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

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Abstract

Background: 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.

Objective: 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$^{-1}$. 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 bath kg$^{-1}$, 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$^{-1}$. The total cost of using infrared radiation heating application and chemical application equal to 0.3096 and 0.3037 bath kg$^{-1}$, respectively. Therefore, the infrared method increase total cost by 1% or cost increase of 112,218 baht year$^{-1}$.

Keywords: Cost, infrared radiation, chemical, rice weevil

INTRODUCTION

Rice (Scientific name: *Oryza 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 105 which is a high quality rice and unique fragrance. The major planting provinces such as Mahasarakham, Roi-et, Yaksothon, Surin and Sesakhet Province (W. Buamuan, 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⁻¹ (baht ton⁻¹) | 17,928 | 18,961 | 19,077 | 27,710 |

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

| 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 | 110,535 | 110,535 | 110,535 |
| Etc       | 412,785 | 478,436 | 627,832 | 598,591 |
| Total     | 1,147,498 | 1,320,495 | 1,418,251 | 1,201,676 |

(From Department of agriculture, Thailand, 2009)

### Table 3: Quantity and value of chemical import

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

(From Department of agriculture, Thailand, 2009)

### MATERIALS AND METHODS

- Data and information collected by surveying and interviewing 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 (A. Noomhom et al., 2009; O. Raturai, 2009). Rate of return was also determined.

### RESULTS

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 scattered in the region which is equivalent to 74.3% of the country. (B. Limpayoonwong, 2009) Nowaday, 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 (C. Suprakan et al., 2009; N. 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 wildly 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 (C. Rattankosum, 2009). The amount of imported chemical use in agricultural are listed in Table 3.

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 (A. Vairabutr, 2009; S. Prasungsuk, 2009).

### RESULTS
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 per days. 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.

Table 4: Amount of rice milling (Surin province)

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

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:

1. Fixed cost such as salary and wage, house depreciation/building office and tool/equipment depreciation etc. 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\(^{-1}\). 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\(^{-1}\).

2. 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 6: Fixed cost, variable cost and total cost

| Items                        | Value (baht year\(^{-1}\)) | Percent |
|------------------------------|-----------------------------|---------|
| Fixed cost                   |                             |         |
| Salary and wages             | 2,510,000                   | 2       |
| Total property depreciation  | 2,875,256                   |         |
| Total of fixed cost          | 5,385,256                   |         |
| Variable cost                |                             |         |
| Paddy (14,000 baht ton\(^{-1}\)) | 266,280,000                |         |
| Transportation/fuel          | 3,000,000                   |         |
| Milled rice packing sacks    | 5,057,665                   |         |
| Cord                         | 45,000                      |         |
| Interest                     | 57,505                      |         |
| Telephone bill               | 12,367                      |         |
| 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\(^{-1}\)) | 19,020                  |         |
| Average cost /1 ton of paddy | 14,737,51                  |         |

The total paddy quantity (ton year\(^{-1}\)) was 19,020. 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 8: The rate of return of rice milling from paddy 19,020,000 kg.

(60×317 days = 19,020 ton years⁻¹)

| Items                  | Sale quantity (kg) | Sale price (Baht) | Money (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   | 9.89    |
| 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          | 2.2               | 3,765,960    | 1.09    |
| Total                  | 19,020,000         |                   | 342,892,560  | 100.00  |

### 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 such as milled rice sale, broken rice sale, bran sale 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 9.89% of total income.

### Table 9: The fixed cost of infrared radiation heating application

| Items                          | Amount (unit) | Cost per unit (baht) | Capital money (baht unit⁻¹) | Application time (year) | Cost (baht year⁻¹) |
|-------------------------------|--------------|----------------------|-----------------------------|--------------------------|-------------------|
| 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 (unit) | Price (baht unit⁻¹) | Total (baht year⁻¹) |
|-------------------------------|--------------|---------------------|---------------------|
| Wage of an operator of infrared radiation machine | 5 person | 151 (baht day⁻¹) | 239,335             |
| Wage of an operator of sack sewing machine (3×151×317 = 143,601 baht year⁻¹) | 3 persons | 151 (baht day⁻¹) | 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               |
| PE plastic sack; size 49 kg | 23,168 pieces | 45 baht | 1,042,560           |
| 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⁻¹) | Application age (year) | Cost (baht year⁻¹) |
|-------------------------------|--------------|----------------------|-----------------------------|--------------------------|-------------------|
| 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⁻¹) | Total (baht year⁻¹) |
|-------------------------------|--------------|---------------------|---------------------|
| Wage of an operator of sack sewing machine (3×151×317 = 143,601 baht year⁻¹) | 3 persons | 151 (baht day⁻¹) | 143,601             |
| Electricity of sack sewed machine | 3 machines | 236.41 (3×236.41×12) | 8,511               |
| PE plastic sack; size 49 kg | 23,168 pieces | 45 baht | 1,042,560           |
| 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⁻¹) | 19,020 ton   | 10.5                | 199,710             |
| Total                         |              |                     | 5,766,987           |
The cost comparisons rice disinfestations between infrared radiation heating application and chemical application:

- 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 (P. Zhongli et al., 2007).

The rice milling are productivity average 60 ton day\(^{-1}\) or 60×317 days equal to 19,020 ton year\(^{-1}\) (19,020,000 kg year\(^{-1}\)). 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 hour or 12 ton day\(^{-1}\) machine\(^{-1}\). The optimal is 5 machines to support rice of 60 ton day\(^{-1}\):

\[
\text{Fixed cost / unit} = \frac{\text{Fixed cost}}{\text{Products amount year}} = \frac{75,340}{19,020,000} = 0.0039 \text{ baht kg}^{-1}
\]

\[
\text{Variable cost / unit} = \frac{\text{Variable cost}}{\text{Products amount year}} = \frac{5,815,957}{19,020,000} = 0.3057 \text{baht kg}^{-1}
\]

Total cost / unit = Fixed cost / unit + variable cost / unit = 0.0039 + 0.3057 = 0.3096 baht kg\(^{-1}\)

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\(^{-1}\). The income from rice sale was approximately 284,349,000 baht year\(^{-1}\) (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\(^{-1}\), respectively. Therefore, the infrared method increase total cost by 1% or cost reduction of 112,218 baht year\(^{-1}\).

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