036 MMK per hectare respectively. On the other hand, net benefit (gross margin) was 21.76% of gross benefit in DSR method and net loss was 2.04% of gross benefit in TPR method. Return above cash cost of DSR and TPR methods were 1.89 and 1.32 respectively. The benefit-cost ratio of DSR and TPR methods were 1.28 and 0.98 respectively. From the study, the benefit of Hnan Kar rice just covered the total variable costs in DSR method and in the case of TPR method; benefit did not cover the total variable costs. It means that while Hnan Kar rice growers grown by DSR method just received money back for their family effort in the rice production and the interest on the capital, Hnan Kar rice growers grown by TPR method faced with loss. When the Hnan Kar rice growers invest one MMK in the rice production, they will receive 1.28 MMK for DSR method and 0.98 MMK for TPR method.

4.3.2 Gross margin analysis of Sin Thu Kha rice production by different crop establishment methods (DSR and TPR) (Maubin Township, 2014 monsoon season)

The gross margin analysis of Sin Thu Kha rice production by DSR and TPR methods was indicated in Table 4.4. Total cash cost was 343,618 MMK per hectare in DSR method and 466,018 MMK per hectare in TPR method. Total opportunity cost was 117,325 MMK per hectare in DSR method and 134,684 MMK per hectare in TPR method. DSR method expensed total variable cost of 495,305 MMK/ha and TPR method expensed total variable cost of 647,303 MMK/ha. Among total variable cost, total labor cost for TPR method was almost two times higher than that of DSR method. Therefore, DSR method expensed less in total variable cost than TPR method

Table 4.3 Gross margin analysis of Hnan Kar rice production by different crop establishment methods (DSR and TPR) (Maubin Township, 2014 monsoon season)

Items	Average Value (MMK/ha)	
	DSR method N=28	TPR method N=5
(A) Gross benefit ($Y*P_y$)	**517,065**	**492,172**
Average yield (Y) (kg/ha)	2,661	2,504
Average producer price (P_y) (MMK/kg)	194	197
(B) Material cost (B.1+B.2)	**88,076**	**116,456**
(1) Non-cash cost	11,300	13,387
(2) Cash cost	76,776	103,068
(C) Labor cost (C.1+C.2)	**220,079**	**258,421**
(1) Family labor cost	68,719	57,304
(2) Hired labor cost	151,360	201,117
(D) Farm power cost (D.1+D.2)	**69,089**	**90,180**
(1) Own	24,330	22,848
(2) Hired	44,760	67,332
(E) Total cash cost (B.2+C.2+D.2)	**272,895**	**371,517**
(F) Interest on cash cost	**27,290**	**37,152**
(G) Total opportunity cost (B.1+C.1+D.1+F)	**104,349**	**93,539**
(H) Total variable cost (E+G)	**404,534**	**502,208**
(I) Gross margin per unit of land (A-H)	**112,531**	**-10,036**
(J) Return above cash cost (A/E)	**1.89**	**1.32**
(K) Benefit and cost ratio (BCR) (A/H)	**1.28**	**0.98**

However, the average yield in DSR method (3,435 kg/ha) was lower than that of TPR method (3,972 kg/ha). Therefore, total gross benefit for DSR method (768,444 MMK per hectare) was lower than that of TPR method (906,252 MMK per hectare). Gross margin per unit of land for DSR method (273,139 MMK per hectare) was higher than that of TPR method (258,949 MMK per hectare). On the other hand, net benefit (gross margin) was 35.54% of gross benefit in DSR method and 28.57% of gross benefit in TPR method. Return above cash cost of DSR and TPR methods were 2.24 and 1.94 respectively. The benefit and cost ratio of DSR and TPR methods were 1.55 and 1.40 respectively.

4.3.3 Gross margin analysis of Thee Htat Yin rice production by different crop establishment methods (DSR and TPR) (Maubin Township, 2015 summer season)

The gross margin analysis of Thee Htat Yin rice production by DSR and TPR methods was indicated in Table 4.5. Total cash cost was 490,858 MMK per hectare in DSR method and 640,230 MMK per hectare in TPR method. Total opportunity cost was 179,648 MMK per hectare in DSR method and 171,974 MMK per hectare in TPR method. DSR method expensed total variable cost of 719,592 MMK/ha and TPR method expensed total variable cost of 876,227 MMK/ha. Among total variable cost, total labor cost for TPR method was almost two times higher than that of DSR method. Therefore, DSR method expensed less in total variable cost than TPR method. However, the average yield in DSR method (4,610 kg/ha) was lower than that of TPR method (4,895 kg/ha). Therefore, total gross benefit for DSR method (877,988 MMK per hectare) was lower than that of TPR method (936,600 MMK per hectare). Gross margin per unit of land for DSR method (158,396 MMK per hectare) was higher than that of TPR method (62,373 MMK per hectare). On the other hand, net benefit (gross margin) was 18.04% of gross benefit in DSR method and 6.65% of gross benefit in TPR method. Return above cash cost of DSR and TPR methods were 1.79 and 1.47 respectively. The benefit and cost ratio of DSR and TPR methods were 1.22 and 1.47 respectively.

Table 4.4 Gross margin analysis of Sin Thu Kha rice production by different crop establishment methods (DSR and TPR) (Maubin Township, 2014 monsoon season)

Items	Average Value (MMK/ha)	
	DSR method N=3	TPR method N=27
(A) Gross benefit ($Y*P_y$)	**768,444**	**906,252**
Average yield (Y) (kg/ha)	3,435	3,972
Average producer price (P_y) (MMK/kg)	224	228
(B) Material cost (B.1+B.2)	**121,936**	**141,874**
(1) Non-cash cost	19,760	5,558
(2) Cash cost	102,176	136,317
(C) Labor cost (C.1+C.2)	**184,015**	**286,697**
(1) Family labor cost	86,039	99,852
(2) Hired labor cost	97,976	186,844
(D) Farm power cost (D.1+D.2)	**154,993**	**172,131**
(1) Own	11,527	29,274
(2) Hired	143,466	142,857
(E) Total cash cost (B.2+C.2+D.2)	**343,618**	**466,018**
(F) Interest on cash cost	**34,362**	**46,602**
(G) Total opportunity cost (B.1+C.1+D.1+F)	**117,325**	**134,684**
(H) Total variable cost (E+G)	**495,305**	**647,303**
(I) Gross margin per unit of land (A-H)	**273,139**	**258,949**
(J) Return above cash cost (A/E)	**2.24**	**1.94**
(K) Benefit and cost ratio (BCR) (A/H)	**1.55**	**1.40**

Table 4.5 Gross margin analysis of Thee Htat Yin rice production by different crop establishment methods (DSR and TPR) (Maubin Township, 2015 summer season)

Items	Average Value (MMK/ha)	
	DSR method N=28	TPR method N=2
(A) Gross benefit ($Y*P_y$)	**877,988**	**936,600**
Average yield (Y) (kg/ha)	4,610	4,895
Average producer price (P_y) (MMK/kg)	190	192
(B) Material cost (B.1+B.2)	**321,413**	**336,229**
(1) Non-cash cost	14,776	8,336
(2) Cash cost	306,637	327,983
(C) Labor cost (C.1+C.2)	**215,581**	**362,355**
(1) Family labor cost	112,826	85,833
(2) Hired labor cost	102,755	276,523
(D) Farm power cost (D.1+D.2)	**133,512**	**113,620**
(1) Own	52,046	77,805
(2) Hired	81,466	35,815
(E) Total cash cost (B.2+C.2+D.2)	**490,858**	**640,230**
(F) Interest on cash cost	**49,086**	**32,789**
(G) Total opportunity cost (B.1+C.1+D.1+F)	**179,648**	**171,974**
(H) Total variable cost (E+G)	**719,592**	**876,227**
(I) Gross margin per unit of land (A-H)	**158,396**	**62,373**
(J) Return above cash cost (A/E)	**1.79**	**1.47**
(K) Benefit and cost ratio (BCR) (A/H)	**1.22**	**1.07**

4.3.4 Gross margin analysis of Hmawbi-2 rice production by different crop establishment methods (DSR and TPR) (Daik U Township, 2014 monsoon season)

The gross margin analysis of Hmawbi-2 rice production by DSR and TPR methods was indicated in Table 4.6. Total cash cost was 314,468 MMK per hectare in DSR method and 461,721 MMK per hectare in TPR method. Total opportunity cost was 108,359 MMK per hectare in DSR method and 132,902 MMK per hectare in TPR method. DSR method expensed total variable cost of 454,274 MMK/ha and TPR method expensed total variable cost of 640,796 MMK/ha. Among total variable cost, total labor cost for TPR method was almost two times higher than that of DSR method. Therefore, DSR method expensed less in total variable cost than TPR method. However, the average yield in DSR method (3,066 kg/ha) was lower than that of TPR method (3,440 kg/ha). Therefore, total gross benefit for DSR method (665,751 MMK per hectare) was lower than that of TPR method (815,223 MMK per hectare). Gross margin per unit of land for DSR method (211,478 MMK per hectare) was higher than that of TPR method (174,427 MMK per hectare). On the other hand, net benefit (gross margin) was 31.77% of gross benefit in DSR method and 21.40% of gross benefit in TPR method. Return above cash cost of DSR and TPR methods were 2.12 and 1.77 respectively. The benefit and cost ratio of DSR and TPR methods were 1.47 and 1.27 respectively.

4.3.5 Gross margin analysis of Sin Thu Kha rice production by different crop establishment methods (DSR and TPR) (Daik U Township, 2014 monsoon season)

The gross margin analysis for Sin Thu Kha rice production by DSR and TPR methods was indicated in Table 4.7. Total cash cost was 287,792 MMK per hectare in DSR method and 422,033 MMK per hectare in TPR method. Total opportunity cost was 99,418 MMK per hectare in DSR method and 121,603 MMK per hectare in TPR method. DSR method expensed total variable cost of 415,989 MMK/ha and TPR method expensed total variable cost of 585,839 MMK/ha. Among total variable cost, total labor cost for TPR method was almost two times higher than that of DSR

Table 4.6 Gross margin analysis of Hmawbi-2 rice production by different crop establishment methods (DSR and TPR) (Daik U Township, 2014 monsoon season)

Items	Average Value (MMK/ha)	
	DSR method N=10	TPR method N=30
(A) Gross benefit ($Y*P_y$)	**665,751**	**815,223**
Average yield (Y) (kg/ha)	3,066	3,440
Average producer price (P_y) (MMK/kg)	217	237
(B) Material cost (B.1+B.2)	**107,630**	**158,780**
(1) Non-cash cost	12,103	15,355
(2) Cash cost	95,527	143,425
(C) Labor cost (C.1+C.2)	**157,240**	**261,614**
(1) Family labor cost	73,038	64,195
(2) Hired labor cost	84,202	197,419
(D) Farm power cost (D.1+D.2)	**157,957**	**174,230**
(1) Own	23,218	53,352
(2) Hired	134,739	120,878
(E) Total cash cost (B.2+C.2+D.2)	**314,468**	**461,721**
(F) Interest on cash cost	**31,447**	**46,172**
(G) Total opportunity cost (B.1+C.1+D.1+F)	**108,359**	**132,902**
(H) Total variable cost (E+G)	**454,274**	**640,796**
(I) Gross margin per unit of land (A-H)	**211,478**	**174,427**
(J) Return above cash cost (A/E)	**2.12**	**1.77**
(K) Benefit and cost ratio (BCR) (A/H)	**1.47**	**1.27**

method. Therefore, DSR method expensed less in total variable cost than TPR method. However, the average yield in DSR method (3,195 kg/ha) was lower than that of TPR method (3,635 kg/ha). Therefore, total gross benefit for DSR method (594,183 MMK per hectare) was lower than that of TPR method (715,206 MMK per hectare). Gross margin per unit of land for DSR method (178,194 MMK per hectare) was higher than that of TPR method (129,367 MMK per hectare). On the other hand, net benefit (gross margin) was 29.99% of gross benefit in DSR method and 18.09% of gross benefit in TPR method. Return above cash cost of DSR and TPR methods were 2.06 and 1.69 respectively. The benefit and cost ratio of DSR and TPR methods were 1.43 and 1.22 respectively.

