

## Cost Comparisons in the Rice Disinfestations between Infrared Radiations Heating Application and Chemical Application

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**Abstract: Problem statement:** Rice is one of importance export goods especially Hom Mali Rice. Therefore, rice storage is very important. The main enemy of Hom Mali Rice is Rice Weevil. It is a small insect and grows fast with small amount of food eating. Its deteriorate rice by bite both internal and external rice kernel resulting in damage and loss of rice. However, its necessary to the study of cost in the rice disinfestations between the Infrared radiation heating application and chemical application in order to obtain information in decision making. **Approach:** The purpose of this research is to evaluate cost structure in the disinfestations of rice insect between chemical method and infrared radiation heating application. **Methodology:** (1) Data and information collected by surveying and rice milling enterprises from private in Surin province. The information studied were type of insects, rice storage method, organization and business method, cost structure and exportation system. (2) Cost analysis and rate of return. **Results:** The calculation of cost based on the large rice mill export factory in Surin province of Thailand. The cost structure of rice milling can be divided into 2 types: Fixed cost and variable cost which are equal to 5,385,256 baht (2% of total cost) and 274,922,345 baht (98 % of total cost), respectively. The rate of return in rice milling is 19,020 ton year<sup>-1</sup>. The income is from rice sale was approximately 284,349,000 baht (82.93% of total income) and from broken rice sale was approximately 30,812,400 baht (8.99% of total income). The cost of disinfestations by infrared radiation heating application and chemical equal to 0.3096 and 0.3037 baht kg<sup>-1</sup>, respectively. Therefore, the non-chemical method increase total cost only by 1% or 112,218 baht. **Conclusion:** Major enemy of Hom Mali Rice during stock is rice weevil. The rice deteriorations caused by rice weevil such as dirty rice, powder dust, weight loss and bad taste. The economic expenses and involving cost in applying radiation heating and chemical were calculated and compared. The cost structure of rice milling business consist of 2 groups include fixed cost equal to 5,385,256 baht (2% of total cost) and variable cost equal to 274,922,345 baht (98% of total cost). The rate of return in rice milling was 19,020 ton year<sup>-1</sup>. The total cost of using infrared radiation heating application and chemical application equal to 0.3096 and 0.3037 bath kg<sup>-1</sup>, respectively. Therefore, the infrared method increase total cost by 1% or cost increase of 112,218 baht year<sup>-1</sup>.

**Keywords:** Cost, infrared radiation, chemical, rice weevil

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### INTRODUCTION

Rice (Scientific name: *Oryzae sativa* L.) is an important plant for human for several year. The populations of more than half the world consume rice. Thailand has a reputation as an export rice country. The main planting area in Thailand is the northeast region. The mainly type of rice planted is Hom Mali Rice due to it well endurance to dry atmosphere, good price sale and widely marketing. The most popular

Hom Mali planted in the northeast region is Hom Mali Rice 105 which is a high quality rice and unique fragrance. The major planting provinces such as Mahasarakham, Roi-et, Yaksothon, Surin and Sesakhet province (Buanuan, 2009).

Rice is one of an important export goods especially Hom Mali Rice. The quantity and value of the Hom Mali Rice class 2(100%) reported by the Thai rice export association between year 2005-2008 is shown in Table 1. Also major countries of exportation are listed in Table 2.

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Table 1: The export of Hom Mali rice class 2 (100%)

Year	2005	2006	2007	2008
Quantity of export (ton million)	1.15	1.32	1.42	1.20
Total of value (million baht)	20,572	25,038	27,056	33,298
Average value ton <sup>-1</sup> (baht ton <sup>-1</sup> )	17,928	18,961	19,077	27,710

Table 2: The major exportation countries of Hom Mali rice 100% class 2 from Thailand

Country	Unit (ton)			
	2548	2549	2550	2551*
America	263,648	299,732	298,326	274,400
China	244,678	270,125	185,316	83,309
Hong Kong	95,209	105,173	110,535	100,810
Kodivoh	22,279	51,327	110,294	62,691
Singapore	108,899	115,701	85,946	81,875
Etc	412,785	478,436	627,832	598,591
Total	1,147,498	1,320,495	1,418,251	1,201,676

(Department of Agriculture, 2009)

Table 3: Quantity and value of chemical import

Items	Years		
	2003	2004	2005
<b>Insecticide</b>			
Quantity (ton)	6,239	7,745	19,080
Value (million baht)	1,646	2,179	6,589
<b>Fungicide</b>			
Quantity (ton)	4,015	2,429	4,962
Value (million baht)	627	579	914
<b>Herbicide</b>			
Quantity (ton)	12,946	8,697	15,662
Value (million baht)	2,473	2,217	3,260
<b>Other</b>			
Quantity (ton)	489	519	1,189
Value (million baht)	247	118	163
<b>Total</b>			
Quantity (ton)	23,689	19,390	40,893
Value (million baht)	4,991	5,093	10,926

(Department of Agriculture, 2009)

Apart from large area of rice plantation, the northern region also the most growth of rice milling industry. Department of industrial work in 2005 reported that there are more than 29,000 rice mills are scatted in the region which is equivalent to 74.3% of the country (Limpayoonwong, 2009) Nowadays, the rice milling industry is expanding according to the increasing of exportation market.

