Advances in Management & Applied Economics, vol. 5, no.6, 2015, 79-110
ISSN: 1792-7544 (print version), 1792-7552(online)
Scienpress Ltd, 2015

Conjoint Analysis on Reduction of Production Loss through Rice Storage Management in Northeastern Thailand

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Abstract

This study aims to examine the pattern of the storage of rice of farmers' crops in the northeast of Thailand. The sample set of the study consisted of 770 farmers from Khon Kaen and Sakon Nakorn provinces. Most farms grow outside irrigated area. Rice types that farmers mostly grow are RD6 and Khao Dawk Mali 105. Most farmers get one crop per year, in an in-season rice field. Most farmers store their crop in a barn. For 93%, this method of storage has not changed from the past. Most storage grains contain low moisture. Most storage grains are RD6. Most farmers keep grains in storage less than 6 months. The assistance that farmers want from the government is: 1) distribution of rice seeds, fertilizers, pesticides; 2) support of the rice production price; 3) recognition of the successful farms, such as those with high production, energy-saving equipment, high production technology and good profits.

JEL classification numbers: O16, O18, R20.
Keywords: Conjoint Analysis; Rice Storage Management; Rice Production Process; Production Loss Reduction; Agricultural Practice Change

1 Introduction

World food security is unstable. In 2013, total world rice production was nearly equal to rice consumption. Globally, China is the world's largest rice producer. However, with the greatest population, China's rice consumption is forecast to outpace production in the near future. India is second in the world in rice production, with more than 100 million

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Article Info: *Received* : September 15, 2014. *Revised* : October 12, 2015.
Published online : December 5, 2015

tons per year. The forecast for the gap between demand and supply shows that currently Asia is not only meeting its own rice consumption demand, but also enjoys a net trade surplus. The entire increase in rice demand would have to be met through enhanced production in Asia, especially in Thailand, India and Vietnam (Table 1).

Rice is a major food crop for the people of the world in general and Asia in particular; nearly 90% of the world's rice is produced and consumed in this region (FAO, 1995) [1]. Thailand has been a rice civilization for many centuries, where its economically and culturally important. Economically, rice is the agricultural product that can create the highest income for country. In addition, Thailand is the world's largest rice exporter. In 2011, Thai rice export value was peaked at 193 million Baht or 6,400 million US dollars. Main rice importing markets are Africa, the Middle East, and Asia (Table 2). For Thailand, rice production represents a significant portion of the economy and labor force. Rice cultivation for more than 50% of all agricultural activities in the country and 3.7 million farm households depend on its production. Thailand has the fifth-largest amount of land under rice cultivation in the world.

Among the overall economic crops, rice is the main cash crop of Thailand. According to the rice production of Thailand, the average cultivated rice area of the country between 2012 and 2013 was about 65 million rai[2] per year for wet season rice and 17 million rai for dry season rice, totaling 82 million rai. The average total harvest area of the country in the same period was around 60 million rai for wet season rice and 17 million rai for dry season rice, totaling 77 million rai per year. Rice production between 2012 and 2013 averaged 27.5 million tons for wet season rice and 11.5 million tons for dry season rice, totaling around 39 million tons per year (Table 3). Rice production of Thailand has been steadily increasing (Table 4, Figure 1).

Table 1: World Rice Production and Consumption

World Rice Production	**2011**	**2012**	**2013**	**Average 2011-2013**	**2014***	**% Change**
China	137	140.7	143	140.23	144	0.7
India	95.98	105.31	104	101.76	108	3.85
Indonesia	35.5	36.5	37.5	36.50	37.7	0.53
Bangladesh	31.7	33.7	34	33.13	34.2	0.59
Vietnam	26.37	27.15	27.65	27.06	27.85	0.72
Thailand	**20.26**	**20.46**	**20.2**	**20.31**	**21.1**	**4.46**
Philippines	10.54	10.7	11.35	10.86	11.7	3.08
Myanmar	10.53	10.82	10.67	10.67	11	3.13
Brazil	9.3	7.89	8.16	8.45	8.5	4.17
Japan	7.72	7.65	7.76	7.71	7.72	-0.46
World Total	**449.3**	**465.81**	**470.19**	**461.77**	**479.16**	**1.91**
World Rice Consumption	**2011**	**2012**	**2013**	**Average 2011-2013**	**2014***	**% Change**
China	135	139.6	144	139.53	147	2.08
India	90.21	93.33	96.1	93.21	98.5	2.5
Indonesia	39	39.55	40	39.52	40.3	0.75

[2]One rai is equal to approximately 1600 square meters or 0.4 US acres.

Bangladesh	32.4	34.3	34.5	33.73	34.7	0.58
Vietnam	19.4	19.65	20.1	19.72	20.6	2.49
Philippines	12.9	12.85	12.93	12.89	12.93	0
Thailand	**10.3**	**10.4**	**10.5**	**10.40**	**10.6**	**0.95**
Myanmar	10.1	10.2	10.2	10.17	10.25	0.49
Japan	8.2	8.05	8.25	8.17	8.15	-1.21
Brazil	8.2	7.93	7.9	8.01	7.8	-1.27
World Total	**445.51**	**459.48**	**469.85**	**458.28**	**476.84**	**1.49**

Demand and Supply Gap (Production– Consumption)	**2011**	**2012**	**2013**	**Average 2011-2013**	**2014***	**Average 2011-2013**
China	2	1.1	-1	0.70	-3	1
India	**5.77**	**11.98**	**7.9**	**8.55**	**9.5**	**9**
Indonesia	-3.5	-3.05	-2.5	-3.02	-2.6	-3
Bangladesh	-0.7	-0.6	-0.5	-0.60	-0.5	-1
Vietnam	**6.97**	**7.5**	**7.55**	**7.34**	**7.25**	**7**
Thailand	**9.96**	**10.06**	**9.7**	**9.91**	**10.5**	**10**
Philippines	-2.36	-2.15	-1.58	-2.03	-1.23	-2
Myanmar	0.43	0.62	0.47	0.51	0.75	1
Brazil	1.1	-0.04	0.26	0.44	0.7	0
Japan	-0.48	-0.4	-0.49	-0.46	-0.43	0
World Total	3.79	6.33	0.34	3.49	2.32	3

Source: World Market and Trade; USDA**.**
Note: Unit in Million Ton (Milled Basis), * is forecast

Table 2: Thai Rice Export Classified by Continent between 2010 and 2013, Unit in Ton

Continent	**2010**	**2011**	**2012**	**2013**
Asia	2,198,888	3,407,551	1,178,589	1,232,450
Middle East	1,251,044	1,374,965	1,300,160	1,101,860
Europe	479,517	488,650	283,691	292,284
Africa	4,431,798	4,687,962	3,600,471	3,749,082
America	488,387	518,315	457,052	465,712
Oceania	197,752	188,678	134,548	128,690
Total	**9,047,386**	**10,666,120**	**6,954,511**	**6,970,077**
Rice Value (Million Baht)	**168,634**	**192,956**	**147,082**	**137,861**
Rice Value (Million Dollar)	**5,345**	**6,389**	**4,764**	**4,555**

Source: Department of Foreign Trade, Ministry of Commerce; Board of Trade of Thailand, 2014.

Table 3: Rice Cultivated Area, Harvest Area, Production and Production per Cultivated Area with 15% Moisture Content, Classified into Wet and Dry Season Rice, year 2012-2014

		Wet Season Rice				
Region		**Overall country**	North	**Northeast**	Center	South
Cultivated Area (Rai)	**2012**	**64,950,593**	14,927,584	**39,487,220**	9,553,265	982,524
	2013	**64,998,380**	14,996,608	**39,431,708**	9,605,305	964,759
	2014*	**64,658,652**	14,875,570	**39,255,260**	9,575,442	952,380
Harvest Area (Rai)	**2012**	**58,766,481**	14,673,445	**33,852,006**	9,290,298	950,732
	2013	**61,369,270**	14,662,901	**36,523,279**	9,245,447	937,643
	2014*	**62,147,780**	14,631,224	**37,187,650**	9,395,098	933,808
Production (Ton)	**2012**	**27,233,903**	8,744,836	**12,303,561**	5,751,115	434,391
	2013	**28,021,697**	8,665,028	**13,185,684**	5,729,266	441,719
	2014*	**28,581,781**	8,739,560	**13,532,777**	5,866,642	442,802
Production per Cultivated Area (Kg)	**2012**	**419**	586	**312**	602	442
	2013	**431**	578	**334**	596	458
	2014*	**442**	588	**345**	613	465
		Dry Season Rice				
Region		**Overall country**	North	**Northeast**	Center	South
Cultivated Area (Rai)	**2012**	**18,101,239**	7,615,783	**2,946,744**	7,095,692	443,020
	2013	**16,087,295**	7,089,885	**1,681,868**	6,915,306	400,236
	2014*	**15,846,650**	6,257,138	**2,689,101**	6,524,298	376,113
Harvest Area (Rai)	**2012**	**17,976,574**	7,586,545	**2,928,843**	7,022,228	438,958
	2013	**15,963,399**	7,040,997	**1,623,527**	6,901,668	397,207
	2014*	**15,278,645**	5,946,089	**2,620,547**	6,338,940	373,069
Production (Ton)	**2012**	**12,235,347**	5,198,586	**1,638,381**	5,165,330	234,050
	2013	**10,766,286**	4,752,078	**835,147**	4,960,973	218,088
	2014*	**10,225,123**	3,983,075	**1,463,816**	4,571,913	206,319
Production per Cultivated Area (Kg)	**2012**	**676**	683	**556**	728	528
	2013	**669**	670	**497**	717	545
	2014*	**645**	637	**544**	701	549

Source: Office of Agricultural Economics, 2014.
Note: Year 2014 is the forecast from the first quarter. Data update on 10 February 2014.