4.3.6 Gross margin analysis of Sin Thu Kha rice production by different crop establishment methods (DSR and TPR) (Daik U Township, 2015 summer season)

The gross margin analysis for Sin Thu Kha rice production by DSR and TPR methods was indicated in Table 4.8. Total cash cost was 396,545 MMK per hectare in DSR method and 578,279 MMK per hectare in TPR method. Total opportunity cost was 73,716 MMK per hectare in DSR method and 82,745 MMK per hectare in TPR method. DSR method expensed total variable cost of 509,915 MMK/ha and TPR method expensed total variable cost of 718,852 MMK/ha. Among total variable cost, total labor cost for TPR method was almost two times higher than that of DSR method. Therefore, DSR method expensed less in total variable cost than TPR method. However, the average yield in DSR method (3,246 kg/ha) was lower than that of TPR method (3,864 kg/ha). Therefore, total gross benefit for DSR method (631,085 MMK per hectare) was lower than that of TPR method (792,120 MMK per hectare). Gross margin per unit of land for DSR method (121,170 MMK per hectare) was higher than that of TPR method (73,268 MMK per hectare). On the other hand, net benefit (gross margin) was 19.20% of gross benefit in DSR method and 9.25% of gross benefit in TPR method. Return above cash cost of DSR and TPR methods were 1.59 and 1.37 respectively. The benefit and cost ratio of DSR and TPR methods were 1.24 and 1.10 respectively.

Table 4.7 Gross margin analysis of Sin Thu Kha rice production by different crop establishment methods (DSR and TPR) (Daik U Township, 2014 monsoon season)

Items	Average Value (MMK/ha)	
	DSR method N=10	TPR method N=22
(A) Gross benefit ($Y*P_y$)	**594,183**	**715,206**
Average yield (Y) (kg/ha)	3,195	3,635
Average producer price (P_y) (MMK/kg)	186	197
(B) Material cost (B.1+B.2)	**104,580**	**121,361**
(1) Non-cash cost	11,362	14,820
(2) Cash cost	93,218	106,541
(C) Labor cost (C.1+C.2)	**132,022**	**256,925**
(1) Family labor cost	79,411	73,325
(2) Hired labor cost	52,611	183,600
(D) Farm power cost (D.1+D.2)	**150,608**	**165,350**
(1) Own	8,645	33,457
(2) Hired	141,968	131,892
(E) Total cash cost (B.2+C.2+D.2)	**287,792**	**422,033**
(F) Interest on cash cost	**28,779**	**42,203**
(G) Total opportunity cost (B.1+C.1+D.1+F)	**99,418**	**121,603**
(H) Total variable cost (E+G)	**415,989**	**585,839**
(I) Gross margin per unit of land (A-H)	**178,194**	**129,367**
(J) Return above cash cost (A/E)	**2.06**	**1.69**
(K) Benefit and cost ratio (BCR) (A/H)	**1.43**	**1.22**

Table 4.8 Gross margin analysis of Sin Thu Kha rice production by different crop establishment methods (DSR and TPR) (Daik U Township, 2015 summer season)

Items	Average Value (MMK/ha)	
	DSR method N=9	TPR method N=3
(A) Gross benefit ($Y*P_y$)	**631,085**	**792,120**
Average yield (Y) (kg/ha)	3,246	3,864
Average producer price (P_y) (MMK/kg)	194	205
(B) Material cost (B.1+B.2)		
(1) Non-cash cost	4,830	-
(2) Cash cost	134,450	166,272
(C) Labor cost (C.1+C.2)		
(1) Family labor cost	52,419	72,865
(2) Hired labor cost	129,812	239,313
(D) Farm power cost (D.1+D.2)		
(1) Own	16,467	9,880
(2) Hired	132,282	172,694
(E) Total cash cost (B.2+C.2+D.2)	**396,545**	**578,279**
(F) Interest on cash cost	**39,654**	**57,828**
(G) Total opportunity cost (B.1+C.1+D.1+F)	**73,716**	**82,745**
(H) Total variable cost (E+G)	**509,915**	**718,852**
(I) Gross margin per unit of land (A-H)	**121,170**	**73,268**
(J) Return above cash cost (A/E)	**1.59**	**1.37**
(K) Benefit and cost ratio (BCR) (A/H)	**1.24**	**1.10**

4.3.7 Comparison of yields of selected rice varieties

Paddy yield comparison of selected rice varieties by type of crop establishment (DSR versus TPR) was given in Figure 4.3. The results showed that on an overall basis, paddy yields of all selected rice varieties with TPR method were higher than with DSR method except in Hnan Kar rice variety. Hnan Kar is a traditional rice variety and it is cultivated in deep water rice field and suitable for DSR only. Therefore, in Hnan Kar rice variety, paddy yield with DSR method (2,661 kg/ha) was higher than under TPR method (2,504 kg/ha). In both Townships, all varieties for both crop establishment methods, average grain yield during the summer season was higher than that during the monsoon season. In Maubin Township, total material cost of Thee Htat Yin summer rice variety was almost 3 times higher than that of Hnan Kar monsoon rice variety and 2 times on Sin Thu Kha monsoon rice variety (Appendix 3, 4 and 5). Thus, yield of Thee Htat Yin rice variety was considerably higher than those of monsoon rice varieties. However, in Daik U Township, total material cost of Sin Thu Kha summer rice variety was not considerably higher than those of Hmawbi-2 and Sin Thu Kha monsoon rice varieties (Appendix 6, 7 and 8). Therefore, yields were not significantly different among summer rice and monsoon rice varieties. Among monsoon rice varieties in Maubin Township, the highest yield was observed in Sin Thu Kha rice variety with 3,435 kg/ha in DSR method and 3,972 kg/ha in TPR method. Similarly, in Daik U Township, the highest monsoon rice yield was obtained from Sin Thu Kha variety with 3,195 kg/ha in DSR method and 3,635 kg/ha in TPR method. Therefore, yield comparison across monsoon rice varieties with different crop establishment methods indicated that Sin Thu Kha gave higher yield than others in both Townships.

4.3.8 Comparison of Benefit and Cost Ratios (BCRs) of selected rice varieties

In Maubin Township, the Benefit and Cost Ratios (BCRs) of Hankar, Sin Thu Kha and Thee Htat Yin under DSR method were 1.28, 1.55, and 1.22 as compared to 0.98, 1.40 and 1.07 in TPR method (Figure 4.4). Similarly, in Daik U Township, the Benefit and Cost Ratios of Hmawbi-2, Sin Thu Kha under monsoon season and Sin Thu Kha under summer season in DSR method were 1.46, 1.43 and 1.24 as compared to 1.27, 1.22 and 1.10 in case of TPR method. Having compared BCRs, it can be seen that growing of whatever rice variety through DSR method gave better profit than TPR method. Although summer rice varieties produced higher yields than monsoon

rice varieties, BCRs were higher in monsoon rice varieties. This may be due to higher total variable costs especially total material costs and lower paddy price of summer rice varieties. Farmers can't maintain optimum moisture level for summer rice varieties. Moreover, they had to pay back MADB loan at this time. So, they sold out summer rice varieties immediately after harvest. Due to these reasons, summer rice varieties usually obtain lower price. In Maubin Township, BCR approach clearly showed that Sin Thu Kha variety was more profitable for farmers than that of all different varieties under study in this research. In Daik U Township, although Sin Thu Kha gave the highest yield in yield comparison, the highest BCR value was observed for Hmawbi-2 with 1.46. This may be due to price differential; price of Hmawbi-2 was higher than that of Sin Thu Kha. In comparison of BCRs of Sin Thu Kha monsoon rice varieties in Maubin and Daik U Townships, Sin Thu Kha from Maubin obtained higher BCR than from Daik U. This may be due to yield and price differential. Possession of warehouse of sample farm households in Maubin Township was 12% higher than that from Daik U Township (Table 4.2). Low percentage of possessing warehouse in Daik U made most farmers to sell out immediately after harvest and this leads to obtain lower paddy price.

4.4 Labor Use Efficiency Analysis

4.4.1 Calculation of the labor use efficiency in production of selected rice varieties in Maubin Township

According to the results of Table 4.9, labor cost share in total cost of Hnan Kar rice variety in DSR and TPR method were 54% and 51% respectively. Labor cost share of Sin Thu Kha variety was 37% in DSR method and 44% in TPR method. Moreover, that of Thee Htat Yin variety was 30% in DSR method and 41% in TPR method. From these results, it can be seen that labor cost shares were higher in TPR method than DSR method except for Hnan Kar. Among them, labor cost share of Hnan Kar rice variety was the highest. Among the selected rice varieties, harvesting operation of Hnan Kar rice production can only be done by manually although harvesting operation of others can be done by combine harvesters. Thus, labor cost share of Hnan Kar was the highest among the selected rice varieties.

Average labor productivity was computed by dividing the value of farm production by the number of farm labor used (both family and hired labor). Labor

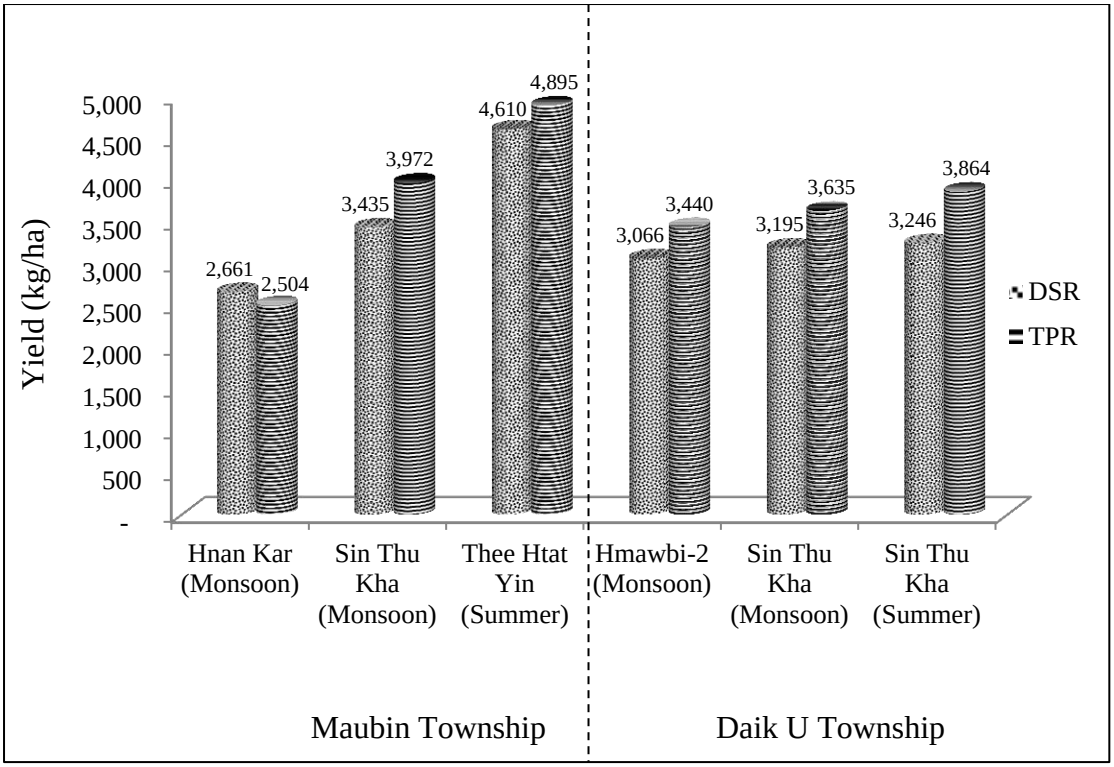

Figure 4.3 Comparison of yields of selected rice varieties between DSR and TPR method in Maubin and Daik U Townships (2014-15)

