

FACTORS AFFECTING THE PRODUCTION OF EXPORT QUALITY DURIANS BY FARMERS IN CHANTHABURI PROVINCE, THAILAND

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Abstract: The quality of durian fruits is a very important factor which contributes to the confidence of consumers and countries that import durian products, thus helping farmers to face the problem of dramatic drops in the price of durian products. Increasing the quality of durians produced by farmers is important in the process of producing export durians in Thailand. The objective of this research is to study basic economic, social and technological factors in the production of durians, including related factors affecting the potential of farmers in producing quality durian fruits for export. The sample includes 393 durian farmers in Chanthaburi province and descriptive statistics is used to explain the basic characteristics of farmers as well as binary logistic regression to prove factors affecting the farmers' potential. The findings highlighted soil texture, training attendance, durian maturity inspection, spread of pests, branch pruning, application of fertilizer on fruit maturity and income were factors that affected the farmers' potential to produce quality durians for export.

Keywords: Binary logistic regression, tropical fruit, consumers, pests, fertilizer.

Introduction

Thailand is a country with a geographical landscape which is beneficial to various agricultural and farming activities. It has been named "the Kitchen of the World". In 2016, Thailand exported various agricultural products for human consumption, animal feeds and alternative energy. The most important agricultural products exported were rubber (USD 4,413 millions) followed by rice (USD 4,382 millions), cassava (USD 2,925 millions), processed chicken (USD 2,026 millions) and fruits (USD 1,544 millions). Thai fruits include durian, longan, mangosteen, lychee and rambutan.

Durian is the most important fruit and is called "the King of Fruits" in Thailand. Presently, Thailand has become the biggest exporter of durians in the world. From 2006-2015, about 294,479 tons of durians per year were exported, with an export value on average

of USD 212 million per year, or 41.21% of overall fruit export (Office of Agricultural Economics, 2015a). "Monthong" durian is regarded by sellers and durian transforming sellers as the best durian variety that has a good taste, thick flesh, not a very strong smell and is able to maintain its freshness for a longer period of time. Its quality is consistent and can be transformed into other quality products needed by the markets. Furthermore, 93.81% of all Monthong products have been exported by Thailand, increasing export value by 12.32% per year.

Important partner countries for Thailand include the Republic of China, Hong Kong, Indonesia and Taiwan (Office of Agricultural Economics, 2015b). Important competitor countries include Vietnam and Cambodia, where fresh durians from both countries are of very good quality. It is expected that, in the future, these two countries will be important competitor countries to Thailand (Angyurekul & Soratana,

2014). The increase in the demand by overseas markets is causing the price of fresh durians to increase. This factor should stimulate farmers to convert to growing durians instead of “Para rubbers” and other fruits. In 2015, statistics showed that Thailand had 109,853 hectares of farmland for growing durians, with the largest area in eastern Thailand, in the provinces of Chanthaburi, Rayong and Trad.

In 2015, these provinces had an overall farmland area of 46,571 hectares, with 337,618 tons of durian products, estimated at 55.96% of the overall products in the country. The highest potential province for producing durians and also one with the highest quality is Chanthaburi province, which has approximately 31,543 hectares for growing durians and with approximately 234,524 tons of durian products, or 38.96% of the total products in the country and has durian products per farmland of 8,775 kilograms per hectare, which is the highest ratio product for the country (Office of Agricultural Economics, 2015c). Furthermore, Chanthaburi province is also the biggest producer of fresh durians in the country, as more than 90% of the exporters have farm plants for selecting and packing durian products in Chanthaburi. For these reasons, the researcher has chosen Chanthaburi farmers as the sampling population for this study.

Although Thailand ranks first as a durian exporter country in the world, there are still some problems associated with toxic residues, chemical or biological contamination and early maturity durian cuttings. These are the major problems which may cause durian importer countries to decrease the amount of durians imported from Thailand (Yiemchawe, 2003). These problems are caused by improper farmland management using unauthorized chemicals and using overdose of chemicals beyond the country's regulations (Visarathanonth, 1999). These factors not only affect export but also affect production costs and farmers' health.

Nowadays, consumers have a better understanding of the dangers of chemical substances and prefer to consume products free

from chemical substances and, consequently, many countries have converted to implementing a non-tariff barrier on agricultural products under the agreement on the application of sanitary and phytosanitary measures of the World Trade Organization (WTO). Any partner countries which have not implemented the agreement will face decreasing selling prices, decreasing needs of overseas consumers and delays of import products.