Therefore, rice storage is very important. There are many types of enemy of rice that deteriorate quality such as *Rhyzopertha dominica* F., Red flour beetle, Siamese grain beetle, Angoumois Grain Moth, Rice weevil and Maize weevil (Suprakan *et al.*, 2009; Mungpaseard *et al.*, 2009). The main enemy of Hom

Mali Rice is Rice Weevil. It is a small insect and grows fast with small amount of food eating. Its deteriorate rice by bite both internal and external rice kernel resulting in damage and loss of rice.

In the present, there are wildy use of agriculture chemical to kill insects during rice storage because of it ease to use, simple technique and convenience. The chemicals used are imported (Rattankosum, 2009). The amount of imported chemical use in agricultural are listed in Table 3.

However, it is known that there are many possible of toxic in human and environment from using chemical. Furthermore, chemical usage is not meet export standard of organic Agriculture Certification Thailand (ATC), Good Manufacturing Practice (GMP) and Hazard Analysis and Critical Control Point (HACCP), if there is residual toxic (Insorn *et al.*, 2009). From those problems, there are many attempts to avoid chemical using such as cleaning the storage, natural substance or controlling atmosphere (Visantanon and Nuanwat, 2005). But these methods could not totally get rid of insects. The used of infrared radiation heating in disinfestations was first reported by (Pan *et al.*, 2007; Ramatchima, 2009). By applying heat to rice for a short period of time, insects are gradually dead. The infrared radiation is also used in drying process for agriculture products.

However, it is necessary to the study of cost in the rice disinfestations between the Infrared radiation heating application and chemical application in order to obtain information in decision making. Therefore, the aims of this research are to study economic expenses and involving cost including fixed cost and variable cost. For example, the fixed cost; rent, depreciation and house and the variable cost; paddy rice, transportation, direct labor, packaging, commission, insurance, rice mill plant fuel, maintenance and factory overhead (Vairabutr, 2009; Prasungsuk, 2009).

## MATERIALS AND METHODS

- Data and information collected by surveying and interview both government and rice milling enterprises from private in Surin province. The information studied were type of insects, rice storage method, organization and business method, cost structure and exportation system
- Cost analysis in this study follows the method reported by (Noomhom *et al.*, 2009; Raturai, 2009). Rate of return was also determined.

## RESULTS

### Rice mill enterprise: Surin province area:

- The majority of the rice milling business characteristic is in the form of company co, Ltd
- From the database of the department of industrial, the listed of licensed enterprises are shown in Table 4
- The licensed enterprises were random sampling for 10 enterprises to visit and collected business data and engineering data. It was found that for the large rice mills were established for more than 25 years. The production was average 60 ton days<sup>-1</sup>. The property value was average 46,681,450 baht. Drying paddy rice was performed using dryer or sun drying. The fuel and energy used mostly was electricity

The J.P. inter rice international co.ltd was chosen as a case study. This is due to the J.P. inter rice international co.ltd is the largest rice mill in the exported only licensed enterprise.

**The business process of the rice mill:** The rice milling process started from buying rice paddy from Farmers, then milling rice and selling rice to consumers abroad. In this study, costs used in this study calculation were collected from cost involving only in the rice milling process in year 2008. The total cost in rice milling business can be divided into 2 types as below:

- Fixed cost such as salary and wage, house depreciation/building office and tool/equipment depreciation. Table 5 is a listed of major properties involving in rice milling business. The depreciation cost of each property was calculated from value divided by its service lift. Therefore, the depreciation cost of whole properties per year is equal to 2,875,256 baht year<sup>-1</sup>. Salary is estimated from 7 office workers and wages are estimated from temporally workers. Therefore, total salary and wages were 2,510,000 baht year<sup>-1</sup>
- Variable cost such as price of paddy, transportation, packaging cost. All costs are listed in Table 6.

From Table 6, the fixed cost equal to 5,385,256 baht or 2% of total cost in year 2008 and variable cost equal to 274,922,345 baht or 98% of total cost.