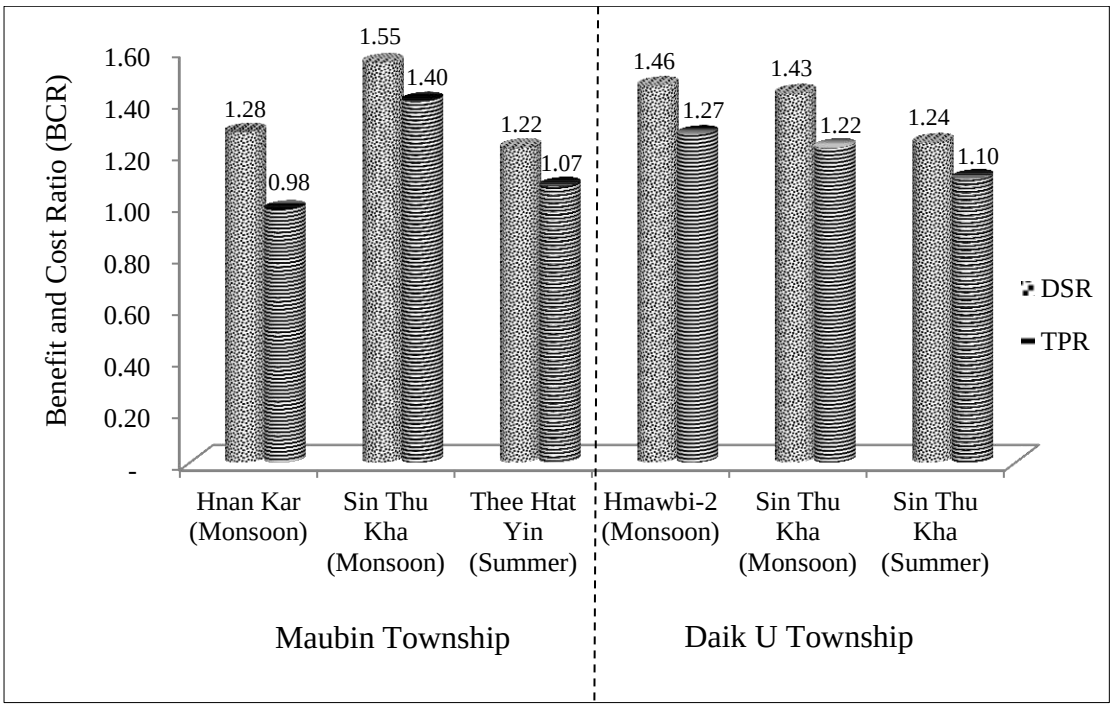

Figure 4.4 Comparison of benefit and cost ratios of selected rice varieties between DSR and TPR method in Maubin and Daik U Townships (2014-15)

productivity tends to be high when large amounts of capital (eg., machines) are used, when high quality land is used or when skillful farm managers are employed (Langemeier 2015). Average labor productivity for DSR method of Hnan Kar (8,223 MMK), Sin Thu Kha (14,616 MMK) and Thee Htat Yin (14,254 MMK), and for transplanting method Hnan Kar (6,666 MMK), Sin Thu Kha (11,064 MMK) and Thee Htat Yin (9,066 MMK) were observed. Among them, the highest labor productivity was obtained from Sin Thu Kha variety grown by DSR method and the lowest from Hnan Kar rice variety grown by TPR method.

Labor use efficiency measures return above labor cost. Labor use efficiencies of Hnan Kar rice variety under DSR and TPR methods were 2.35 and 1.90 respectively. The result of 2.35 means that if 1 MMK invested in labor, 1.35 MMK of gross return can be received. Labor use efficiencies of Sin Thu Kha and Thee Htat Yin varieties were 4.18 and 4.07 in DSR method and 3.16 and 2.59 in TPR method. Based on the findings, it can be said that labor use efficiencies were lowest in Hnan Kar rice variety and highest in Sin Thu Kha variety. Among the computed rice varieties, DSR method gave higher labor use efficiency than TPR method.

4.4.2 Calculation of the labor use efficiency in production of selected rice varieties in Daik U Township

According to the results of Table 4.10, labor cost share in total cost of Hmawbi-2 rice variety in DSR and TPR method were 35% and 41% respectively. Labor cost share of Sin Thu Kha (monsoon rice) was 32% in DSR method and 41% in TPR cost. Moreover, that of Sin Thu Kha (summer rice) was 36% in DSR method and 43% in TPR method. From the results, it can be seen that labor cost shares were higher in TPR method than DSR method. Among them, labor cost share of Sin Thu Kha (summer rice) was the highest.

Average labor productivities (MMK per man-day) for DSR method were Hmawbi-2 (14,819 MMK), Sin Thu Kha in monsoon season (15,752 MMK), Sin Thu Kha in summer season (11,265 MMK). For transplanting Hmawbi-2 (10,906 MMK), Sin Thu Kha in monsoon season (9,743 MMK), Sin Thu Kha in summer (8,881 MMK) were also observed in average labor productivities. Among them the highest labor productivity was obtained from Sin Thu Kha monsoon rice variety grown by DSR method with 15,752 MMK and the lowest from Sin Thu Kha summer rice variety grown by TPR method with 8,881 MMK. The result of 15,752 MMK means

Table 4.9 Labor use efficiency in production of selected rice varieties in Maubin Township

No.	Items	Unit	Broadcasting (DSR)			Transplanting (TPR)		
			Hnan Kar (monsoon) (N=28)	Sin Thu Kha (monsoon) (N=3)	Thee Htat Yin (summer) (N=28)	Hnan Kar (monsoon) (N=5)	Sin Thu Kha (monsoon) (N=27)	Thee Htat Yin (summer) (N=2)
1.	Gross benefit	MMK/ha	517,065	768,444	877,988	492,172	906,252	938,600
2.	Total variable cost	MMK/ha	404,534	495,305	719,592	502,208	647,303	876,227
3.	Total labor cost	MMK/ha	220,079	184,015	215,581	258,421	286,697	362,355
4.	Total labor used	md/ha	62.88	52.58	61.59	73.83	81.91	103.53
5.	Return from labor (average labor productivity) (1/4)	MMK/ha	8,223	14,616	14,254	6,666	11,064	9,066
6.	Labor cost share in total cost {(3/2)*100}	%	54	37	30	51	44	41
7.	Labor use efficiency (1/3)		2.35	4.18	4.07	1.90	3.16	2.59

that in Sin Thu Kha monsoon rice variety grown by DSR method, each farm labor was generated 15,752 MMK of output per hectare on average.

Labor use efficiencies of Hmawbi-2 rice variety under DSR and TPR methods were 4.23 and 3.12 respectively. The result of 4.23 means that if 1 MMK invested in labor, 3.23 MMK of gross return can be received. Labor use efficiencies of Sin Thu Kha variety under monsoon and summer season were 4.50 and 3.46 in DSR method and 2.78 and 2.54 in TPR method. Based on the findings, it can be said that labor use efficiency of summer rice was lower than that of monsoon rice. Among the computed monsoon rice varieties, Sin Thu Kha gave higher labor use efficiency than Hmawbi-2.

4.4.3 Comparison of average labor productivities and labor use efficiencies of selected rice varieties

In both methods and Townships, DSR method gave higher labor productivity and labor use efficiency than TPR method (Figure 4.5 and 4.6). Labor productivity and labor use efficiency of computed rice varieties for Daik U Township was higher than that of rice varieties for Maubin Township. It might be due to the reason that most of the farmers from Daik U Township used combine harvester for harvesting operation than farmers from Maubin Township. However, in the case of summer rice, yield of Sin Thu Kha was considerably lower than that of Thee Htat Yin (Figure 4.3). Therefore, in summer rice, labor productivity and labor use efficiency of Thee Htat Yin was higher than that of Sin Thu Kha in Daik U Township. Among monsoon rice varieties, labor productivity and labor use efficiency of Sin Thu Kha was higher than others in both Townships.

Table 4.10 Labor use efficiency in production of selected rice varieties in Daik U Township

No.	Items	Units	Broadcasting (DSR)			Transplanting (TPR)		
			Hmawbi-2 (monsoon) (N=10)	Sin Thu Kha (monsoon) (N=10)	Sin Thu Kha (summer) (N=9)	Hmawbi-2 (monsoon) (N=5)	Sin Thu Kha (monsoon) (N=22)	Sin Thu Kha (summer) (N=3)
1.	Gross benefit	MMK/ha	665,751	594,183	631,085	815,223	715,206	792,120
2.	Total variable cost	MMK/ha	454,274	415,989	509,915	640,796	585,839	718,852
3.	Total labor cost	MMK/ha	157,240	132,022	182,231	261,614	256,925	312,178
4.	Total labor used	md/ha	44.93	37.72	56.02	74.75	73.41	89.19
5.	Return from labor (average labor productivity) (1/4)	MMK/ha	14,819	15,752	11,265	10,906	9,743	8,881
6.	Labor cost share in total cost {(3/2)*100}	%	35	32	36	41	44	43
7.	Labor use efficiency (1/3)		4.23	4.50	3.46	3.12	2.78	2.54

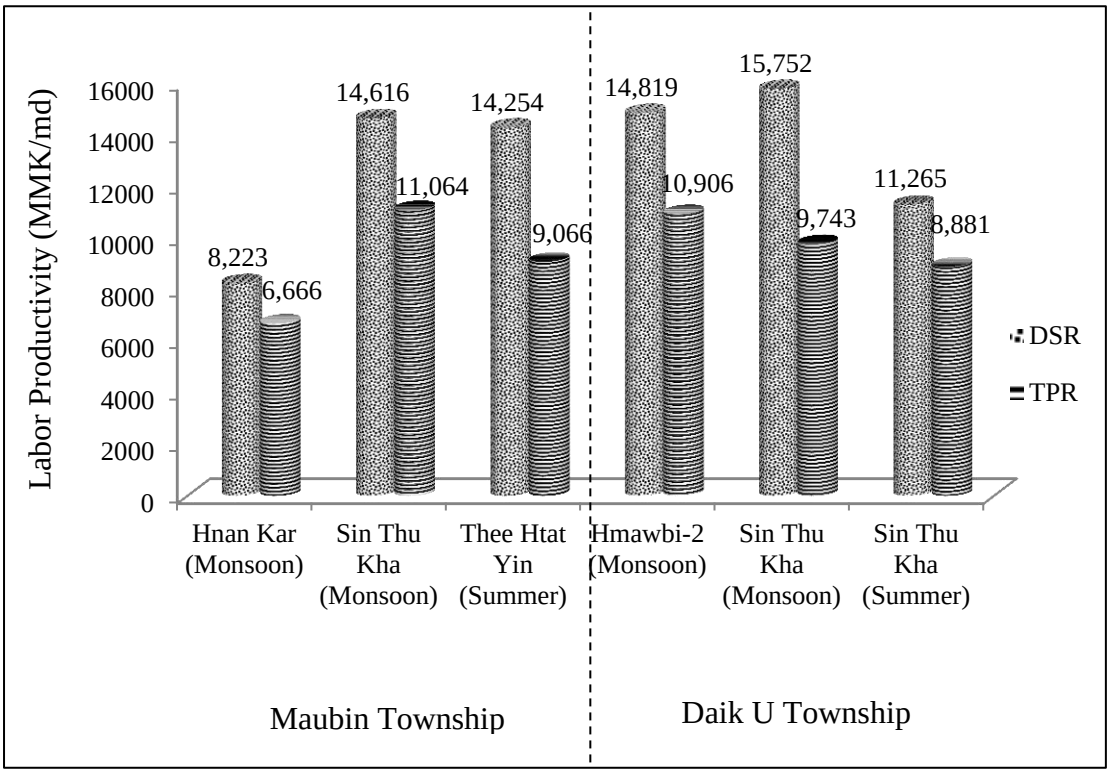

Figure 4.5 Comparison of labor productivities of selected rice varieties between DSR and TPR method in Maubin and Daik U Townships (2014-15)