In 2016, Indonesia announced quota regulations and chemical residue inspections for imported fruits and vegetables. These measures have resulted in Thailand losing nearly 50% of fresh durian export to Indonesia. On the other hand, the price of durians in Thailand has dropped lower than previously (Office of Agricultural Economics, 2016). The problem of early maturity durians, which is a regular occurrence, may be due to many factors such as the shape of the Monthong durians and the cultivation of durians before the appropriate maturity period to avoid the period of low prices. Due to these problems, the National Bureau of Agricultural Commodity and Food Standards (ACFS, 2013) has implemented measures for the quality and safety control for fresh durians for export, so that qualified farmers who can sell durians for export should have the certifications guaranteeing their implementation following the Good Agriculture Practice or Q-GAP. The standard regulations for qualified fresh durians are that there are no deformations or blemishes, must be 1.5 - 6.0 kg of fresh weight for each and dry weight must not be lower than 32% of fresh weight. As a result, the Thai government organised various training courses for durian farmers such as the technology for producing quality durians, Q-GAP durian production standards and pest control and elimination. By 2015, nearly 60% of farmers in Chanthaburi province had attended these courses. As a result, around 75% of all the products in the province were of higher quality and were exported. In contrast, between 2013-2015, durian products which passed Q-GAP Standard decreased by 9.20% on average (National Statistical Office, 2015). Although durian products exported were

75% of all products, the number of farmers who could produce standard durians was still lower than expected. Therefore, it is necessary to find methods to solve problems of durian production to increase the quality of the durians which farmers could produce more efficiently. This was done by studying factors that affected the production of quality durians and understanding the appropriate models of management of durian production. This knowledge would help solve the problems that farmers were facing with low price of durian products. It would also create greater acceptance for overseas consumers and enhance competition in the free trade market system of Thailand.

Methodology

Study Area

Durian is a fruit which requires a humid climate, a temperature of 10-46 degrees Celsius, rainfall between 1,600-3,000 mm per year and relative

humidity of more than 30%. Chanthaburi province is one of the best durian-growing areas of Thailand. It is located in the eastern part of the Gulf of Thailand (latitude 12° 37' north and longitude 102° 07' east), has a total farmland area of 633,800 hectares, an average temperature of between 27.4-32.2 degrees Celsius and rainfall of 1,600-2,000 mm per year in the north and east. The central and southern regions of the province receive 2,500-3,000 mm of rain per year. Most of the farmlands are located 30-190 meters above sea level and some are in gently sloping areas, about 1-5 meters above sea level (Climatological Center, 2014). Detailed information of durian farmers in Chanthaburi province is shown in Table 1.

Data Collection

This survey research involved farmers who had grown durians in Chanthaburi province which had a population of 20,958 people, according to the name list of the Department of Agricultural

Table 1: Detailed information of durian farmers in Chanthaburi province.

District	Number of household (Persons)	Cultivated farmland (Hectares)
MueangChanthaburi	799	1,266.88
Khlung	3,436	6,281.60
Tha Mai	7,736	10,664.48
Pong Nam Ron	944	1,840.64
Makham	3,084	3,741.28
Laem Sing	317	253.28
Soi Dao	87	80.80
Kaeng Hang Maeu	558	728.80
Na Yai Am	1,493	1,157.12
KhaoKhitchakut	2,504	5,528.00
Total	20,958	31,542.88

Source: National Statistical Office (2015)

Extension (2015). Calculating for population sample size by applying Yamane's Formula (1973), with a discrepancy level at 5%, 393 samples were used and the data was collected during the durian production for the years 2015/16.

A structured interview was applied, involving basic factors in economic, social and technological aspects of durian production. All questionnaires had been tested with 30 durian farmers in Sisaket province, which is one of the major durian-growing regions in Thailand. A Cronbach's alpha value was set at 0.77 and data collection was conducted in Chanthaburi province by simple random sampling. Following this, the researcher conducted purposive sampling, particularly with farmers' groups who passed the standard of ACFS. The researcher then classified farmers into two groups: "potential farmers" and "non-potential farmers", by using the average of sample farmers as the mean, where potential farmers were those that had a ratio of quality durians more than or equal to the mean and the rest of the sample farmers were non-potential farmers.

Variables Related to Producing Quality Durians for Export

The factors influencing productivity and production efficiency of durian production which tend to make farmers produce quality durians for export were factors which relate to socio-economic characteristics such as gender, age, education level, income, size of farm, labor, membership and status in society (Son, *et al.*, 1993; Krasachat, 2012; Alwarritzia, *et al.*, 2015; Parichatnon *et al.*, 2017). Besides, there are direct factors which influence the quality of the durians, such as farmland preparation for growing durians (soil texture improvement, sufficient water source and pest prevention and elimination), care of the durians (water and fertilizer management, limb, flower and fruit pruning) and cultivation (Department of Agricultural Extension, 2000; Hirunpradit *et al.*, 2003). All these factors which are of interest to the researcher are shown in Table 2.

Data Analysis

Binary logistic regression is the analytical technique in which corresponding variables are qualitative variables and will be classified into 2 small groups: those which are 1 means that there is occurrence of an event of interest while 0 means that there is no occurrence of an event of interest. Besides, the relationship between the independent variable and corresponding variable will explain the possibility of an event of interest.