Table 4: Amount of rice milling (Surin province)

Type of licensed enterprise	Amount (unit)
Exported only	8
Large rice mill plant (>20 ton day <sup>-1</sup> )	47
Medium rice mill plant (6-20 ton day <sup>-1</sup> )	2
Wholesale	21
Rice hub	7
Total	85

Table 5: The properties in rice milling business

Items	Value (baht)	Life (years)	Depreciation cost = value/year (baht years <sup>-1</sup> )
Office/rice milling building	18,000,000	20	900,000
Rice storage building	1,950,000	20	97,500
Rice milling machines	7,200,000	15	480,000
Humidity reduction machines	1,250,000	15	83,333
Truck 6 wheels	15,000,000	15	1,000,000
Big weight	450,000	15	30,000
Small weight	27,000	5	5,400
Flock lift hydraulics	950,000	15	63,333
Small trolley	3,450	5	690
Belt conveyer	1,500,000	10	150,000
Humidity measurement equipment	220,000	5	44,000
Sack sewing machines	52,000	10	5,200
Vacuum bag packing machine	79,000	5	15,800
Total	46,681,450	Total	2,875,256

Table 6: Fixed cost, variable cost and total cost

Items	Value (baht year <sup>-1</sup> )	Percent
<b>Fixed cost</b>		
Salary and wages	2,510,000	
Total property depreciation	2,875,256	
Total of fixed cost	5,385,256	2
<b>Variable cost</b>		
Paddy (14,000 baht ton <sup>-1</sup> )	266,280,000	
Transportation/fuel	3,000,000	
Milled rice packing sacks	5,057,665	
Cord	45,000	
Interest	57,505	
Telephone bill	12,567	
Milling rice energy and water bill	429,358	
Maintenance	24,500	
Factory overhead	15,750	
Total of variable cost	274,922,345	98
Total cost	280,307,601	100
The total paddy quantity (ton year <sup>-1</sup> )	19,020	
Average cost /1 ton of paddy	14,737,51	

## DISCUSSION

### Calculate of the capital rate of return in rice milling business:

**The capital rate of return:** The rate of return for rice milling business come from products sale as shown in Table 7 and 8 such as milled rice sale, broken rice sale, bran sale and hush sale polish and husk.

Therefore, income that rises from milled rice sale was approximately 284,349,000 baht (82.93% of total income) and big rice broken sale was approximately 30,812,400 baht or 8.99% of total income (Table 8).

**The cost comparisons rice disinfestations between infrared radiation heating application and chemical application (Table 9-12):**

- The infrared radiation machine would be applied after milled rice before packaging. The infrared radiation machine would be 200×300×250 cm in size and it will operate at 60°C for 60 sec (1 min) as demonstrated by (Pan *et al.*, 2007).

The rice milling are productivity average 60 ton day<sup>-1</sup> or 60×317 days equal to 19,020 ton year<sup>-1</sup> (19,020,000 kg year<sup>-1</sup>). The operation of infrared machine would be done in a tray with 50×100 cm with one layer of rice. Therefore, in one operation (1 min) can process 25 or 1,500 kg of rice in 1 h or 12 ton day<sup>-1</sup> machine<sup>-1</sup>. The optimal is 5 machines to support rice of 60 ton day<sup>-1</sup>:

$$\begin{aligned} \text{Fixed cost / unit} &= \frac{\text{Fixedcost}}{\text{Products amount year}^{-1}} \\ &= 75,340 / 19,020,000 \\ &= 0.0039 \text{ baht kg}^{-1} \end{aligned}$$

$$\begin{aligned} \text{Variable cost / unit} &= \frac{\text{Variable cost}}{\text{Products amount year}^{-1}} \\ &= 5,815,957 / 19,020,000 \\ &= 0.3057 \text{ baht kg}^{-1} \end{aligned}$$

$$\begin{aligned} \text{Total cost / unit} &= \text{Fixedcost / unit} + \text{variable cost / unit} \\ &= 0.0039 + 0.3057 \\ &= 0.3096 \text{ baht kg}^{-1} \end{aligned}$$

Table 7: The rate of return of rice milling from paddy 1,000 kg

Items	Sale quantity (kg)	Sale price (Baht)	Money total (Baht)	Percent
Milled rice sale	650	23.0	14,950	82.93
Big rice broken sale	90	18.0	1,620	8.99
Small rice broken sale	60	13.0	780	4.33
Rough rice bran sale	40	2.0	80	0.44
Fine rice bran sale	50	8.0	400	2.22
Husk sale	110	1.8	198	1.09
Total	1,000		18,028	100.00

Table 8: The rate of return of rice milling from paddy 19,020,000 kg. (60×317 days = 19,020 ton years<sup>-1</sup>)

Items	Sale quantity (kg)	Sale price (baht)	Money total (baht)	Percent
Milled rice sale	12,363,000	23.0	284,349,000	82.93
Big rice broken sale	1,711,800	18.0	30,812,400	8.99
Small rice broken sale	1,141,200	13.0	14,835,600	4.33
Rough rice bran sale	760,800	2.0	1,521,600	0.44
Rice polish sale	951,000	8.0	7,608,000	2.22
Husk sale	2,092,200	1.8	3,765,960	1.09
Total	19,020,000		342,892,560	100.00