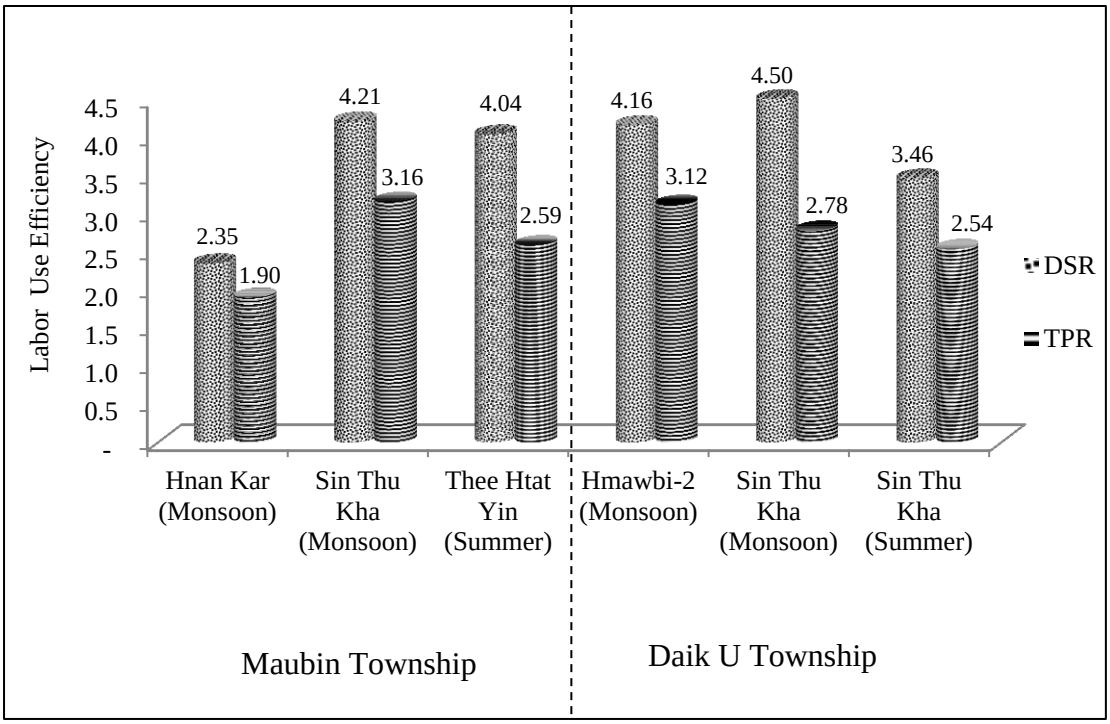

Figure 4.6 Comparison of labor use efficiencies of selected rice varieties between DSR and TPR method in Maubin and Daik U Townships (2014-15)

4.5 Factors Affecting the Profitability of Rice Production for the Sample Farm Households in the Study Areas

This section indicated the estimated results of factors affecting on the profit of rice production for the selected rice varieties in Maubin and Daik U Townships. To determine the factors affecting the paddy profit, log linear regression function was employed. The specific profit function of paddy farmers were estimated by using 7 independent variables; yield (kg/ha), total labor used (md/ha), total fertilizer cost (MMK/ha), sown area of paddy (ha), age of household's head (yr), schooling year of household head (yr), seed source (dummy), crop establishment method (dummy) and income source (dummy).

4.5.1 Factors affecting the profitability of Hnan Kar rice production for the sample farm households (Maubin Township, 2014 monsoon season)

Multiple regression results on factors influencing the profitability of Hnan Kar rice production in Maubin Township was shown in Table 4.11. The regression results in Table 4.11 showed that about 67.5 percent of the variation in the gross margin is explained by the regressors.

Estimates of the regression output indicated that the yield, total labor used, age of household's head and seed source (dummy variable) were statistically significant in explaining the profitability of Hnan Kar rice production. The variables yield and total labor used were highly significant (significant at 1% level) in influencing the gross margin. As expected, a positive relationship existed between yield and gross margin in that at higher yield levels, other things being equal, the total revenue increased and in turn positively impacted on the gross margin. The result pointed out that paddy profit will be increased by 23.065% when yield was increased by 1%. A negative relationship existed between total labor used and gross margin. According to the regression estimate, if one percent increases in total labor used, the paddy profit will be decreased 19.493%. The result showed that the farmers who used more labor in paddy production had suffered high cost of labor and can receive low profit. The variable age of household's head was significant in explaining the observed gross margin at 0.05 alpha level. The result showed that if one percent increased in age of household's head, the paddy profit will be increased 9.990%. The result showed that the farmers who were in old age can be received higher paddy profit than younger farmers. This may be due to good farming experience of old age farmers in paddy

cultivation. The dummy variable seed source was negatively correlated with paddy profit at 10% level. According to the regression result, farmers who used own seeds for Hnan Kar rice production received lower paddy profit by 4.239% than farmers who used other seed sources.

4.5.2 Factors affecting the profitability of Sin Thu Kha rice production for the sample farm households (Maubin Township, 2014 monsoon season)

The results of the estimation of the profitability of Sin Thu Kha rice production for the sample farm households in Maubin Township were described in Table 4.12. According to the paddy profit regression estimates, paddy profit of the sample farm households was positively and significantly influenced by yield at 1 percent level. According to the regression estimates, if one percent increases in yield, the paddy profit will be increased 4.137%. The result showed that the farmers who had got the higher yield can receive more profit because yield greatly affected on profit. The total labor used of the sample farm households was negatively and significantly influenced on profit at 5 percent level. It means that if one percent increases in total labor used on the farm in the study area, the paddy profit will be decreased 1.972%. The variables sown area of paddy, age of HH's head, schooling year of HH's head, seed source (dummy), harvesting practice (dummy) and crop establishment method (dummy) were not significantly influenced on paddy profit, but, expected relationships existed between these variables and gross margin. However, unexpected relationships existed for the variable total fertilizer cost and dummy variable income source. Total fertilizer cost was positively correlated and income source was negatively correlated with paddy profit. This means that if fertilizer cost increased, paddy profit will be increased. From the result, it can be seen that farmers' utilization of fertilizers were below the optimal level. In the case of income source, the result showed that farmers who had only farm income source can receive higher profit than farmers who had non-farm income source. This might be due to the reason that farmers who had only farm income source pay more concentration on rice production.

Table 4.11 Determinants of the profitability of Hnan Kar rice production for the sample farm households (Maubin Township, 2014 monsoon season)

Variables	Unstandardized Coefficients		Standardized Coefficients	t value	Sig.
	B	Std. Error	β		
(Constant)	28.800^{ns}	61.169		0.471	0.642
Ln yield	23.065***	6.858	0.522	3.363	0.003
Ln total labor used	-19.493***	4.940	-0.555	-3.946	0.001
Ln total fertilizer cost	-0.685^{ns}	0.529	-0.167	-1.296	0.208
Ln sown area of paddy	1.608^{ns}	1.667	0.128	0.965	0.345
Ln age of HH's Head	9.990**	4.159	0.300	2.402	0.025
Ln schooling year	1.970^{ns}	3.352	0.085	0.577	0.562
Seed source (Dummy)	-4.239*	2.270	-0.273	-1.867	0.075
Crop establishment method (Dummy)	3.150^{ns}	2.880	0.146	1.094	0.285
Income source (Dummy)	1.008^{ns}	2.462	0.061	0.409	0.686
R^2		0.675			
Adjusted R^2		0.567			

Table 4.12 Determinants of the profitability of Sin Thu Kha rice production for the sample farm households (Maubin Township, 2014 monsoon season)

Variables	Unstandardized Coefficients		Standardized Coefficients	t value	Sig.
	B	Std. Error	β		
(Constant)	-17.042^{ns}	10.210		-1.669	0.111
Ln yield	4.137***	1.288	0.604	3.212	0.005
Ln total labor used	-1.972**	0.899	-0.594	-2.193	0.041
Ln total fertilizer cost	0.053^{ns}	0.118	0.088	0.449	0.658
Ln sown area of paddy	0.032^{ns}	0.241	0.024	0.132	0.897
Ln age of HH's Head	0.495^{ns}	1.007	0.092	0.491	0.629
Ln schooling year	0.415^{ns}	1.071	0.088	0.387	0.703
Seed source (Dummy)	-0.317^{ns}	0.463	-0.123	-0.686	0.501
Harvesting practice (Dummy)	0.224^{ns}	0.437	0.097	0.513	0.614
Crop establishment method (Dummy)	0.352^{ns}	0.728	0.092	0.483	0.635
Income source (Dummy)	-0.237^{ns}	0.462	-0.100	-0.513	0.614
R^2		0.544			
Adjusted R^2		0.304			

4.5.3 Factors affecting the profitability of Thee Htat Yin rice production for the sample farm households (Maubin Township, 2015 summer season)

According to the results described in Table 4.13, paddy profit of the sample farm households was positively and significantly influenced by yield at 1% level. According to the regression estimates, if one percent increases in yield, the paddy profit will be increased 24.115%. According to the result, it can be seen that yield was very influential in explaining profitability. Total labor used and total fertilizer cost negatively influenced on paddy profit at 5% level. Paddy profit will be decreased by 3.998% if there is a 1% increase in total labor used. Similarly, 1% increase in total fertilizer cost will lead to decrease the paddy profit by 2.514%. Dummy variable harvesting practice was negatively correlated with paddy profit at 10% level. Farmers who used combine harvester in harvesting operation reduced paddy profit by 2.420% than farmers who did not use. This result might be due to high rental charges of combine harvesters in the study area. The adjusted R squared pointed out that the model was significant and it can explain on the variation in rice profit by 71.9 percent.

4.5.4 Factors affecting the profitability of Hmawbi-2 rice production for the sample farm households (Daik U Township, 2014 monsoon season)

The multiple regression results on factors influencing the profitability of Hmawbi-2 rice production in Daik U Township was shown in Table 4.14. The regression results in Table 4.14 show that about 53.2 percent of the variation in the gross margin is explained by the regressors.

Paddy profit of the Hmawbi-2 rice growers in Daik U Township was positively and significantly influenced by yield at 1 percent level. According to the regression estimates, if one percent increases in yield, paddy profit will be increased by 19.998 percent. Total labor used was negatively and significantly influenced on paddy profit at 5 percent level. If one percent increased in total labor used, paddy profit will be decreased by 8.004%. The variables total fertilizer cost, sown area of paddy, age of HH’s head, schooling year of HH’s head and crop establishment method (dummy) were not significantly influenced on paddy profit, but, expected relationships existed between these variables and gross margin. However, unexpected relationships existed for the dummy variables seed source, harvesting practice and income source.