Table 4: Thai Rice Production Classified into white rice, glutinous, Hommali, Unit in Ton

Year	Production of Paddy: White Rice	Production of Paddy: Glutinous	Production of Paddy: Hommali	Total Paddy Production
2005	16,130,324.05	6,902,840.14	6,699,828.81	29,732,993
2006	17,013,753.74	6,667,576.02	6,461,566.24	30,142,896
2007	16,947,099.29	6,811,853.64	6,610,232.07	30,369,185
2008	19,074,793.67	6,804,986.59	6,611,656.73	32,491,437
2009	18,851,068.75	6,777,770.35	6,568,068.91	32,196,908
2010	19,123,036.65	7,719,300.31	7,528,718.05	34,371,055
2011	21,774,268.09	7,532,044.47	7,358,864.44	36,665,177
2012	23,351,492.14	7,905,094.43	7,714,143.43	38,970,730
2013	22,346,697.51	8,372,541.09	8,144,648.40	38,863,887

Source: CEIC, 2014.

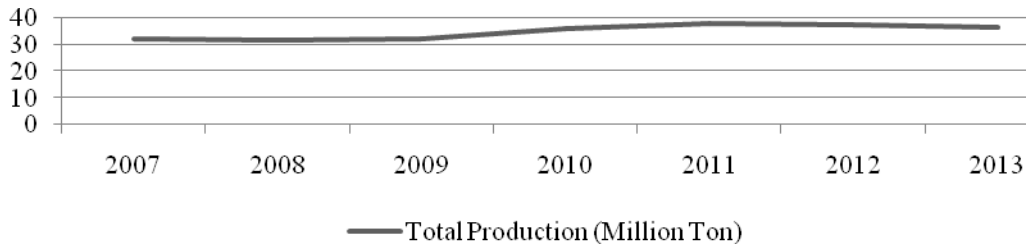

Figure 1: Total Rice Production of Thailand
Source: CEIC, 2014.

Thailand is a leading rice exporter but Thai rice is not alone in the market. The ASEAN members have the potential of producing rice as well (Table 5). Thailand has neighbors that are both competitors and partners in rice trading. They are Myanmar, Vietnam, Laos, Indonesia, Malaysia, Philippines, and Cambodia. At present, Thailand is losing its competitiveness to India and Vietnam. Therefore, there are the questions of how to increase the competitiveness of Thai rice. Shall the farmers reduce the production loss or decrease cost of production or increase quality of production or all three?

Table 5: World Rice Export and Import

World Rice Export	**2011**	**2012**	**2013**	**2014***	**% Change**
India	**4.64**	**10.25**	**9**	**8.5**	**-5.56**
Thailand	**10.65**	**6.95**	**7.5**	**8**	**6.67**
Vietnam	**7**	**7.72**	**7.4**	**7.7**	**4.05**
Pakistan	3.41	3.4	3.2	3.2	0
United States	3.25	3.3	3.4	3.2	-5.88
Cambodia	0.86	0.8	0.98	1	2.56
Uruguay	0.84	1.06	0.9	0.9	0
Brazil	1.3	1.11	0.85	0.85	0
Egypt	0.32	0.6	0.85	0.85	0
Burma	0.78	0.69	0.75	0.75	0
World Total	**36.25**	**39.15**	**38.1**	**38.14**	**0.09**
World Rice Importer	**2011**	**2012**	**2013**	**2014***	**% Change**
China	0.58	2.9	3	3	0
Nigeria	2.55	3.4	2.4	2.4	0
Indonesia	3.1	1.96	1.5	1.5	0
Iran	1.87	1.55	1.5	1.45	-3.33
Iraq	1.04	1.48	1.4	1.4	0
Saudi Arabia	1.06	1.19	1.23	1.25	2.04
Philippines	1.2	1.5	1.5	1.2	-20
Cote d'Ivoire	0.94	1.45	1.15	1.1	-4.35
Malaysia	1.08	1.01	1.05	1.1	4.76
Senegal	0.81	1.2	1	1	0
World Total	**36.25**	**39.15**	**38.1**	**38.14**	**0.09**

Source: World Market and Trade; USDA
Note: Unit in Million Ton (Milled Basis), * is forecast

There are many problem with Thai rice production such as an unstable production price, production loss, increase production cost, etc. The instability the price of rice is because of the great amount of rice production hitting the market at the same time. The objective of the rice mortgage scheme is to delay the amount of rice supply to market in the peak period. The government receives the harvest rice from the farmer; when the price increases it will be sold. It is away to diversify risk because of low price. To delay rice sale, farmers can keep the harvest in the barn and wait to sell.

The next important problem is the production loss after harvest. Thailand has a very high rice production but the loss in the rice production process is very high as well. It is interesting that the loss in the production process between 2012 and 2013 averaged nearly 5 million rai in wet season and only 120,000 rai in dry season. In all crops, average production loss represented a large quantity, estimated at 5 million rai. In this same period, average harvest area was 77 million rai and average production was 27 tons per rai. Thus, rice production loss for 5 million rai was 1 million tons per year. The value of the loss was around 21,480 million Baht if the calculation at the rice price at 12,000 Baht per ton

(Table 6).

Table 6: Comparison of Rice Production Loss in Overall Country

		Average Cultivated Area (Rai) 2012-2013	**Percent**	**Average Harvest Area (Rai) 2012-2013**	**Percent**
Wet Season Rice	Overall country	64,974,486.50	79.16	60,067,875.50	77.97
	Average of Rice Loss from Harvest (Rai)			4,906,611.00	
Dry Season Rice	Overall country	17,094,267.00	20.84	16,969,986.50	22.03
	Average of Rice Loss from Harvest (Rai)			124,280.50	
Wet and Dry Season Rice	Overall country	82,068,753.50		77,037,862.00	
	Average of Rice Loss from Harvest (Rai)			**5,030,891.50**	

Source: Office of Agricultural Economics, 2014.

The loss of rice occurs in every stage, such as loss during planting, when harvesting, from keeping rice in storage, during transportation, etc. The study related to the loss of rice from the production process of Prasuit Sithisuang, et al. (1983) [2] identified a16.8% loss from the production process. The processes which led to the greatest losses were, threshing, harvesting, and storage. Storage resulted in a 5% loss by weight when keeping rice for eight months. The process of threshing caused a loss of 4%. Lastly, the harvesting process resulted in a 3.8% loss. Thailand can produce a minimum of 27 million tons per year in wet season (Table 3). The loss from the production process is 16.8%. The rice loss is around 4.5 million tons, and the value is around 5.4 billion Baht if the rice price is at 12,000 Baht per ton. Farmers can reduce production loss by concentrating on every rice production process, such as the elimination of bird, mice or insects on the farm and the reduction of broken grain when threshing rice (Table 7).

Table 7: Rice Production Loss in Nine Rice Experiment Field in Rice Research Institute

Rice Production Process	**Loss (% by Weight)**
Harvesting	3.83
Drying and bundling rice	1.03
Moving rice to thresh	0.27
Threshing rice	3.99
Cleaning rice	1.79
Moving rice to keep in barn	0.92
Keeping rice for 8 months	5
Total	**16.83**

Source: Prasuit Sithisuang and other, 1983.

Decreasing rice production losses in every planting process is very important. Therefore, this research attempts to study the reduction of the production process losses. In addition,

this study has the purpose to examine the pattern of rice storage in order to extend the time to sell rice until there is not an oversupply and the price increases.

2 Objectives, Research Area, and Data Collection

These objectives of this research are to study the reduction of loss in the rice production process, identify the demand on pattern of rice storage of farmers in the northeastern region of Thailand, and to suggest policy recommendation for supporting rice production. The research area is in the northeastern region of Thailand, where there is a wide rice cultivation area. More than a half of cultivated area of wet season rice in the entire country is in the northeast. Between the years 2012 and 2013, the average cultivated area of wet season rice in the northeast was 61% of the overall country, and harvested area accounted for 58.5% of the country, while production of main season rice was42% of the overall country. Therefore, rice production in the northeast region plays an important role countrywide. However, when comparing the share of rice production of the northeast with the overall country in all rice seasons, it averaged 35.7% of the entire country. Rice production in the northeast is very high in the wet season but it is very low in the dry season (Table 8). Data collection was from 770 farmers in Khon Kaen and Sakon Nakhorn provinces. This random sample was from two provinces that have a cultivated area of more than 2 million rai per year (Table 9). In this study, there were roughly 185,000 farmers in Khon Kaen and 179,000 farmers in Sakon Nakhorn, thus the required sample size is 384 for a confidence level of 95% or a sampling error of 5% (Table 10).