**Note:** Sale price average kg<sup>-1</sup> (rice sale price/amount of output) 18.028 baht kg<sup>-1</sup>

Table 9: The fixed cost of infrared radiation heating application

Items	Amount (unit)	Cost per unit (baht)	Capital money (baht unit <sup>-1</sup> )	Application time (year)	Cost (baht year <sup>-1</sup> )
Infrared radiation machine	5	65,000	325,000	5	65,000
Sack sewing machine	3	17,333	51,999	5	10,340
Total					75,340

Table 10: The variable cost of infrared radiation application

Items	Amount and unit	Price (baht unit <sup>-1</sup> )	Total (baht year <sup>-1</sup> )
Wage of an operator of infrared radiation machine (5× 151×317 = 239,335 baht year <sup>-1</sup> )	5 person	151 (baht day <sup>-1</sup> )	239,335
Wage of an operator of sack sewing machine (3×151×317 = 143,601 baht year <sup>-1</sup> )	3 persons	151 (baht day <sup>-1</sup> )	143,601
Electricity of Infrared radiation machine	5 machine	155.75 (5×155.75×12)	9,345
Electricity of sack sewed machine	3 machine	236.41 (3×236.41× 12)	8,511
Amount of rice sack; size 101 kg	23,168 pieces	45 baht	1,042,560
PE plastic sack; size 49 kg	27,347 pieces	15 baht	410,205
Jumbo sack; size 1,000 kg	15,340 pieces	235 baht	3,604,900
Cord	550 rolls	650	357,500
Total			5,815,957

Table 11: Fixed cost of chemical application

Items	Amount (unit)	Cost per unit (baht)	Capital money (baht unit <sup>-1</sup> )	Application age (year)	Cost (baht year <sup>-1</sup> )
Sack sewing machine	3 17,333	51,999	5	10,340	
Total					10,340

Table 12: Variable cost of chemical application

Items	Amount (unit)	Price (baht unit <sup>-1</sup> )	Total (bahtyear <sup>-1</sup> )
Wage of an operator of sack sewing machine (3×151×317 = 143,601 baht year <sup>-1</sup> )	3 persons	151 (baht day <sup>-1</sup> )	143,601
Electricity of sack sewed machine	3 machines	236.41 (3×236.41×12)	8,511
Amount of rice sack; size 101 kg	23,168 pieces	45 baht	1,042,560
PE plastic sack; size 49 kg	27,347 pieces	15 baht	410,205
Jumbo sack; size 1,000 kg	15,340 pieces	235 baht	3,604,900
Cord	550 rolls	650	357,500
Chemical (1 ton 10.50 baht <sup>-1</sup> )	19,020 ton	10.5	199,710
Total			5,766,987

The cost comparisons of chemical application:

$$\begin{aligned} \text{Fixed cost unit}^{-1} &= \frac{\text{Fixed cost}}{\text{Products amount year}^{-1}} \\ &= 10,340 / 19,020,000 \\ &= 0.0005 \text{ baht kg}^{-1} \end{aligned}$$

$$\begin{aligned} \text{Variable cost / unit} &= \frac{\text{Variable cost}}{\text{Products amount year}^{-1}} \\ &= 5,766,987 / 19,020,000 \\ &= 0.3032 \text{ baht kg}^{-1} \end{aligned}$$

$$\begin{aligned} \text{Total cost / unit} &= \text{Fixed cost / unit} + \text{variable cost / unit} \\ &= 0.0005 + 0.3032 \\ &= 0.3037 \text{ baht kg}^{-1} \end{aligned}$$

### CONCLUSION

Major enemy of Hom Mali Rice during stock is rice weevil. The rice deteriorations caused by rice weevil such as dirty rice, powder dust, weight loss and bad taste. The economic expenses and involving cost in applying radiation heating and chemical were calculated and compared. The necessary information were collected from the J.P. Inter rice International co. Ltd., the largest export rice mill in Surin province.

The cost structure of rice milling business consist of 2 groups include fixed cost equal to 5,385,256 baht (2% of total cost) and variable cost equal to 274,922,345 baht (98% of total cost).

The rate of return in rice milling was 19,020 ton year<sup>-1</sup>. The income from rice sale was approximately 284,349,000 baht year<sup>-1</sup> (82.93% of total income) and from broken rice sale was approximately 30,812,400 baht (8.99% of total income). The total cost of using infrared radiation heating application and chemical application equal to 0.3096 and 0.3037 bath kg<sup>-1</sup>, respectively. Therefore, the infrared method increase total cost by 1% or cost reduction of 112,218 baht year<sup>-1</sup>.

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