Table 4.13 Determinants of the profitability of Thee Htat Yin rice production for the sample farm households (Maubin Township, 2015 summer season)

Variables	Unstandardized Coefficients		Standardized Coefficients	t value	Sig.
	B	Std. Error	β		
(Constant)	-153.989***	30.703		-5.015	0.000
Ln yield	24.115***	3.694	1.156	6.529	0.000
Ln total labor used	-3.998**	1.636	-0.427	-2.443	0.025
Ln total fertilizer cost	-2.514**	1.223	-0.234	-2.056	0.054
Ln sown area of paddy	-0.141^{ns}	0.565	-0.029	-0.250	0.805
Ln age of HH's Head	1.939^{ns}	1.844	0.134	1.051	0.306
Ln schooling year	0.302^{ns}	0.893	0.040	0.338	0.739
Seed source (Dummy)	0.160^{ns}	0.913	0.022	0.175	0.863
Harvesting practice (Dummy)	-2.420*	1.249	-0.290	-1.938	0.068
Crop establishment method (Dummy)	0.404^{ns}	1.664	0.027	0.243	0.811
Income source (Dummy)	1.069^{ns}	0.880	0.137	1.216	0.239
R^2		0.816			
Adjusted R^2		0.719			

Table 4.14 Determinants of the profitability of Hmawbi-2 rice production for the sample farm households (Daik U Township, 2014 monsoon season)

Variables	Unstandardized Coefficients		Standardized Coefficients	t value	Sig.
	B	Std. Error	β		
(Constant)	-148.733**	66.325		-2.242	0.033
Ln yield	19.998***	6.274	0.472	3.187	0.003
Ln total labor used	-8.004**	3.696	-0.407	-2.165	0.039
Ln total fertilizer cost	-0.486^{ns}	0.549	-0.154	-0.886	0.383
Ln sown area of paddy	-0.134^{ns}	1.431	-0.013	-0.093	0.926
Ln age of HH's Head	9.417^{ns}	6.520	0.230	1.444	0.159
Ln schooling year	1.525^{ns}	3.213	0.072	0.475	0.639
Seed source (Dummy)	0.189^{ns}	2.246	0.012	0.084	0.934
Harvesting practice (Dummy)	-2.677^{ns}	2.608	-0.147	-1.026	0.313
Crop establishment method (Dummy)	6.122^{ns}	3.918	0.336	1.562	0.129
Income source (Dummy)	-2.507^{ns}	2.787	-0.127	-0.900	0.376
R^2		0.532			
Adjusted R^2		0.370			

4.5.5 Factors affecting the profitability of Sin Thu Kha rice production for the sample farm households (Daik U Township, 2014 monsoon season)

The multiple regression results on factors influencing the profitability of Sin Thu Kha rice production in Daik U Township was shown in Table 4.15. The adjusted R squared pointed out that the model is significant and it can explain on the variation in paddy profit by 63 percent.

According to the paddy profit regression estimates, paddy profit of the sample farm households was positively and significantly influenced by yield at 1 percent level and crop establishment method at 5 percent level. According to results, if one percent increases in yield, the paddy profit will be increased 6.364%. Moreover, farmers who used DSR method received higher profit by 1.154% than farmers who used TPR method. Income source and total labor used of the sample farm households was negatively and significantly influenced on profit at 1 percent and 5 percent level respectively. According to the regression results, farmers who had non-farm income sources received higher paddy profit by 1.411% than farmers who had only farm income source. Furthermore, the results pointed out that if one percent increases in total labor used in production of Sin Thu Kha in Daik U Township, the paddy profit will be decreased by 1.135%.

Table 4.15 Determinants of the profitability of Sin Thu Kha rice production for the sample farm households (Daik U Township, 2014 monsoon season)

Variables	Unstandardized Coefficients		Standardized Coefficients	t value	Sig.
	B	Std. Error	β		
(Constant)	-41.052***	10.368		-3.960	0.001
Ln yield	6.364***	1.165	0.813	5.462	0.000
Ln total labor used	-1.135**	0.453	-0.308	-2.506	0.020
Ln total fertilizer cost	0.003^{ns}	0.048	0.008	0.068	0.946
Ln sown area of paddy	0.349^{ns}	0.248	0.159	1.406	0.174
Ln age of HH's Head	1.515^{ns}	1.186	0.160	1.278	0.215
Ln schooling year	-0.120^{ns}	0.447	-0.035	-0.268	0.791
Seed source (Dummy)	0.030^{ns}	0.351	0.010	0.084	0.934
Harvesting practice (Dummy)	-0.144^{ns}	0.509	-0.036	-0.283	0.780
Crop establishment method (Dummy)	1.154**	0.414	0.371	2.789	0.011
Income source (Dummy)	-1.411***	0.465	-0.382	-3.032	0.006
R^2			0.749		
Adjusted R^2			0.630		

4.6 Constraints of Sample Farmers in the Study Area

Figure 4.7 shows the farmers' perception of constraints on rice production. In Maubin Township, major constraints described by sample farmers were scarcity of labor, lack of storage facilities, weakness of extension service, difficulty in access to quality seed and extreme weather (flood/drought). The major problem facing by sample farmers in Daik U Township was extreme weather (flood/drought) followed by scarcity of labor, price fluctuation, insufficient capital, high input price, poor irrigation infrastructure and so on.

Scarcity of labor

The most serious problem facing by sample farmers in Maubin and Daik U Townships was scarcity of labor. Many of the people in these areas migrated to other Townships for many job opportunities that will give regular income. As a result, some farmers could not hire labor at all at the peak season. Moreover, labor scarcity has driven up local wages, cutting into the profitability of small family farms, the foundation of the rural economy.

Lack of storage facilities

If there is a bumper year for rice, the farmers can have an opportunity for greater return. But, they have to store the product after harvesting to obtain that chance. In Maubin and Daik U, 67% and 11% of farmers did not have storage facilities. This lack of storage facilities caused the price of rice to be low during harvesting time.

Weakness of extension service

The extension service can give awareness and information concerned with updated high production technologies, new released crop varieties and market information. But, about 43% and 12% of farmers in Maubin and Daik U were facing the weakness of extension services. Most of farmers who were not facing this constraint were the key farmers of the villages.

Difficulty in access to quality seed

About 42% and 30% of sample farmers in Maubin and Daik U mentioned that there was difficulty for accessing rice quality seed. This was because the supply of improved rice seeds by formal sectors did not meet with the demanded amount and

the formal relevant institutions encouraged producing more the seeds of hybrid varieties.

Extreme weather (flood/drought)

About 36% and 75% of selected respondents were challenging with climate change in Maubin and Daik U. The farmers used flood or drought resistant varieties of rice to cope the changing climate. If the local varieties were applied, the farmers managed the sowing time depending on climate even though it is very risk.

Price fluctuation

The reason for low income of farmers is the price fluctuation. About 29% of farmers in Maubin and 62% in Daik U answered the price fluctuation as a problem. This was because of supply and demand. If the production is early as possible, farmers always earned more income because of selling at high price and when the supply was high in the market, the price became low.

Insufficient capital

In the study areas, insufficiency of investment was one of the problems for all farmers. But only 35% of sample farmers in Maubin and 45% in Daik U stated this as a problem. Due to less of capital, nearly all of the farmers borrowed money with high interest rate for running of their production. They had to repay for their loan after harvesting their crops.

High input price

High input price was a common problem for rice production. About 17% and 42% of sample respondents in Maubin and Daik U faced the high price of inputs – fertilizer, pesticide, herbicide and machine that were essential for crop yield. Therefore, most of farmers used the low quality of inputs especially fertilizer imported by China.

Poor irrigation infrastructure

Nowadays, the climate change is happening more and more. During growing time, the fields need to apply the water. Even though the water can irrigate from the reserved and natural water sources if the raining is not enough, 23% and 42% of farmers in Maubin and Daik U did not have advanced irrigation system.

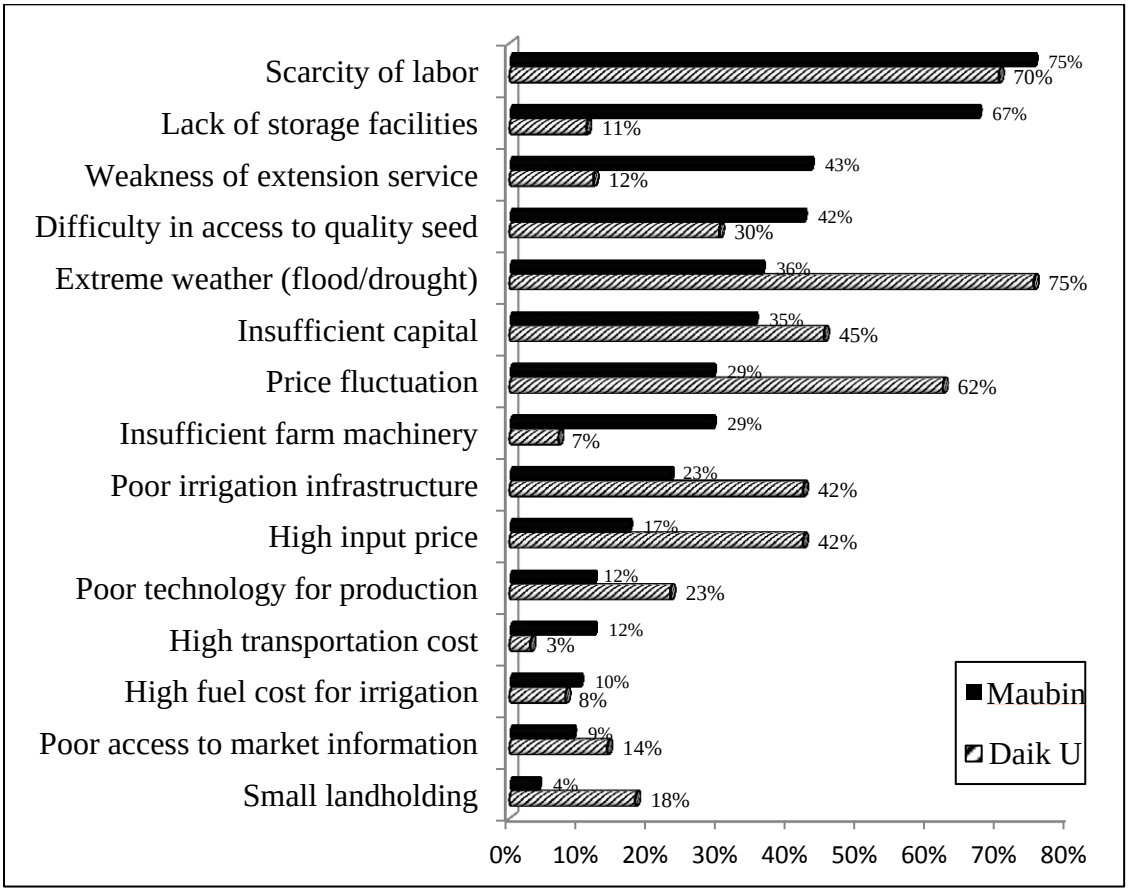

Figure 4.7 Constraints faced by selected farmers in Maubin and Daik U Townships

CHAPTER V
SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary of Findings and Conclusion

The descriptive analysis showed that the average age of the household heads of the sample farm households in Maubin and Daik U Townships were about 50 years in Maubin and 51 years in Daik U Township. The average farming experience of the household heads were about 24 and 27 years in Maubin and Daik U Townships respectively. The average schooling year of household heads from both Townships was about 7 years. There were not many differences between Maubin and Daik U Townships in terms of average age of household heads, farming experiences and schooling years of the sampled farm households. It can be seen that most of the household heads from both Townships were in middle school education level and had good working farm experiences.