Table 8: Comparison of Rice Production in the Northeast and Overall Country

		Wet Season Rice			**Dry Season Rice**		
Region		**Overall country**	**Northeast**	Percent	**Overall country**	**Northeast**	Percent
Cultivated Area (Rai)	**2012**	64,950,593	39,487,220	60.8	18,101,239	2,946,744	16.28
	2013	64,998,380	39,431,708	60.67	16,087,295	1,681,868	10.45
			Average	**61**		Average	**13.37**
	2014*	64,658,652	39,255,260	60.71	15,846,650	2,689,101	16.97
Harvest Area (Rai)	**2012**	58,766,481	33,852,006	57.6	17,976,574	2,928,843	16.29
	2013	61,369,270	36,523,279	59.51	15,963,399	1,623,527	10.17
			Average	**58.56**		Average	**13.23**
	2014*	62,147,780	37,187,650	59.84	15,278,645	2,620,547	17.15
Production (Ton)	**2012**	27,233,903	12,303,561	45.18	12,235,347	1,638,381	13.39
	2013	28,021,697	13,185,684	47.06	10,766,286	835,147	7.76
			Average	**42.12**		Average	**10.57**
	2014*	28,581,781	13,532,777	47.35	10,225,123	1,463,816	14.32
Production per Cultivated Area (Kg)	**2012**	419	312		676	556	
	2013	431	334		669	497	
	2014*	442	345		645	544	

		Wet and Dry Season Rice		
Region		**Overall country**	**Northeast**	Percent
Cultivated Area (Rai)	**2012**	83,051,832	42,433,964	51.09
	2013	81,085,675	41,113,576	50.7
			Average	**50.9**
	2014*	80,505,302	41,944,361	52.1
Harvest Area (Rai)	**2012**	76,743,055	36,780,849	47.93
	2013	77,332,669	38,146,806	49.33
			Average	**48.63**
	2014*	77,426,425	39,808,197	51.41
Production (Ton)	**2012**	39,469,250	13,941,942	35.32
	2013	38,787,983	14,020,831	36.15
			Average	**35.74**
	2014*	38,806,904	14,996,593	38.64

Source: Office of Agricultural Economics, 2014.

Table 9: Cultivated Area in the Northeast Province of Thailand between 2012 and 2014

	Province	Cultivated Area		Province	Cultivated Area
1	Loey	0.42	11	Ubonratchathani	4.31
2	Nongbualamph	0.87	12	Srisaket	3.06
3	Udonthani	2.04	13	Surin	3.21
4	Nongkhai	0.56	14	Buriram	3.05
5	Bungkran	0.55	15	Mahasarakhram	2.23
6	**Sakonnakhon**	**2.08**	16	Roiet	3.10
7	Nakhonphano	1.36	17	Karasin	1.57
8	Mukdahan	0.49	**18**	**Khon Kaen**	**2.57**
9	Yasotron	1.34	19	Chaiyapum	1.71
10	Amnatcharoen	1.03	20	Nakhonratsima	3.83

Source: Office of Agricultural Economics, 2014.

Table 10: Data Sampling of Farmers in 2006

Province	**Total**	**Rice Cultivated**	**Number of Farm**	**Data**
Khon Kaen	3,454,425	2,239,184	**184,616**	385
Sakonnakhon	2,017,340	1,965,943	**179,004**	385

Source: Office of Agricultural Economics, Khon Kaen and Sakonnakhon, 2008.

3 Research Procedure, Research Framework, and Methodology

3.1 Research Procedure

This research procedure is divided into two parts; descriptive analysis and quantitative analysis. The first objective, rice planting loss, applies qualitative analysis. The second, rice storage management, applies quantitative analysis (Figure 2).

Qualitative Approach
Reduction of Rice Production Loss
Research Tool: Questionnaire. Methodology: Descriptive Analysis. Statistics Uses: Frequency, Percentage, Standard Division, Rating Scale

Quantitative Approach
Pattern of Rice Storage Management
Attribute: Pattern of Storage, Rice keeping period, Percentage of Moisture Contain, Sold Price of Paddy, Type of Rice
Methodology: Conjoint Analysis

Figure 2: Research Procedure
Source: Own Modification (2014).

3.2 Research Framework

Research framework on the loss reduction in rice production and the pattern of rice storage management are shown in Figure 3.

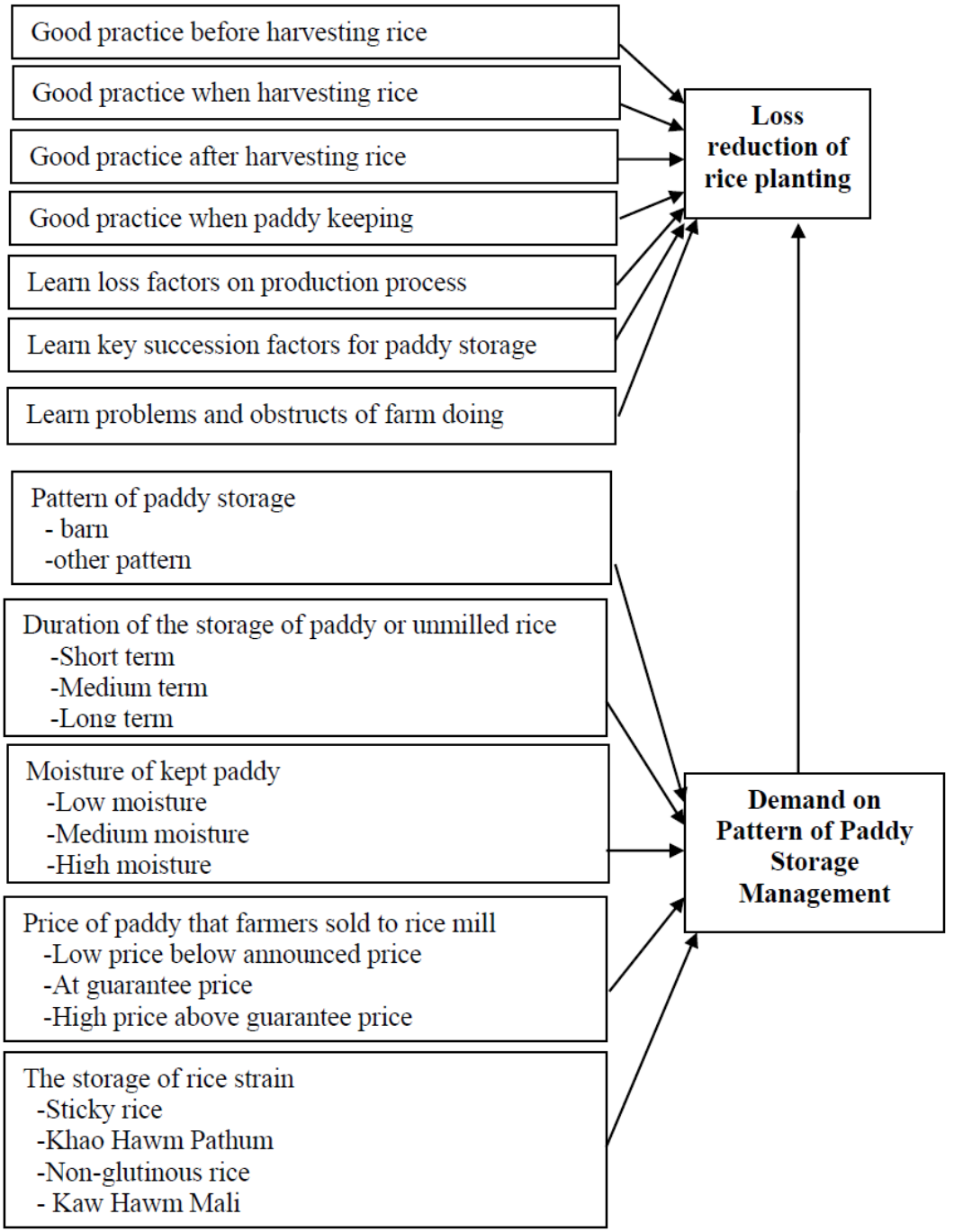

Figure 3 Research Framework on Loss Reductions during Rice Production Process and Pattern of Paddy Storage Management

Source: Own Modification (2014).

3.3 Methodology

In the first part the methodology is the descriptive analysis of the reduction of rice loss from planting to harvesting involved the following areas: rice planting procedures and problems, cost and return of rice farming, production price, rice storage management, the required cost reductions, the need for help from outside organizations, etc. The analysis of the reduction of rice production loss is presented by frequency, percentage, and standard division.

The second part examines the pattern of rice storage management to reduce the losses of production. The methodology applies the techniques of "conjoint analysis", which is a multivariate technique to evaluate patterns of rice storage management in different ways. The basic conjoint analysis (CA) model may be represented by following formula (Malhotra, 2004) [3]:

$$Y = \sum_{i=1}^{n} \sum_{j=1}^{m} \beta_{ij} Xij \tag{1}$$

Conjoint analysis in this study is used to quantify and predict client preferences for various levels of attributes. For this purpose, CA frequently employs additive models. The cluster and the componential segmentation model are depicted below (Schrieder, 1994) [4].

$$Y = \sum_{i=1}^{n} \sum_{j=1}^{m} \beta_{ij} Xij + \sum_{i=1}^{n} \sum_{k=1}^{m} \gamma_{jk} Z_k + \varepsilon \tag{2}$$

Y denotes the clients' overall preference, specifically choice for the service alternatives under investigation. These alternatives are described in terms of *j* -levels for *i* -attributes *ij*. β_{ij} is the part-worth utility associated with the j^{th}–level of the i^{th}-attribute. The part-worth utility measures the relative importance of X_{ij}in estimating the dependent variable. X_{ij} is a control variable to flag either presence (X_{ij} =1) or absence (X_{ij}=1) of the j^{th}–level for the t^{th}–attribute.

The attribute of the pattern of rice storage profile analyzed here are:

Y = Pattern of rice storage profile choice. Y expressed the satisfaction of farmers to choose the pattern of rice storage, which indicates the aggregate of the various alternatives. Alternatives are show in level j for alternative i. Data may be metric (Interval, Ratio Scale) or Non-metric (Nominal, Ordinal Scale);

Assigned

β_{ij} = The utility measurement of the consumption on j of the alternative choice i by comparing the importance of the variables X_{ij}.

X_{ij} = Explanatory health insurance concept variable. X_{ij} is the control variable of j of the alternative choice i. Data is non metric variable.

Z = Respondent's explanatory background variable;

ε = Error term;

X for *i* = 1 to 3: (1) Pattern of rice storage,

(2) Duration of rice keeping,

(3) Moisture of rice,

(4) Sale price of rice, and

(5) Type of rice

The levels for each attribute are:

X_{1j} for j = 1 to 2: (1) Storage of rice in barn
(2) Storage of rice in other areas
X_{2j} for j = 1 to 2: (1) Short term
(2) Medium term
(3) Long term
X_{3j} for j = 1 to 2: (1) Low moisture
(2) Medium moisture
(3) High moisture
X_{4j} for j = 1 to 3: (1) Low price
(2) Middle price
(3) High price
X_{5j} for j = 1 to 3: (1) Sticky rice
(2) Khao Hawm Pathum
(3) Non-glutinous rice
(4) Kao Hawm Mali

The componential segmentation model emphasizes the interaction between alternative choices profile X, and the respondents' profile. This requires the extension of the additive model by a vector Z_k that describes the respondents in terms of demographic, socioeconomic and background variables. Interaction between a person's background variable and the attribute levels X_{ij} is represented by the parameter γ_{jk} . Z_k denotes the vector of background variables (Schrieder, 1994).

Choice-based conjoint analysis is used to determine the rice storage pattern. This study considers five attributes of rice storage; pattern, duration of rice storage, moisture of rice, sale price of rice, and type of rice, as listed in the X alternatives, above, and in Table11.

Table 11: Pattern of paddy storage Concepts and Their Empirically Researched Attributes, Levels and Detail

Attribute	**Attribute Levels**	**Detail**
Pattern of Paddy Storage	Storage paddy in barn	Barn is an agricultural building primarily located on farms and used for storage of crops.
	Storage paddy in other patterns	Storage paddy in other pattern such as storage in bag, wood box, on the ground under the house, and so on.
Duration of Paddy Keeping	Short term	Less than 6 months
	Medium term	6-12 months
	Long term	More than 12 months
Moisture of Paddy Contain	Low moisture	Less than 15% moisture contain
	Medium moisture	At 15% moisture contain
	High moisture	More than 15% moisture contain
Sale Price of Paddy	Low price	Low price below announced price at 10,000-12,000 Baht per ton.
	Middle price	Middle price at guarantee price at 12,001-14,000 Baht per ton.
	High price	High price above guarantee price at 14,001-16,000 Baht per ton.
Type of Paddy	Sticky paddy	Sticky paddy or glutinous paddy
	Khao Hawm Pathum	A kind of rice call Khao Hawm Pathum
	Non-glutinous rice	A kind of white paddy
	Kao Hawm Mali	A kind of rice call Jasmine rice

Source: Own Modification (2014).

4 Results on the Loss Reduction of Rice Production

The purpose of rice storage after harvesting is the reduction of rice loss while maintaining both quantity and quality. The principle of rice storage is to keep rice in a barn where it has low moisture and temperature. The requirements for keeping good quality rice are: control moisture area must be clean; protection from birds, such as netting; control of mice and other pests; good air flow, including raised the ground to let the air flow below; away from coverage by trees; it must have strong walls with no holes; a roof to protect against sunshine, rain, and dew. These are some of the best practices for maintaining the quality of rice during storage.

However, the rice storage management of farmers, in reality, may be different from the theory. For example, most farmers stack the rice close to the barn wall or stack it too high. They do not take care to turn over of rice to reduce the moisture or they may keeping rice on ground, e.g. under the house, etc. The practices of farmers are different from person to person. Therefore, the quality of rice, quantity of rice production, and sale price are also different, too.

Thus, if farmers understand and be strict in the practice of every process of rice production, it can decrease their losses. The farmers should maintain a record from the beginning of each process, from seed preparation to plowing to rice prices, as a way to reduce losses occurring during farming. It is important for farmer to have a record of quantity of rain, annual production, the sale price of rice, cost and so on. This can help farming be the systematic and up-to-date. Besides, applying technology to support farming can help to save labor, time, and cost. This research presents the overall picture of farming at each step compared to the best practices, and then how successful farming can be different among farmers.

4.1 Farming in the Research Area

Rice planting in Thailand is separated into two seasons, rainy season and dry season. Types of rice that are popular to plant are the type that sensitive to light and the type that is not sensitive to light. The rice types that can be grown both in rainy and dry season are RD7, RD21, RD23, Krong Luang 1, Supanburi 1. There are two groups that farmers like to plant in dry season: the local rice type and the official rice type such as RD 10, Supanburi 60, Supanburi 90, Chainat 1. Chainat 1 is popular because it has high production per cultivated area.

There are also two types of rice that farmers like to plant in the rainy season: the local rice type and the official rice type such as RD6, RD15, RD27, Kao Hawm Mali 105, Supanburi 90, Kao Ruang 86, Kao Ta Hang, Kao Pak Mor, Pathumthani 60, Luang Yai, Patalung 60, Nang Nuang S 4, Luang Pratiw 123, Sanpathong, Puangrai 2, Nangpaya 132, Kawtahang 17 and Muak nam. The type that farmers like to plant is RD6 with the area around 16 million rai or 28% of total rice cultivated area. Most of RD6 is planted in the northeast region. The requirement of planting rice to increase productivity is the correct practice from the first step of selecting grain to the time to harvest.

Khon Kaen province is the third biggest province in the northeast after Nakhon Ratchasima and Ubon Ratchathani. Agriculture is the main vocation of 1 million, accounting for 7% of the total Khon Kaen population. Farm households account for 55% of the total. Rice cultivation accounts for 65% of the total land. Main cash crops of Khon Kaen are rice, potatoes, and sugarcane. The next are soy beans, corn, green beans, fruit,

standing timber, vegetable, and silkworms. Wet season rice in 2014 accounts for 2.6 million rai and a harvest area of 2.4 million rai. Total rice production is at 780,000 tons. The production per cultivated area is 304 kilograms. In 2014, Sakon Nakhorn province had a wet season rice cultivation area of 2.01 million rai and a harvest area of around 2 million rai. Total production was742,000 tons. Rice production per cultivated area is around 357 kilograms (Table 12).

Table 12: Rice production in Khon Kaen and Sakonnakorn province in 2012-2014

		Wet Season Rice		**Dry Season Rice**	
		Khon Kaen	**Sakonnakorn**	**Khon Kaen**	**Sakonnakorn**
Cultivated Area (Rai)	2012	2,574,947	2,083,998	296,019	99,562
	2013	2,566,965	2,086,916	149,914	59,189
	2014	2,566,965	2,078,778	289,630	113,394
Harvest Area (Rai	2012	2,107,302	1,760,844	294,972	98,729
	2013	2,332,375	2,024,310	131,446	54,797
	2014	2,387,277	2,000,530	274,628	110,425
Production (Ton)	2012	706,209	628,583	173,569	50,758
	2013	760,496	742,444	67,801	26,374
	2014	779,102	741,633	159,355	55,592
Production per Cultivated Area (Kilogram)	2012	274	302	586	510
	2013	296	356	452	446
	2014	304	357	550	490

Source: Office of Agricultural Economics, 2014.

Table 13: Rice Farm Working of Farmers in Research Area

	Total	**Mean**	**Standard Deviation**
Age	770	51.58	14.85
Farm doing experience	770	31.22	15.55
Number of year being member of BAAC bank	770	2.58	5.77
Rice cultivated area (rai)	770	10.48	11.54
Farm work in own area (rai)	770	0.65	2.69
Farm work as employee (rai)	770	0.20	1.27
Total cultivated area (rai)	770	10.97	11.23
Total harvest area (rai)	770	10.88	11.21
Do rice farm (number of time per year)	770	1.02	0.12
Wet season rice			
Glutinous rice (rai)	770	4.05	5.63
Non glutinous rice (rai)	770	6.85	8.13
Dry season rice			
Glutinous rice (rai)	770	0.03	0.45
Non glutinous rice (rai)	770	0.05	0.54
Soil preparation by plowing (number of time)	770	1.91	0.32
Age of rice sprout plant (day)	770	29.09	6.06

Source: Own Survey, 2013.

This research section attempted to analyze loss reduction in rice production in the northeastern region of Thailand. The total sample used for the analysis included 770 farmers, of which 385 came from Khon Kaen province and the remainder from Sakon

Nakhorn province. 34% were aged between 41-50 years. A majority had an average farming experience of 31 years. 35% work an area less than 5 rai. 13.5% of farmers are members of BAAC bank. A majority plant rice once per year and most farms are located outside of the irrigated areas. The popular rice seeds grown are RD6 and Khao Dawk Mali 105. After harvest, most farmers store the rice in a barn, accounting for 62%. The method of the storage of rice has not changed from the past, representing 93% (Table 13). Cultivated and harvested area is between 10 and 19 rai. Average production is between0.126 and 0.5 tons per rai. Farmers generally get one crop per year, mostly wet season rice. Cultivated area in wet season is divided into glutinous rice for 4.05 rai, non-glutinous rice 6.85 rai, while in the dry season glutinous rice is in 0.03 rai and non-glutinous rice 0.05 rai. The type of rice is primarily RD 6 and Khao Khaw Mali 105. Most farmers use a wheel plow twice to the prepare soil. Indirect seeding is most prevalent. This is the process of growing seedlings in a greenhouse or other controlled environment before placing young plants into the field. The age of the rice sprouts at planting is usually about 29 days. July sees mostly indirect seeding, while November is the month for harvesting. Most farmers sell rice in October to December. The harvesting mostly uses household labor and threshing uses labor and machine together.