The average farm size of the sample farm households in Maubin and Daik U Townships were about 5 and 10 hectare respectively. The mean household size of the respondents was about 4 and 5 in Maubin and Daik U Townships. In both Townships, about half of the family members worked on farm.

When comparing farming assets of sample farm households, most of the sample farm households in Maubin Township possessed water pump, sprayer and power tiller. Only a small number of the sample farm households possessed tractor, buffalo and intercultivator. In Daik U Township, most of the sample farm households possessed sprayer, plough and harrow. Myanmar is at her very beginning stage of farm mechanization that only a small number of sample farm households possessed tractor, thresher, drum seeder and intercultivator.

There were different types of rice varieties grown in Maubin and Daik U Townships. In Maubin Township, farmers widely used Hnan Kar, Sin Thu Kha varieties under monsoon season and Thee Htat Yin variety under summer season. The major rice varieties grown in Daik U Township were Hmawbi-2 and Sin Thu Kha under monsoon season and Sin Thu Kha under summer season. In both Townships, two most widely used monsoon rice varieties (Hnan Kar and Sin Thu Kha in Maubin and Hmawbi-2 and Sin Thu Kha in Daik U) and one summer rice variety of Thee Htat Yin for Maubin and Sin Thu Kha for Daik U Township were selected for profitability analysis.

On an overall basis paddy yields of all selected rice varieties with TPR method were higher than those under DSR method except in Hnan Kar rice variety. Hnan Kar is a traditional rice variety and it is cultivated in deep water rice field and suitable for DSR only. Therefore, in Hnan Kar rice variety, paddy yield with DSR method was higher than under TPR method. In both Townships, all varieties for both crop establishment methods, average grain yield during the summer season was higher than that of the monsoon season. Among monsoon rice varieties in Maubin Township, the highest yield was observed in Sin Thu Kha rice variety with 3,435 kg/ha in DSR method and 3,972 kg/ha in TPR method. Similarly, in Daik U Township, the highest monsoon rice yield was received from Sin Thu Kha variety with 3,195 kg/ha in DSR method and 3,635 kg/ha in TPR method. Therefore, yield comparison across monsoon rice varieties with different crop establishment methods indicated that Sin Thu Kha gave higher yield than others in both Townships.

Although summer rice received higher yield than monsoon rice, BCRs were lower due to price differential, i.e., summer rice usually gets low price. For monsoon rice, in Maubin, high-price-variety Sin Thu Kha received higher BCR. In Daik U Township, although Sin Thu Kha gave the highest yield in yield comparison, the highest BCR value was observed for Hmawbi-2 with 1.46. According to the results, it can be seen that price is the major driver for making good profit.

From the view point of cultivation practice, labor productivity and labor use efficiency for farmers who used broadcasting (DSR) method was observed to be higher than for those who transplanted (TPR). This was due to much lower labor requirement for broadcasting compared to transplanting. In both Townships, the highest labor productivity and labor use efficiency was obtained from Sin Thu Kha rice variety.

In profit function analysis, paddy yield and total labor used were the influencing factors for profitability of selected rice varieties. Paddy profit was positively affected by paddy yield and negatively affected by total labor used. Rental charges of combine harvester were higher in Daik U than Maubin. In Maubin, rental charges of combine harvester were higher in summer rice than monsoon rice. In Maubin Township, in Thee Htat Yin summer rice variety, paddy profit was negatively and significantly influenced by harvesting practice. In Daik U Township, in monsoon rice varieties, paddy profit was negatively correlated with harvesting practice.

In Maubin Township, major constraints described by sample farmers were scarcity of labor, lack of storage facilities, weakness of extension service, difficult in access to quality seed and extreme weather (flood/drought). The major problem facing by sample farmers in Daik U Township was extreme weather (flood/drought) followed by scarcity of labor, price fluctuation, insufficient capital, high input price and poor irrigation infrastructure.

5.2 Recommendation

In the study areas, although yields of summer rice were higher than monsoon rice, summer rice obtained lower price than monsoon rice. Thus, BCRs were lower in summer rice than monsoon rice. In monsoon season, high-price-variety, Sin Thu Kha obtained higher BCR than Hnan Kar in Maubin Township. Similarly, in Daik U Township, high-price-variety, Hmawbi-2 obtained higher BCR than Sin Thu Kha. Thus, price is major driver for making good profit. Therefore, utilization of high market-demand variety should be encouraged.

The most serious problem facing by sample farmers in Maubin and Daik U Townships was scarcity of labor. Many of the people in these areas migrated to other Townships for many job opportunities that will give regular income. As a result, some farmers could not hire labor at all at the peak season. Moreover, labor scarcity has driven up local wages, cutting into the profitability of small family farms, the foundation of the rural economy. Furthermore, TPR is the labor consuming technology. Thus, BCR, labor productivity and labor use efficiency were much higher in DSR method than TPR method in all of the selected rice varieties. Moreover, in regression analysis, paddy yield and total labor used were the influencing factors for profitability of selected rice varieties. Paddy profit was positively affected by paddy yield and negatively affected by total labor used. DSR method is preferably practicing by sampled farmers in Maubin and Daik U Township at the current time for cost minimization objective since they are small holders with limited capital. Therefore, cultural practices for the farmers would be economically attractive because most of the farmers in the study areas were small farmers and they had to get the economic profit for the crop production.

The population of Myanmar has been growing year by year and rice is the staple food of Myanmar people. To get maximum production of rice is very important. Moreover, in Myanmar, about 70% of country population lives in rural

area and their livelihoods mainly rely on agriculture particularly in rice cultivation. Therefore, profitability of rice farming is essential for improving their livelihoods. Therefore, to obtain maximum production with high amount of income from rice production is very important. In TPR method, although BCRs were lower, yields were higher. In rice production, labor cost is the largest share among the total production cost. Besides, labor cost share in TPR was about 10% higher than those of DSR method in all of the selected rice varieties. Farmers should be encouraged for profit maximization by boosting rice yield by practicing TPR in cost minimization way, i.e., reducing labor cost. Thus, high-yield labor saving technologies should be encouraged. At macro or national level, to obtain maximum production, labor substitution technologies for TPR method are to be encouraged.

In profit function analysis, harvesting practice (harvested by combine harvester or otherwise) was added as dummy independent variable. In Maubin Township, in Thee Htat Yin summer rice variety, paddy profit was negatively and significantly influenced by harvesting practice. In Daik U Township, in monsoon rice varieties, paddy profit was negatively correlated with harvesting practice. Combine harvesters become more popular as the farmers become aware of post-harvest losses due to a practice, stacking of rice bundles after harvest, to grow pulses urgently before moisture recedes, in the project areas. Combine harvesters were in high demand that rental prices were relatively very high and finally this leads to lower profit. Cost for hiring combine harvester is more or less similar to cost of labor for harvesting. Therefore, very limited supply of combine harvesters does contribute only for labor saving but not for cost minimization. Therefore, rental charges of combine harvester should be reasonable and affordable price.

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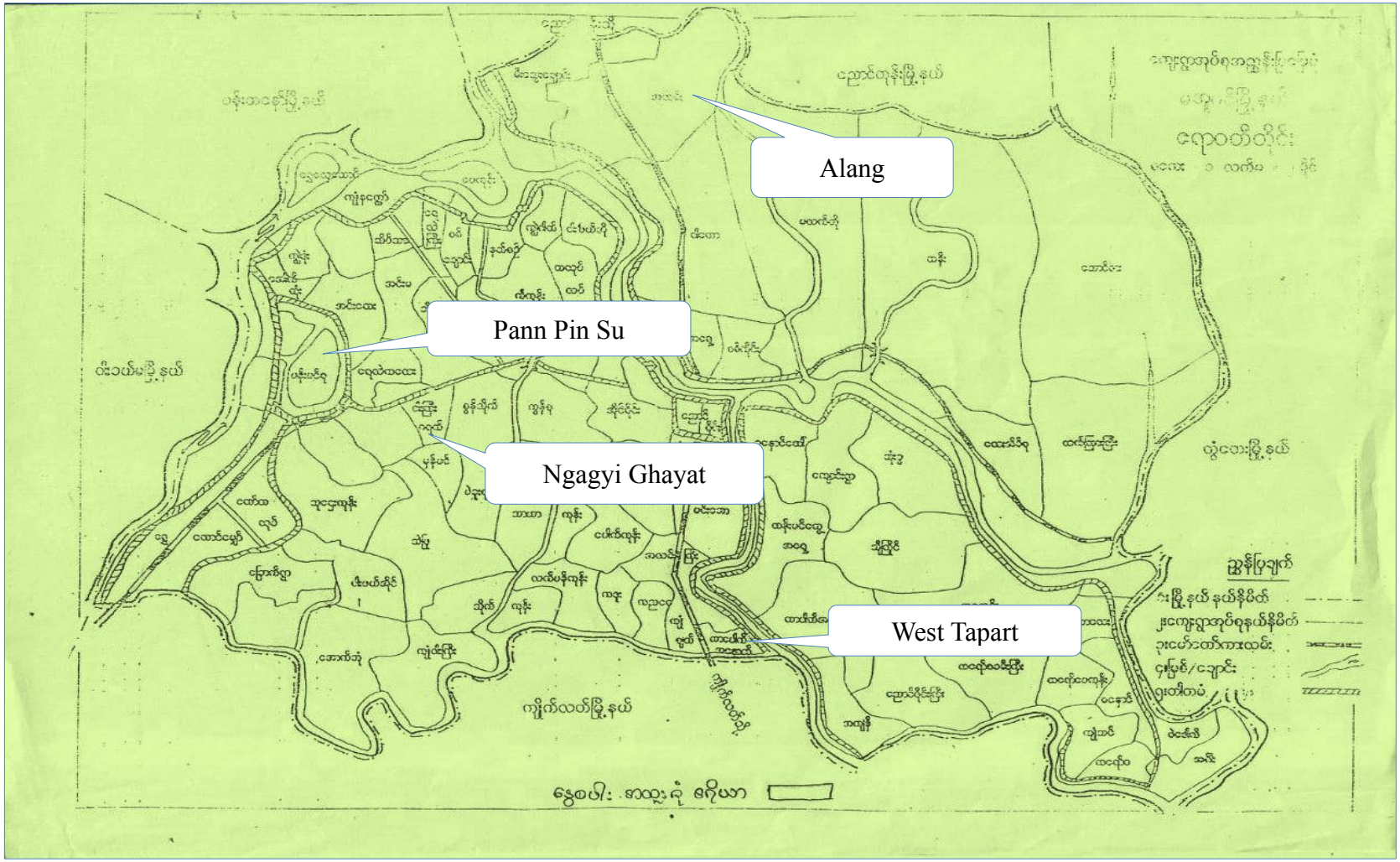
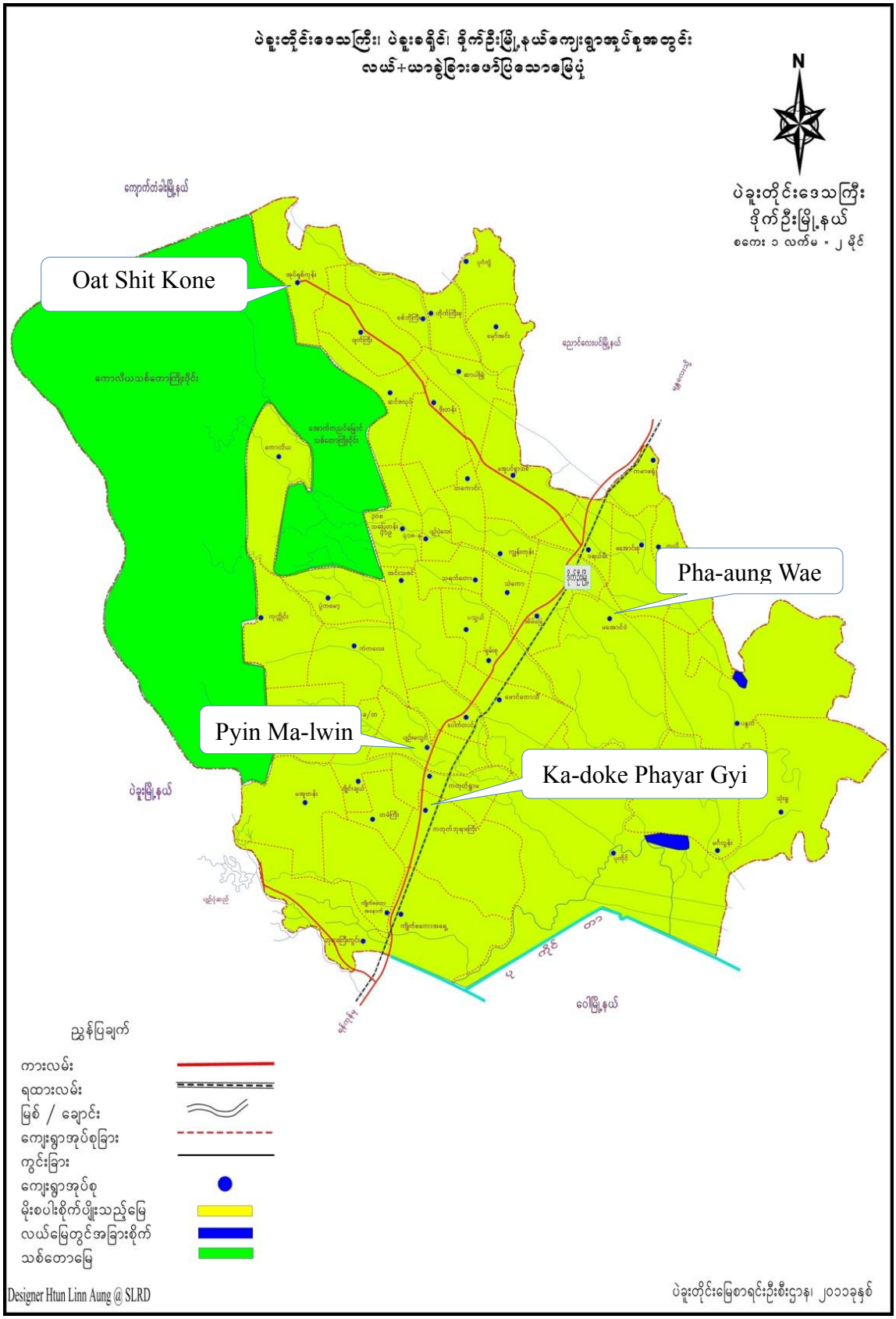
APPENDICES

Appendix 1 Map of Maubin Township Showing the Study Area



Appendix 2 Map of Daik U Township Showing the Study Area



Appendix 3 Enterprise budget of Hnan Kar rice production by different crop establishment methods (DSR and TPR) during monsoon season (Maubin Township, 2014-2015)

Items	Average Value (MMK/ha)	
	DSR method (N=28)	TPR method (N=5)
(A) Gross Benefit		
Average yield (kg/ha)	2,661	2,504
Average producer price (MMK/kg)	194	197
Gross Benefit (a)	**517,065**	**492,172**
(B) Opportunity Cost		
(i) Material cost		
Own seed	11,300	13,387
Total material cost (b)	**11,300**	**13,387**
(ii) Family labor cost		
Seedbed preparation	-	7,911
Land preparation	16,584	14,820
Broadcasting	6,793	-
Thinning and gap filling	2,646	-
Fertilizer application	5,513	4,199
Pesticide and herbicide application	2,691	2,964
Manual weeding	10,012	-
Harvesting (manually)	2,646	1,482
Threshing	7,542	4,446
Drying	3,220	-
Transportation	11,071	1,482
Total family labor cost (c)	**68,719**	**57,304**
Total family labor used (d)	**19.63**	**16.37**
(iii) Farm power cost (own)		
Seedbed preparation with machinery	-	9,880
Land preparation with machinery	20,113	12,968
Land preparation with draft cattle	882	-
Threshing	1,394	-
Transportation	1,941	-
Total farm power cost (own) (e)	**24,330**	**22,848**
Total Opportunity Cost (b+c+e) (f)	**104,349**	**93,539**
(C) Cash Cost		
(i) Material cost		
Seed	12,976	10,868

Fertilizer	39,099	59,082
Pesticide	5,293	4,099
Herbicide	3,626	-
Fuel	15,782	9,019
Total material cost (g)	**76,776**	**103,068**
(ii) Hired labor cost		
Seedbed preparation	-	10,186
Land preparation	13,056	4,446
Broadcasting	1,661	-
Pulling out seedlings	-	37,065
Transplanting	-	54,362
Fertilizer application	3,529	5,434
Pesticide and herbicide application	1,500	988
Manual weeding	24,612	1,976
Harvesting (manually)	65,102	6,690
Threshing	17,273	2,597
Drying	5,530	7,373
Transportation	19,098	-
Total hired labor cost (h)	**151,360**	**201,117**
Total hired labor used (i)	**43.25**	**57.46**
(iii) Farm power cost (hired)		
Seedbed preparation with machinery	-	19,760
Land preparation with machinery	26,729	35,568
Land preparation with draft cattle	441	-
Threshing	11,300	12,004
Transportation	6,290	-
Total farm power cost (hired) (j)	**44,760**	**67,332**
Total Cash Cost (g+h+j) (k)	**272,895**	**371,517**
(D) Interest on Cash Cost		
Interest on cash cost (10%) for 4 months	27,290	37,152
Interest on Total Cash Cost (l)	**27,290**	**37,152**
Total Variable Cost (f+k+l)	**404,534**	**502,208**
Total Labor Cost (c+h)	**220,079**	**258,421**
Gross margin per unit of land {a-(f+k+l)}	**112,531**	**(10,036)**
Benefit and Cost Ratio (BCR) {a/(f+k+l)}	**1.28**	**0.98**
Return above Cash Cost	**1.89**	**1.32**

Appendix 4 Enterprise budget of Sin Thu Kha rice production by different crop establishment methods (DSR and TPR) during monsoon season (Maubin Township, 2014-2015)

Items	Average Value (MMK/ha)	
	DSR method (N=3)	TPR method (N=27)
(A) Gross Benefit		
Average yield (kg/ha)	3,435	3,972
Average producer price (MMK/kg)	224	228
Gross Benefit (a)	**768,444**	**906,252**
(B) Opportunity Cost		
(i) Material cost		
Own seed	19,760	5,558
Total material cost (b)	**19,760**	**5,558**
(ii) Family labor cost		
Seedbed preparation	-	25,399
Land preparation	23,634	24,929
Broadcasting	9,880	-
Thinning and gap filling	5,763	-
Pulling out seedlings	-	2,927
Transplanting	-	4,391
Fertilizer application	9,880	9,560
Pesticide and herbicide application	12,350	1,555
Manual weeding	12,762	15,552
Harvesting (manually)	2,470	4,666
Harvesting (combine harvester)	1,647	2,013
Threshing	3,293	-
Drying	243	7,214
Transportation	4,117	1,647
Total family labor cost (c)	**86,039**	**99,852**
Total family labor used (d)	**24.58**	**28.53**
(iii) Farm power cost (own)		
Seedbed preparation with machinery	-	8,874
Land preparation with machinery	7,410	13,173
Land preparation with draft cattle	-	5,031
Threshing	-	823
Transportation	4,117	1,372
Total farm power cost (own) (e)	**11,527**	**29,274**
Total Opportunity Cost (b+c+e) (f)	**117,325**	**134,684**
(C) Cash Cost		
(i) Material cost		
Seed	8,233	32,398

Fertilizer	63,726	77,617
Pesticide	13,997	5,169
Herbicide	7,575	1,875
Fuel	8,645	19,257
Total material cost (g)	**102,176**	**136,317**
(ii) Hired labor cost		
Seedbed preparation	-	7,440
Land preparation	2,058	8,599
Broadcasting	1,647	-
Thinning and gap filling	7,410	-
Pulling out seedlings	-	32,320
Transplanting	-	59,051
Fertilizer application	6,587	7,776
Pesticide and herbicide application	-	2,835
Manual weeding	46,107	27,170
Harvesting (manually)	16,467	37,170
Harvesting (combine harvester)	3,293	3,934
Threshing	3,293	-
Drying	5,236	-
Transportation	5,879	549
Total hired labor cost (h)	**97,976**	**186,844**
Total hired labor used (i)	**27.99**	**53.38**
(iii) Farm power cost (hired)		
Seedbed preparation with machinery	-	17,271
Land preparation with machinery	40,343	29,303
Land preparation with draft cattle	8,233	10,383
Harvesting (combine harvester)	74,100	49,154
Threshing	5,763	23,910
Transportation	15,026	12,836
Total farm power cost (hired) (j)	**143,466**	**142,857**
Total Cash Cost (g+h+j) (k)	**343,618**	**466,018**
(D) Interest on Cash Cost		
Interest on cash cost (10%) for 4 months	34,362	46,602
Interest on Total Cash Cost (l)	**34,362**	**46,602**
Total Variable Cost (f+k+l)	**495,305**	**647,303**
Total Labor Cost (c+h)	**184,015**	**286,697**
Gross margin per unit of land {a-(f+k+l)}	**273,139**	**258,949**
Benefit and Cost Ratio (BCR) {a/(f+k+l)}	**1.55**	**1.40**
Return above Cash Cost	**2.24**	**1.94**

Appendix 5 Enterprise budget of Thee Htat Yin rice production by different crop establishment methods (DSR and TPR) during summer season (Maubin Township, 2014-2015)

Items	Average Value (MMK/ha)	
	DSR method (N=28)	TPR method (N=2)
(A) Gross Benefit		
Average yield	4,610	4,895
Average producer price	190	192
Gross Benefit (a)	**877,988**	**938,600**
(B) Opportunity Cost		
(i) Material cost		
Own seed	14,776	8,336
Total material cost (b)	**14,776**	**8,336**
(ii) Family labor cost		
Seedbed preparation	-	29,640
Land preparation	24,127	-
Broadcasting	7,586	-
Thinning and gap filling	5,462	-
Fertilizer application	13,629	9,880
Pesticide and herbicide application	11,777	3,088
Manual weeding	8,204	-
Irrigation and drainage	31,985	37,050
Harvesting (combine harvester)	2,205	-
Threshing	7,851	6,175
Transportation	7,675	-
Total family labor cost (c)	**112,826**	**85,833**
Total family labor used (d)	**32.24**	**24.52**
(iii) Farm power cost (own)		
Seedbed preparation with machinery	-	14,820
Land preparation with machinery	17,555	27,170
Land preparation with draft cattle	3,705	6,175
Irrigation and drainage	27,788	29,640
Threshing	1,763	-
Transportation	1,235	-
Total farm power cost (own) (e)	**52,046**	**77,805**
Total Opportunity Cost (b+c+e) (f)	**179,648**	**171,974**
(C) Cash Cost		
(i) Material cost		
Seed	29,883	11,115