4.2 Costs of Farming

The growth of rice has 3 steps: rice growth, reproductive growth and grain development. **Rice growth** has 2 periods; seedling stage and tilling stage. **Seedling stage** is the stage that rice germinates to tilling stage. It is approximately 20 days, depending on rice type. At the end of this stage rice has 5-6 leaves. **Tilling stage** is the stage that rice starts to tiller to the panicle initiation stage, for 30-50 days after rice sprout stage. Secondly, **reproductive growth** starts when the rice prepares to flower, past the booting stage to heading, flowering, and fertilization. This is about 30-35 days. Finally, **grain development** is the stage after pollination. Grain filling period at the beginning is the milky stage, then changes to dough and ripening to harvest maturity, spanning 25-30 days.

Average cost of the first fertilizer application (after the rice germinates at 20-30 days) is 2,000 Baht. Average fertilizer application after indirect seeding at 23 days is around 24.5 kilogram for 6.23 rai. The average cost of the second application of fertilizer, during the tilling stage, is 1,600 Baht. Fertilizer input when rice germination at19 days are around 21.15 kilogram per rai for 4.75 rai. The average cost of the third application of fertilizer application (flowering stage) is at 599 Baht. Average cost of seed is 666 Baht. Average cost of herbicide is 150 Baht. Average cost of pesticide is 334 Baht. Average cost of pushcart fuel is 1,865 Baht. Average cost of hired labor to prepare soil is 482 Baht. Average cost of labor to input fertilizer is 93 Baht. Average cost of labor to harvest is 3,435 Baht. Cost of barn maintenance is 595 Baht. Cost of hiring 5 labors is 2,023 Baht. Cost of renting barn is 166 Baht. Average cost of rice storage is 4,514 Baht. The maximum of rice storage is 3 tons.

4.3 The Procedure Before Planting, Before and After Harvesting, and During Rice Storage

Practice before planting 92% of farmers do not burn rice straw and only 32% compost it for fertilizer. Most farmers plough in the rice straw. Loss reduction in the preparation

stage can be achieved by: 1) inspecting for seeds that exhibit panicle disease; 2) selecting the seed that when planted, 100 seeds grow not less than 80 stems; 3) changing seed every 3 years; 4) reducing moisture; and 5) drying in the sun or in a drying machine.

The best practice before harvesting is to inspect the fields during rice start to determine grain production. After that, farmers must drain water from farm 21 days after rice flowering.

Suitable harvest time is 28-30 days after flowering. Harvesting at this time will get better quality rice. Problems of harvesting too early are low weight per grain because of not enough starch and high moisture content. If the farmer is too slow to reduce moisture, rice will have low quality. Lastly, it will be low quality for grinding because rice still has green grain. It will have a lot of broken rice mixed in. Problems of too slow harvest are the loss of rice production because of dry grain falling down. Secondly, birds, rodents and insects will cause damage. Thirdly, quality of ground product will be low because grain is crisping and cracking. Finally, when rice is soaked, new seed will grow.

Methods of harvest are by manual labor and by machine. Harvest by manual labor has several problems. It is time consuming, there may be a lack of labor, and the labor costs may be high. Harvest by machine is fast but 25-30% of the rice has high moisture (Rice Research and Development Institute, 2013) [5].

Survey results indicate that most farmers (around 98%) drain water from the farm 7-10 days before harvesting in order to let rice grow. When the farm is not wet during harvest, rice is more easily dried and cleaned. 68% will separate the mixed rice. Suitable time to harvest is 30 days after rice is 80% flowered, seed in an ear of rice is yellow, and ears of rice bow down. 99% of farmers harvest during this time. 96.5% of farmers record the period of rice plating so they know the age of the rice. They concentrate on the quantity of water, eliminate the pests, know the date of flowering, and forecast the correct date for harvesting. Most farmers, about 95%, harvest by using labor and sickle (Table 14).

Practices after harvesting are many; drying the ears of rice, thresh the rice, then drying the rice. Suitable time for rice to harvest is when seed has moisture around 20-25%. When rice is piled, seed will breathe leading to high temperature in the rice pile that promotes the growth of microbes. This causes the rice quality to decrease since there is rotten rice, spoiled rice and low quality of milling rice. Farmers must reduce moisture of the rice seed to 14% for the storage of rice for 2-3 months. If farmers want to keep rice for longer than 3 months, the moisture should reduce to has less than 12%. The ways to eliminate moisture are by the use of a drying machine or sunshine. The advantages of drying machines are that they can be used if there is rain or little sunshine; they use a small area; they can control moisture to the certain level and can control the loss of rice quality. Negative point is that they are expensive. Using sunshine can help to eliminate moisture as well. There is no cost, it is not complicate, but must use labor, has a larger drying area and it is difficult to control the quality of the rice. Drying in farm cause loss both weight and quality because seed fall down when drying. Losses can occur due to transporting and bird and rodent damage. Quality loss comes from drying in the day time, when rice gets high temperature from sun and the moisture is reduced, but at night the low temperature causes the atmosphere to have high moisture content. So, rice absorbs the moisture return to seed again. The changing of moisture within rice seed coming from this cycle again and again leads to broken seed. In addition, it can cause the rice to rift. When threshing or milling, it will break and then milling quality reduces.

At present, some farmers use carts to reap the rice and they can sell to a trader immediately. So, the reduction of moisture process will be done by the trader or mill.

However, some farmers still dry rice on drying beds to reduce moisture and to keep seed. The drying process starts with the cleaning the drying bed. Dry and clean material, such as mat or burlap, is used to support the seed. It is not good practice to put seed to dry directly on a cement floor or road because it is too hot. Secondly, the thickness of the rice stack should be around 5-10 centimeters. If the drying rice pile is too thick, the air will not flow and the rice will dry too slowly. If the rice pile too thin, high temperatures will cause rice grow. Farmers should turn over the rice pile every 2 hours or 4 times a day to reduce moisture faster and regularly. Thirdly, farmers should have material to cover the rice pile during the night to protect from rain or dew. Fourthly, farmers should not dry rice for too long a time. The duration of time to dry the rice depends on the initial moisture of rice, the thickness of the rice pile, the frequency of time to reverse the rice pile and the moisture level the farmer wants. In general, if the moisture reduces to around 12-14%, farmer should stop drying.

According to the survey, most farmers (74%) dry the ears of rice in pile for 3-4 days before bringing to thresh. Most of them, around 72%, dry the rice after threshing. Threshing rice can be done by using human labor or a threshing machine. In either case, farmers must be aware of the rate of loss when the seed falls down to stick on rice straw. The seed will break. Threshing by machine is widely used because it is convenient, fast, and low cost. Problem is farmer my not learn about the proper adjustment of the threshing machine, causing great loss both in quantity and quality. An example is if the machine takes in too much air, causing many good seeds be suck in and broken. After threshing through the machine, the seed will be pack in gunny sacks. The loss of rice depends on the speed of harvest machine, age of rice and moisture. From the survey, 89% of farmers use threshing machine. Almost all farmers clean the drying area and use cover material the floor before drying the rice. Most farmers are careful to keep the thickness of the drying pile at around 5-10 centimeters. However, many farmers do not pay attention to turning the rice pile every 2 hours, with just 55% of them doing it. Finally, most farmers use plastic to cover the rice when drying to prevent moisture damage.

Table 14: Practice before Planting, Before, After Harvest and During Paddy Storage

	Percent	Average
Practice before Planting		50.62
Not burn rice straw	91.3	
Do compose from rice straw	31.95	
Plough up and over rice straw	72.73	
Check seeds that are dirty panicle disease	49.09	
Select the seed when plant 100 seeds and it grow not less than 80 stems	30.00	
Change seeds or rice grain every 3 years	66.36	
Reduce moisture in seed	39.35	
Dry seed in the sun	24.16	
Practice before Harvest		90.55
Drain water 7-10 days before plant. Rice field is not wet during harvest.	98.57	
Separate the mixed rice	67.79	
Harvest rice 30-35 days after rice has 80% of its flower	99.35	
Know the age of rice, check water in rice field, eliminate animal	96.49	
Practice after Harvest		76.28
Dry ear of rice in pile before bringing to thresh	73.64	
Thresh paddy and then dry paddy	72.21	
Clean drying area, have material cover on floor before putting rice to dry	90.39	
Drying rice thick around 5-10 centimeter	84.03	
Reverse the rice pile every 2 hours	54.81	
Use plastic cover rice when drying for protecting rice from raining	82.6	
Practice during keeping paddy in storage		66.7
iminate the moisture from paddy during 2-3 months	89.87	
iminate the moisture from paddy in case of keeping paddy for many months	90.39	
ean paddy, not have stone, sand, broken rice grain	50.91	
ean storage, let air flow within storage and do the net to protect bird and mouse	46.75	
akes the wood to support paddy and lift the wood up 12 centimeter from ground to prevent seed suck in the moisture from cement floor	55.58	

Source: Own Survey, 2013.

During rice storage, the farmer should reduce loss from the damage of birds, rodents, insects, and moisture. To control quality, the farmer should beware of yellow seed, fusty smell and dirtiness. Good practice for keeping rice is keeping it in a barn that has low moisture and temperature or in another dry and cool place. There are four ways to keep rice. Firstly, keeping rice in the normal storehouse that is not controlled for temperature and moisture. This way is popular because farmers invest less and pay low costs but there is a chance to lose a lot by keeping in a storehouse, barn, and mill or export warehouse. Next is keeping in a place where there is temperature control only, such as a cooler or silo that has cold wind circulating. Keeping at a low temperature will help to reduce loss both in quantity and quality from insects and allow the seeds to breathe. The third method is to

keep the rice in a container that controls the moisture in the air, such as polyethylene bags. In this case, the moisture of rice will set the moisture within the container. If the rice has low moisture, the moisture within the container will be low. The rice will suffer less damage. In this method, the moisture of the rice should not be more than 10%. This way is suitable and incurs less cost for the farmer. Finally, keep the rice in a germ plasm plant bank under controllable temperature and moisture. This is the most efficient way to protect and reduce the damage of rice. The rice will have good quality but it is high investment and must take a lot of care (BRRD, 2014) [6].

When keeping rice for 2-3 months, 90% of farmers reduce moisture. Nearly all of the farmers (90%) who keep rice for many months reduce moisture. According to the survey, only half the farmers take care to clean the rice, not letting stones, sand or broken rice grains mix with the storage rice. Farmers that take care to clean the rice, keep it in clean storage with air flow, and use nets to protect against birds and rodents, account for 47%. When keeping rice in gunnysacks, 55.5% make use wood to support the rice and raise it 12 centimeters from the ground to prevent seeds absorbing in the moisture from cement floor. In summary, good practice can enhance the yield and quality of rice. Farmers tend to do well before harvest, but the practices of before planting, post-harvest and during storage are weak. The losses occur largely during these processes (Table 14).

4.4 Reduction of Loss in Rice Production Process

One way of loss reduction during rice plating is the inspection for pests such as rice thrips, occurring 10-15 days after sowing. Brown plant hoppers come when rice is producing grain. Rice stem borers and rice leaf folder come when rice is 15-40 days old. Rice bugs occur in the rice milk stage. From the survey, rice thrips are the most prevalent. There are many rice diseases found during inspection. Dirty panicle disease and blown spot disease are most common. Inspection shows that weeds found are grass, fern, sedge, algae, narrow leaf weed (Gramineae), and broadleaf weeds like morning glory. The can be controlled by: 1) preparing rice seed that has high stem count, many leaves, clumps, and the roots expand horizontally; 2) preparing the soil by rough plough for the first time, wait 1-2 weeks for the weeds to grow and then rough plough a second time; 3) not planting rice too fast; 4) preparation phase of indirect seeding; 5) cultural control like water management at 5-10 centimeters; 6) eliminating weeds before applying fertilizer; 7) rotating plants; 8) mechanical control such as labor to eliminate weeds; 9) chemical control like herbicide to control weeds; and 10) biological control like feeding ducks. Research results show that farmers mainly control weeds by using labor to eliminate them. Inspection for other animals on the farm shows that most farmers find snails, crabs, birds and rodents (Table 15).

Table 15: Reduction of Loss from Pest and Disease

Reduction of Loss from Pest and Disease	**Percent**
Inspection of pest	
Rice thrips	71.30
Brown planthopper	51.30
Rice leaffolder	35.19
Rice Stem Borers	32.60
Rice bug	4.94
Not found	0.39
Inspection of rice disease	
Dirty Panicle Disease if Rainy	52.86
Blown Spot Disease	50.13
Rice Blast Disease during Tillering Stage	36.62
Sheath Blight Disease	26.36
Sheath Rot Disease	8.31
Bacterial Leaf Blight or Bacterial Blight	7.92
Not found	9.35
Inspection of Weed	
Glass	74.94
Others: fern, sedge, algae, Gramineae, morning glory	25.06
Control weed by using labor eliminate weed	67.4
Inspection of Other Animals	
Golden apple snail	47.53
Agricultural pest such as crab	43.12
Pest in barn such as bird, mouse	45.71
Overall Inspection	
Survey and find all kind of insect and pest	99.61
Survey and find all kind of rice disease	90.65

Source: Own Survey, 2013.

4.5 Key Succession Factors for Keeping Rice in Storage

Factors contributing to the successful storage of rice are: 1) separating old and new rice into different areas; 2) not bringing hazardous materials such as fertilizer, chemicals, and insecticides in the same storage warehouse; 3) placing the floor covering material before laying down the rice in storage, 4) placing rice in gunny sacks on the litter, which lifts up from the floor 10 centimeter to let air flow; 5) not laying rice piles close to storage walls or piling rice too high; 6) turning over the rice pile to release the accumulated high temperature and moisture; 7) inspecting the rice at least once a week; and 8) frequently cleaning the inside and outside of the rice storage area. Results from the surveys indicate that slightly less than a half of the farmers lay down rice piles close to storage walls, pile rice too high or do not turn the rice pile to release the accumulate high temperature and

moisture (Table 16).Regarding the environment of rice storage, the storage area, in general, is ready for keeping rice in the middle to high level (Table 17).

Table 16: Factors supporting to the successful of paddy storage

Factors supporting to the successful of paddy storage	**Percent**
Not bring new paddy to keep in the same area with old paddy	91.30
Not bring other material such as fertilizer, chemical, insecticide to keep in the same warehouse of paddy storage	88.57
Have the material to cover on floor before laying down paddy in storage	81.30
Lay down paddy that packs in gunny bag on the litter, which lifts up from the floor 10 centimeter to let air flow.	91.43
Not lay down paddy pile close to storage wall or overlap too high paddy pile	51.04
Reverse the paddy pile to release the accumulate high temperature and moisture	51.17
Inspect the paddy that keeping at least once a week	69.09
Clean inside and outside paddy storage frequently	77.53

Source: Own Survey, 2013.

Table 17: Environment of Paddy Storage

Environment of Paddy Storage	**Tota**	**Mea**	**Standard**	**Level**
Storage house has roof to protect rain	770	3.87	0.78	High
Storage house has air flow	770	3.56	0.86	High
Storage house lift up from floor	770	3.54	1.10	High
Storage house has closed wall	770	3.40	0.82	Middl
Storage house has net to protect bird, mouse	770	3.39	1.08	Middl
Storage house is hot	770	3.36	0.77	Middl
Storage house has insect, pest, microbe	770	2.67	1.03	Middl

Source: Own Survey, 2013.

Farmers that have no barns to keep rice will use short term storage sell the rice as quickly as possible to protect from loss from pests, birds, rodents, and moisture. Results show that most farmers keep rice around 2 months before selling. Slightly more than half (51%) of the farmers that have barns keep the rice in the barn for 6-12 months.62% of farmers have barns to store rice (Table 18).

Table 18: Duration of Keeping Paddy in Case of Having and Not Having Barn

	Have no barn		**Have barn**	
	Numbe	**Percent**	**Numbe**	**Percent**
Paddy storage	292	37.92	478	62.08
	Numbe	**Percent**	**Numbe**	**Percent**
	Duration of keeping paddy in case of no storage (Months)		**Duration of keeping paddy in barn (Months)**	
Less than 3 months	467	**60.65**	238	30.91
3-6 months	254	32.98	102	13.25
6-12 months	25	3.25	395	**51.30**
More than 12 months	24	3.12	15	1.95

Source: Own Survey, 2013.

4.6 Problems and Obstructions of Farming

Half of farmers have problems with land holding. Soil quality problems such as lateritic soil (11%), alkaline soil (16%), and sandy soil (26%) occur in the upland areas. Half of farmers have drought problems. Most farmers have problems with insects, plant disease, pests, and weeds. Pest problems are mostly are by crabs and golden apple snail. Most farmers (71.5%) eliminate weeds by manual methods, while the use of chemical and biological methods is less. Most farmers have problems with high input cost and low production price (Table 19).

Table 19: Problem of Farm Doing

Problems	**Frequency**	**Percent**
Problem of land holding	45	5.84
Problem of soil quality	411	**53.38**
Problem of drought	394	**51.17**
Problem of flood	42	5.45
Problem of insect	485	**62.99**
Problem of plant disease	473	**61.43**
Problem of pest such as crab, golden apple snail, bird, mouse	756	**98.18**
Problem of weed	690	**89.61**
Problem of high input cost of production	767	**99.61**
Problem of low production price	759	**98.57**
Total	770	100

The things that farmers most request are for the government to support the cost of rice seed, fertilizer, pesticides to reduce cost of farming. Next, they want government support for the rice production price. Finally, they want scholarships to understand how other farms in other areas that are successful, such as high production yield, use production technology and the use of labor saving devices (Table 20).

Table 20: The Demand of Farmers on Farm Improvement

Demand of Farmers	Total	Mean	Standard Deviation	Level
1. Farmers want government to support the cost of rice seed, fertilizer, pesticide, to reduce cost of farm doing.	770	4.57	0.67	Highest
2. Farmers want government to support rice production price.	770	4.53	0.67	Highest
3. Farmers want the scholarship to support to see other farms in other area that do successful on farm doing such as high production yield, use production technology, use of labor saving devices.	770	4.51	0.74	Highest
4. Farmers want to set the farmer group to exchange new knowledge.	770	4.42	0.72	High
5. Farmers want the irrigation system in farm.	770	4.42	0.73	High
6. Farmers want government to control price of fertilizer and pesticide.	770	4.36	1.01	High
7. Farmers want to learn modern agricultural technology.	770	4.26	0.86	High
8. Farmers want the agricultural officer to inspect and help to solve farm doing technique problem.	770	4.26	0.89	High
9. Farmers want to train the way to increase production and develop to be the modern farm.	770	4.23	0.81	High
10. Farmers want the money support for new investment and circulated money.	770	4.25	1.66	High
11. Farmers want Bank of Agricultural and Cooperatives invest for new technology to increase the efficiency of rice plating such as soil grinder machine, reaping machine. Farmers can rent these machines.	770	4.22	0.93	High
12. Farmers want the practical research and development in farm doing.	770	4.21	0.90	High
13. Farmers want to see farm doing, harvesting way and paddy storage pattern of other countries.	770	4.13	0.86	High
14. Farmers want the instruction of the good pattern of paddy storage.	770	4.11	0.87	High

5 The Conjoint Analysis on Rice Storage Management

Most farmers in the northeast are customers of Agricultural and Cooperatives Bank. Farmers in all regions generally do not have barns to store the rice. Northeastern farmers mostly have barns to keep the rice, while other regions have not many barns (Table 21). In the analysis of the pattern of rice storage management, the research survey finds out that most farmers are between 41-50 years old. Most of them have farm and area with less than five rai. In this part, there is one uncompleted questionnaire, so there are 769 respondents (Table 22).