Fertilizer	153,405	163,638
Pesticide	24,144	9,263
Herbicide	14,458	25,318
Fuel	84,747	118,560
Total material cost (g)	**306,637**	**327,893**
(ii) Hired labor cost		
Seedbed preparation	-	4,205
Land preparation	4,371	27,788
Broadcasting	1,661	-
Thinning and gap filling	7,538	
Pulling out seedlings	-	37,050
Transplanting	-	67,925
Fertilizer application	4,631	-
Pesticide and herbicide application	970	6,793
Manual weeding	3,440	-
Irrigation and drainage	7,454	-
Harvesting (manually)	48,297	98,800
Harvesting (combine harvester)	1,500	
Threshing	15,041	24,700
Transportation	7,851	9,263
Total hired labor cost (h)	**102,755**	**276,523**
Total hired labor used (i)	**29.36**	**79.01**
(iii) Farm power cost (hired)		
Land preparation with draft animal	28,670	12,350
Irrigation and drainage	5,205	-
Harvesting (combine harvester)	34,315	-
Threshing	13,276	23,465
Transportation	4,499	-
Total farm power cost (hired) (j)	**81,466**	**35,815**
Total Cash Cost (g+h+j) (k)	**490,858**	**640,230**
(D) Interest on Cash Cost		
Interest on cash cost (10%) for 4 months	49,086	32,789
Interest on Total Cash Cost (l)	**49,086**	**64,023**
Total Variable Cost (f+k+l)	**719,592**	**876,227**
Total Labor Cost (c+h)	**215,581**	**362,355**
Gross margin per unit of land {a - (f+k+l)}	**158,396**	**62,373**
Benefit and Cost Ratio (BCR) {a/(f+k+l)}	**1.22**	**1.07**
Return above Cash Cost	**1.79**	**1.47**

Appendix 6 Enterprise budget of Hmawbi-2 rice production by different crop establishment methods (DSR and TPR) during monsoon season (Daik U Township, 2014-2015)

Items	Average Value (MMK/ha)	
	DSR method (N=10)	TPR method (N=30)
(A) Gross Benefit		
Average yield	3,066	3,440
Average producer price	217	237
Gross Benefit (a)	**665,751**	**815,223**
(B) Opportunity Cost		
(i) Material cost		
Own seed	12,103	15,355
Total material cost (b)	**12,103**	**15,355**
(ii) Family labor cost		
Seedbed preparation	-	17,825
Land preparation	19,390	13,379
Broadcasting	6,299	-
Pulling out seedlings	-	4,611
Transplanting	-	3,079
Fertilizer application	8,892	6,381
Pesticide and herbicide Application	4,076	6,299
Manual weeding	13,338	494
Harvesting (manually)	3,260	1,383
Harvesting (combine harvester)	6,916	5,311
Threshing	2,717	2,305
Drying	5,434	-
Transportation	2,717	3,129
Total family labor cost (ii)	**73,038**	**64,195**
Total family labor used	**20.87**	**18.34**
(iii) Farm power cost (own)		
Seedbed preparation with machinery	-	12,432
Land preparation with machinery	-	9,880
Land preparation with machinery	6,175	14,491
Land perparation with draft animal	13,091	14,820
Threshing	2,470	-
Transportation	1,482	1,729
Total farm power cost (own) (iii)	**23,218**	**53,352**
Total Opportunity Cost (i+ii+iii) (b)	**108,359**	**132,902**
(c) Cash Cost		
(i) Material cost		
Seed	13,956	14,231

Cow dung	10,868	2,766
Fertilizer	43,077	93,737
Pesticide	6,360	9,263
Herbicide	10,967	8,299
Fuel	10,300	15,129
Total material cost (i)	**95,527**	**143,425**
(ii) Hired labor cost		
Seedbed preparation	-	17,125
Land preparation	21,736	21,654
Broadcasting	5,805	-
Pulling out Seedlings	-	30,192
Transplanting	-	72,677
Fertilizer Application	8,398	9,016
Pesticide and herbicide application	2,347	3,952
Manual weeding	9,880	3,376
Harvesting (manually)	25,910	17,792
Harvesting (combine harvester)	5,558	6,028
Threshing	4,570	4,364
Drying	2,964	6,058
Transportation	-	5,187
Total hired labor cost (ii)	**84,202**	**197,419**
Total hired labor used	**24.06**	**56.41**
(iii) Farm power cost (hired)		
Seedbed preparation with machinery	-	10,004
Seedbed preparation with draft animal	-	2,141
Land preparation with machinery	60,762	26,676
Land preparation with draft animal	2,470	5,269
Harvesting (combine harvester)	64,220	69,983
Threshing	5,928	5,014
Transportation	1,359	1,791
Total farm power cost (hired) (iii)	**134,739**	**120,878**
Total Cash Cost (c)	**314,468**	**461,721**
(d) Interest on Total Cash Cost		
Interest on cash cost (10%) for 4 months	31,447	46,172
Interest on Total Cash Cost (d)	**31,447**	**46,172**
Total Variable Cost (b+c+d)	**454,274**	**640,796**
Total Labor Cost (c+h)	**157,240**	**261,614**
Gross margin per unit of land {a - (f+k+l)}	**211,478**	**174,427**
Benefit and Cost Ratio (BCR)	**1.47**	**1.27**
Return above Cash Cost	**2.12**	**1.77**

Appendix 7 Enterprise budget of Sin Thu Kha rice production by different crop establishment methods (DSR and TPR) during monsoon season (Daik U Township, 2014-2015)

Items	Average Value (MMK/ha)	
	DSR method (N=10)	TPR method (N=22)
(a) Gross Benefit		
Average yield	3,195	3,635
Average producer price	186	197
Gross Benefit (a)	**594,183**	**715,206**
(b) Opportunity Cost		
(i) Material cost		
Own seed	11,362	14,820
Total material cost (i)	**11,362**	**14,820**
(ii) Family labor cost		
Seedbed preparation	-	20,174
Land preparation	24,577	14,708
Broadcasting	7,287	-
Pulling out seedlings	-	7,298
Transplanting	-	3,716
Fertilizer application	8,151	7,354
Pesticide and herbicide Application	6,052	3,986
Manual weeding	15,067	1,403
Harvesting (manually)	988	2,021
Harvesting (combine harvester)	11,115	4,435
Threshing	1,976	1,796
Drying	2,223	4,376
Transportation	1,976	2,059
Total family labor cost (ii)	**79,411**	**73,325**
Total family labor used	**22.69**	**20.95**
(iii) Farm power cost (own)		
Seedbed preparation with machinery	-	6,849
Seedbed preparation with draft animal	-	4,154
Land preparation with machinery	-	8,982
Land preparation with draft animal	8,645	10,105
Transportation	-	3,368
Total farm power cost (own) (iii)	**8,645**	**33,457**
Total Opportunity Cost (i+ii+iii) (b)	**99,418**	**121,603**
(c) Cash Cost		
(i) Material cost		
Seed	19,019	16,841
Cow dung	7,657	-
Fertilizer	37,297	57,989

Pesticide	3,211	5,782
Herbicide	15,685	8,623
Fuel	10,349	17,307
Total material cost (i)	**93,218**	**106,541**
(ii) Hired labor cost		
Seedbed preparation	-	16,897
Land preparation	14,326	17,571
Broadcasting	4,076	-
Pulling out seedlings	-	30,527
Transplanting	-	79,366
Fertilizer application	4,199	6,456
Pesticide and herbicide Application	3,458	3,256
Manual weeding	-	2,807
Harvesting (manually)	9,016	12,911
Harvesting (combine harvester)	5,681	5,558
Threshing	6,299	1,572
Drying	5,558	-
Transportation	-	6,680
Total hired labor cost (ii)	**52,611**	**183,600**
Total hired labor used	**15**	**52**
(iii) Farm power cost (hired)		
Seedbed preparation with machinery	-	12,294
Seedbed preparation with draft animal	-	5,950
Land preparation with machinery	36,556	20,097
Land preparation with draft animal	21,366	11,115
Harvesting (combine harvester)	77,805	72,977
Threshing	3,458	5,726
Transportation	2,779	3,733
Total farm power cost (hired) (iii)	**141,963**	**131,892**
Total Cash Cost (c)	**287,792**	**422,033**
(d) Interest on Cash Cost		
Interest on cash cost (10%) for 4 months	28,779	42,203
Interest on Total Cash Cost (d)	**28,779**	**42,203**
Total Variable Cost (b+c+d)	**415,989**	**585,839**
Total Labor Cost (c+h)	**132,022**	**256,925**
Gross margin per unit of land {a - (f+k+l)}	**178,194**	**129,367**
Benefit and Cost Ratio (BCR)	**1.43**	**1.22**
Return above Cash Cost	**2.06**	**1.69**

Appendix 8 Enterprise budget of Sin Thu Kha rice production by different crop establishment methods (DSR and TPR) during summer season (Daik U Township, 2014-2015)

Items	Average Value (MMK/ha)	
	DSR method (N=9)	TPR method (N=3)
(a) Gross Benefit		
Average yield	3,246	3,864
Average producer price	194	205
Gross Benefit (a)	**631,085**	**792,120**
(b) Opportunity Cost		
(i) Material cost		
Own seed	4,830	-
Total material cost (i)	**4,830**	**-**
(i) Family labor cost		
Seedbed preparation	-	18,937
Land preparation	20,995	17,290
Broadcasting	5,352	-
Pulling out seedlings	-	4,940
Transplanting	-	3,293
Fertilizer application	7,136	7,410
Pesticide and herbicide application	4,528	4,940
Manual weeding	6,861	-
Irrigation and drainage	961	8,233
Harvesting (combine harvester)	5,214	7,822
Threshing	1,372	-
Total family labor cost (i)	**52,419**	**72,865**
Total family labor used	**12.75**	**20.82**
(ii) Farm power cost (own)		
Seedbed preparation with draft animal	-	9,880
Land preparation with machinery	8,233	-
Land preparation with draft animal	,233	-
Total farm power cost (own) (ii)	**16,467**	**9,880**
Total Opportunity Cost (i+ii+iii) (b)	**73,716**	**82,745**
(c) Cash Cost		
(i) Material cost		
Seed	24,151	37,050
Fertilizer	72,248	99,212
Pesticide	4,391	14,820

Herbicide	12,007	11,362
Fuel	21,654	3,829
Total material cost (i)	**134,450**	**166,272**
(ii) Hired labor cost		
Seedbed preparation	-	38,913
Land preparation	33,757	34,580
Broadcasting	12,487	-
Pulling out seedlings	-	28,323
Transplanting	-	93,860
Fertilizer application	15,643	7,410
Pesticide and herbicide application	11,664	11,527
Manual weeding	21,407	8,233
Irrigation and drainage	10,841	3,293
Harvesting (manually)	7,410	-
Harvesting (combine harvester)	9,743	13,173
Threshing	2,744	-
Transportation	4,117	-
Total hired labor cost (ii)	**129,812**	**239,313**
Total hired labor used	**43.27**	**68.38**
(iii) Farm power cost (hired)		
Seedbed preparation with machinery	-	19,760
Seedbed preparation with draft animal	-	24,700
Land preparation with machinery	53,242	33,757
Harvesting (combine harvester)	74,100	86,450
Threshing	3,293	-
Transportation	1,647	8,028
Total farm power cost (hired) (iii)	**132,282**	**172,694**
Total Cash Cost (i+ii+iii) (c)	**396,545**	**578,279**
(d) Interest on Cash Cost		
Interest on cash cost (10%) for 4 months	39,654	57,828
Interest on Total Cash Cost (d)	**39,654**	**57,828**
Total Variable Cost (b+c+d)	**509,915**	**718,852**
Total Labor Cost	**182,231**	**312,178**
Gross margin per unit of land {a - (f+k+l)}	**121,170**	**73,268**
Benefit and Cost Ratio (BCR)	**1.24**	**1.10**
Return above Cash Cost	**1.59**	**1.37**