Table 21: Number of Barns of Farmers Classified by Region

Region	Paddy barn			
	Farmers who plant rice		**Farmers who have barn**	
	Number	Percent	Number of	Percent
Upper North	122,243	7.04	143,521	10.58
Lower North	393,014	22.63	53,542	3.95
Upper Northeast	415,122	**23.91**	624,450	**46.04**
Lower Northeast	557,790	**32.12**	520,664	**38.39**
Center	119,397	6.88	1,605	0.12
East	55,056	3.17	7,725	0.57
West	55,980	3.22	4,286	0.32
Upper South	177	0.01	0	0.00
Lower South	17,719	1.02	547	0.04
Total	**1,736,498**	100.00	**1,356,340**	100.00

Source: Agricultural and Cooperatives Bank, January 2011.

Table 22: Pattern of Paddy Storage Management Classifies by Age and farm area

	Frequency	**Percent**
Age		
30 years and below	54	7.02
31-40 years	109	14.17
41-50 years	262	34.07
51-60 years	146	18.99
More than 60 years	198	25.75
Total	769	
Missing	1	
Farm Area (Rai)		
5 rai and below	271	35.24
6-10 rai	262	34.07
11-15 rai	124	16.12
16-20 rai	46	5.98
More than 20 rai	66	8.58
Total	769	100
Missing	1	

Source: Own Survey, 2013.

5.1 Main Effects and Two-Way Effects of Multi-Attributes of Pattern of Rice Storage and Management

The analysis of the demands on rice storage and management by farmers applies conjoint analysis to find out the demand on rice storage. The analysis of attribute main effect and test of significant level of attribute of rice storage pattern is shown in Table 23.

The results present the pattern of rice storage classified into several patterns. The results show that rice storage in barns is most common with 26% of all occurrences from the total of all choices of 0.48. According to the share of utility in selecting the method of rice storage by age, it shows that most farmers below the age of 30 prefer to keep rice in a barn, along with farmers with the farm area more than 20 rai. Regarding the duration of rice storage, this separates into short term, medium term, and long term. Research results show that short term of rice storage for less than six months is most chosen, with 26%. Most farmers older than 30 years old keep rice for short term, as do farmers with the farming area of 16-20 rai. The moisture that rice contains can be classified into low, medium, and high. It is interesting that 30% of farmers choose to keep rice that has low moisture. Sale price of rice can be divided into low, middle, and high price. Rice price plays an important role on decision on pattern and duration of rice storage. It concludes that farmers of all ages want to sell rice at the highest price of 14,000-16,000 Baht per ton. Farmers with all sizes of farm area are mostly choosing to sell rice at high price. Lastly, the type of rice divides into sticky rice, Khao Hawm Pathum, Non-glutinous rice and Kao Hawm Mali. Farmers express the desire to keep with sticky rice with a percentage of 38% (Table 23-24).

Table 23: Attribute Main Effect and Significant Level of Attribute of Paddy Storage Pattern Classifies by Age

	Age					
	< 30 years (N=54)	31-40 years (N=109)	41-50 years (N=262)	51-60 years (N=146)	> 60 years (N=198)	**Total** (N=769)
Pattern of paddy storage						
Storage paddy in barn	**0.29**	0.26	0.25	0.25	0.28	0.26
Storage paddy in other patterns such as storage in bag, wood box, on the ground under	0.21	0.21	0.24	0.23	0.21	0.22
Within Att. Chi-Square	6.88	4.92	0.79	0.58	23.98	23.71
D.F.	1	1	1	1	1	1
Significance	p < .01	p < .05	not sig	not sig	p < .01	p < .01
Duration of paddy keeping						
Less than 6 months	0.25	0.25	**0.26**	**0.26**	**0.26**	0.26
6-12 months	0.07	0.20	0.21	0.22	0.17	0.19
More than 12 months	**0.32**	0.21	0.22	0.21	0.25	0.23
Within Att. Chi-Square	27.06	4.83	9.27	6.41	13.74	33.95
D.F.	2	2	2	2	2	2
Significance	p < .01	not sig	p < .01	p < .05	p < .01	p < .01
Moisture of paddy contain						
Less than 15% moisture contain	**0.27**	**0.30**	**0.31**	**0.30**	**0.30**	0.30
At 15% moisture contain	0.27	0.23	0.22	0.22	0.23	0.23
More than 15% moisture contain	0.14	0.08	0.12	0.11	0.12	0.11
Within Att. Chi-Square	11.26	62.02	116.42	64.68	75.53	320.45
D.F.	2	2	2	2	2	2
Significance	p < .01	p < .01	p < .01	p < .01	p < .01	p < .01

Sale Price of paddy						
10,000-12,000 Baht per ton	0.17	0.11	0.12	0.12	0.13	0.13
12,001-14,000 Baht per ton	0.23	0.27	0.27	0.29	0.26	0.27
14,001-16,000 Baht per ton	**0.37**	**0.38**	**0.39**	**0.38**	**0.39**	0.39
Within Att. Chi-Square	32.19	128.42	285.22	154.74	202.57	793.22
D.F.	2	2	2	2	2	2
Significance	p < .01	p < .01	p < .01	p < .01	p < .01	p < .01
Type of paddy						
Sticky paddy	**0.47**	**0.36**	**0.36**	**0.37**	**0.41**	0.38
Khao Hawm Pathum	0.10	0.18	0.19	0.18	0.14	0.17
Non-glutinous rice	0.24	0.18	0.21	0.23	0.22	0.21
Kao Hawm Mali	0.10	0.16	0.16	0.13	0.15	0.15
Within Att. Chi-Square	110.33	69.79	144.56	105.64	207.88	603.85
D.F.	3	3	3	3	3	3
Significance	p < .01	p < .01	p < .01	p < .01	p < .01	p < .01

Table 24: Attribute Main Effect and Significant Level of Attribute of Paddy Storage Pattern Classifies by Farm Area

	Farm Area					**Total** (N=769)
	< 5 rai (N=271)	6-10 rai (N=262)	11-15 rai (N=124)	16-20 rai (N=46)	>20 rai (N=66)	
Pattern of paddy storage						
Storage paddy in barn	0.26	0.26	0.26	0.23	**0.27**	0.26
Storage paddy in other patterns such as storage in bag, wood box,	0.22	0.22	0.23	0.25	0.21	0.22
Within Att. Chi-Square	11.15	11.26	1.79	0.61	4.05	23.71
D.F.	1	1	1	1	1	1
Significance	p < .01	p < .01	not sig	not sig	p < .05	p < .01
Duration of paddy keeping						
Less than 6 months	0.26	0.25	0.25	**0.27**	0.24	0.26
6-12 months	0.11	0.20	0.28	0.25	**0.27**	0.19
More than 12 months	0.26	0.23	0.21	0.19	0.23	0.23
Within Att. Chi-Square	63.65	8.95	5.69	5.22	1.18	33.95
D.F.	2	2	2	2	2	2
Significance	p < .01	p < .05	not sig	not sig	not sig	p < .01
Moisture of paddy contain						
Less than 15% moisture contain	0.27	0.29	**0.34**	**0.32**	**0.35**	0.30
At 15% moisture contain	0.25	0.23	0.21	0.20	0.15	0.23
More than 15% moisture contain	0.14	0.11	0.07	0.11	0.09	0.11
Within Att. Chi-Square	54.91	104.63	107.63	27.17	71.27	320.45
D.F.	2	2	2	2	2	2

Significance	p < .01	p < .01	p < .01	p < .01	p < .01	p < .01
Sale Price of paddy						
10,000-12,000 Baht per ton	0.15	0.13	0.11	0.09	0.11	0.13
12,001-14,000 Baht per ton	0.25	0.26	0.29	0.31	0.28	0.27
14,001-16,000 Baht per ton	**0.36**	**0.39**	**0.41**	**0.42**	**0.39**	0.39
Within Att. Chi-Square	194.67	277.64	179.38	78.95	81.76	793.22
D.F.	2	2	2	2	2	2
Significance	p < .01	p < .01	p < .01	p < .01	p < .01	p < .01
Type of paddy						
Sticky paddy	**0.43**	**0.37**	**0.34**	**0.32**	**0.38**	0.38
Khao Hawm Pathum	0.15	0.17	0.18	0.23	0.15	0.17
Non-glutinous rice	0.19	0.22	0.25	0.22	0.21	0.21
Kao Hawm Mali	0.11	0.15	0.19	0.17	0.17	0.15
Within Att. Chi-Square	385.26	168.52	43.44	11.93	48.01	603.85
D.F.	3	3	3	3	3	3
Significance	p < .01	p < .01	p < .01	p < .01	p < .01	p < .01

5.2 Multinomial Logit Estimation of Average Utility Values for Rice Keeping Attributes

Table 25 presents the multinomial logit estimation of average utility value of all farmers. The highest total effect of attribute level is type of rice storage is sticky rice. Considering the pattern of rice storage, most farmers select to store rice in other methods such as storage in bags, wooden boxes or on the ground under the house, with a part-worth value at 0.21.

The duration of rice storage that farmers mostly prefer is the keeping of rice less than 6 months with a part-worth value at 0.19. Rice storage for more than 12 months has a minus utility effect. This means that farmers feel the longer they keep the rice, the less their profit gain.

Concerning to the moisture of the rice, the highest incentive to keep is moisture less than 15% with a part-worth value at 0.4. The higher level of moisture in rice causes a negative demand on rice storage.

Going into the detail, low rice price contains the lowest total effect, accounting for -0.54. Farmers are not satisfied to sell rice at the lowest price. Farmers want to sell rice at the price level of 14,000-16,000 Baht per ton, with a part worth value of 0.79.

Regarding the type of rice, analytical results indicate that farmers enjoy the attribute of sticky rice storage with a part worth value of 1.01.

When compared with the relative importance of all attributes, type of rice has the highest relative importance with 31.32%, followed by sale price of rice, moisture of rice, duration of rice storage, and method of rice storage. According to none option has relative importance at 0.01%.

Table 25: Multinomial Logit Estimation of Average Utility of Paddy Storage Attribute and Its Relative Importance

	Total Effect	t Ratio
Pattern of Paddy Storage		
Storage paddy in barn	-0.2139	-6.3055
Storage paddy in other patterns such as storage in bag, wood box, on the ground under the house	0.2139	6.3055
Relative importance in %	8.75	
Duration of Paddy Keeping		
1 Less than 6 months	0.1933	4.4527
2 6-12 months	0.1758	3.3276
3 More than 12 months	-0.3691	-7.7055
Relative importance in %	11.50	
Moisture of Paddy Contain		
Less than 15% moisture contain	0.4044	13.3464
At 15% moisture contain	0.2265	6.4629
More than 15% moisture contain	-0.6310	-13.6176
Relative importance in %	21.18	
Sale Price of Paddy		
10,000-12,000 Baht per ton	-0.5390	-16.3621
12,001-14,000 Baht per ton	-0.2543	-5.1535
14,001-16,000 Baht per ton	0.7933	19.5324
Relative importance in %	27.25	
Type of Paddy		
Sticky paddy	1.01	20.3925
Khao Hawm Pathum	-0.52	-7.1206
Non-glutinous rice	-0.12	-2.7694
Kao Hawm Mali	-0.37	-7.5225
Relative importance in %	31.32	
NONE	-1.3709	-15.3936
Relative importance in %	0.01	
Chi Square	2810.4192	

Source: Own Survey, 2013.

6 Conclusion

Descriptive analysis part of loss reduction of rice production, and farmers should concentrate on every production process starting from the grain selection, soil preparation, pre-harvest, post-harvest, and rice storage. If farmers do well in every process, the loss can be reduced as well. According to the analysis of the pattern of the storage of rice by the769 respondents, storage of the grain in a barn is mostly selected. The duration of the storage of rice of less than 6 months is selected by26%. Most storage

grains contain low moisture, represent by30%. Farmers typically desire to sell rice to the highest bidder, accounting for 39%. Most of the storage rice is sticky rice type RD6 (Figure 4). The methods of rice storage of farmers are not different from the past. Price of rice has no influence on the changing pattern of rice storage. Return on rice sales has a high fluctuation. Half of farmers farm for their own household consumption. Farmers sell the rest of their production with uncertainty of price. At present, farmers encounter many problems of farm work such as high input cost, low production price. Therefore, there are a lot of farmers leave their farm in the next generation to do other profitable work instead.

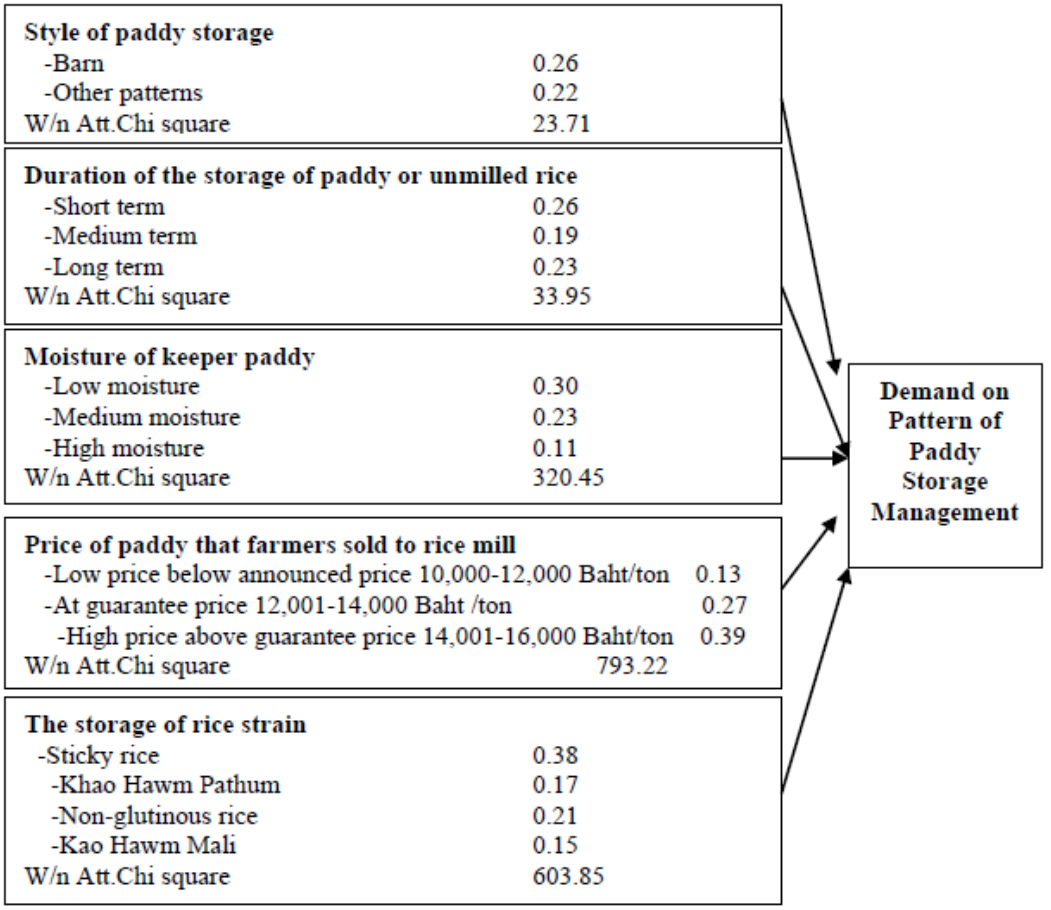

Figure 4: Demands on Pattern of Paddy Storage Management

7 Policy Recommendations

This research suggests alternative policies; process subsidy and input subsidy policy. In the past, the two Thai political parties supported neither a mortgage policy nor a rice price guarantee policy, which are the output subsidy policies. Both policies have strengths and weaknesses. Thinking of the frame of both policies, this research suggests the alternative rice supporting policy. Government should rethink the process subsidy and input subsidy policies. The process subsidy is very important because the loss of rice

during the processes can be a great amount. The subsidy policy should increase the market value of rice and generate income distribution to farmers directly, equal to more than the original policy. In addition, the subsidy policy should cover the whole progression, from rice planting and harvesting to storage and marketing.

The reduction of loss on farm processes is how to help farmers reduce losses from the starting of a new crop to the harvest process. In general, farmers have never changed their pattern of farming. For example, most farmers have not changed the pattern of rice storage, have not changed to a new variety every year, do not turn the drying rice every two hours. Most store the rice in the barn without fighting birds, rodents, and insects. Farmers generally do not concentrate on the time of harvesting. The harvest period has an effect on the sale price and has impact on the consumer getting good quality rice. Farmers can reduce the unnecessary expenditures such as the lowering the amount of chemicals and fertilizer used. If farmers have better production processes, their income per capita will increase and then it can generate economic growth.

Increasing productivity, such as the applying of new technology in farming, is how to increase the efficiency of rice production to increase production per cultivated area. However, in some cases, the use of technology for harvesting can increase the rice quantity but reduce the quality of rice because it has higher moisture.

The training and exchange of knowledge among farmers can help them to understand the best farm practices. They should have a chance to increase their knowledge by training and exchanging ideas with other farmers. For example, northeast farmers should have opportunity to exchange knowledge with farmers in the central area of the country who have the high productivity yields. Furthermore, successful farming should be promoted with lessons of how to increase productivity and be the model farm; other countries can learn together with Thai farmers.

The research and development on rice is important. In the past, the government supported the budget on research and development, but that research is not used in reality. The transfer of knowledge to farmers, who are the key workers, is most important. Good patterns of farming and farming practices, good storage, and loss reduction models are what farmers want to know.

ACKNOWLEDGEMENTS: First and foremost, I would like to express a special thanks to Tony Criswell, International Affair Officer, College of Local Administration, Khon Kaen University, Thailand, who concentrate to read and edit this article. Furthermore, I would like to give many thanks to the Faculty of Management Science, Khon Kaen University, which was generous in providing the necessary funding for the empirical research. Finally, I would thank Faculty of Economics, Kasetsart University, Sriracha Campus for supporting the publication expenses.

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