As logistic regression is not linear, it will be adjusted in the line, in the ratio of possibility of occurrence of an event of interest $\Pr(Y_i = 1;$ potential farmers) compared to the possibility of no occurrence of an event of interest $\Pr(Y_i = 0;$ non-potential farmers) known as the "odds ratio", where if the odds ratio > 1 , there is a possibility that there is an occurrence of an event of interest more than the other event. On the other hand, if odds ratio < 1 , there is a possibility of an event of interest less than the other event. Logistic functions are written in log of odds ratio where details are shown in equations 1-4 as follows:

$$\Pr(Y_i = 1) = P_i = \frac{1}{1 + e^{-f(x_i)}} = \frac{e^{f(x_i)}}{1 + e^{f(x_i)}} \quad (1)$$

$$\Pr(Y_i = 0) = 1 - P_i = \frac{1}{1 + e^{f(x_i)}} = 1 - \left(\frac{e^{f(x_i)}}{1 + e^{f(x_i)}} \right) \quad (2)$$

$$\frac{\Pr(Y_i = 1)}{\Pr(Y_i = 0)} = \frac{P_i}{1 - P_i} = e^{f(x_i)} \quad (3)$$

$$L_i = \ln \left(\frac{P_i}{1 - P_i} \right) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \varepsilon \quad (4)$$

Where, L_i is the log of the odds ratio (logit model), e is the inverse function to natural logarithms, α is a constant; X_1, X_2, \dots, X_k are independent variables, $\beta_1, \beta_2, \dots, \beta_k$ are estimated parameters corresponding to each independent variable, k is the number of independent variables and ε is the random error term. The details of the variables involved in this study, both independent (X_i) and dependent variables (Y_i) used in the binary logistics analysis are in Table 2.

Table 2: The variables used in the binary logistic regression analysis.

Variables	Description	Expected sign
Potential of farmers in producing durian for export (Y)	(1 = Potential farmers - Through durian standards of ACFS. - Proportion of quality durian more than the average of the province. 0 = Otherwise)	
Socio-economic characteristics		
Sex (X_1)	(1 = Male, 0 = Female)	-
Age (X_2)	(Years)	+
Experience (X_3)	(Years)	+
Income (X_4)	(US dollars /year)	+
Labour (X_5)	(People)	+
Area (X_6)	(Hectare)	-
Training attendance (X_7)	(1 = Attendance, 0 = Otherwise)	+
Production technology		
Soil texture (X_8)	(1 = Loam or sandy loam, 0 = Otherwise)	+
Spread out of pest (X_9)	(1 = Severe, 0 = Otherwise)	-
Pruning (X_{11})	(Times/year)	+
Fertilizing during the fruit development (X_{10})	(Times/year)	+
Fruit thinning (X_{12})	(Times/year)	+
Maturity Inspection (X_{13})	(1 = The count of days after flowering, 0 = Otherwise)	+

Results and Discussion

Socio-economic Characteristics and Production Technology of Farmers

The study found that there were two groups of farmers in Chanthaburi province: potential farmers and non-potential farmers. The potential farmers were defined as those who could produce quality durians of which 73.06% of all durians they produced could be exported and non-potential farmers were farmers who could produce quality

durians of which less than 73.06% of the durians they produced could be exported. There were 237 potential farmers with 82.11% on average of all durian products were quality products and only 156 non-potential farmers who produced 59.31% durians that could be exported as quality products. However, means and percentages of some factors were not different in both groups, including gender (70.23% male), age (51.02 years), farming experience (24.90 years), labour used (2.84 head) and size of farms (2.75 hectares).

There were some interesting factors which showed differences of average mean and percentages between the two groups, including farmers' income, attendance at training courses supported by government sectors, soil type and spread of pests. For their income, the two groups had a difference of USD 9,213.38 per year between them, with potential farmers earning USD 29,938.75 per year while the non-potential farmers had an average annual income of USD 20,725.37. It was found that 78.90% of potential farmers had attended training courses

operated by the government sectors but only 62.18% of the non-potential farmers had attended the courses. Moreover, 70.04% of potential farmers had grown durians in loamy or sandy loamy soil but only 48.08% of non-potential farmers had grown durians in these soils. The methods of producing durians differ between the two groups. Potential farmers faced the spread of pests severely, an average of 40.93%, while the other group faced a much higher hazard of spread at 63.46%. The important durian pests were root and stem rot disease, pink disease and durian psyllid.

Table 3: Characteristics of farmers

Variables	Potential farmers (n = 237)	Non-potential farmers (n = 156)	Total (n = 393)
Percentage of quality durian (%)	82.11 ± 6.77	59.32 ± 12.45	73.06 ± 14.62
Age (Years)	51.23 ± 9.76	50.70 ± 10.00	51.02 ± 9.85
Experience (Years)	26.12 ± 11.26	23.05 ± 10.14	24.90 ± 10.92
Income (US dollars/year)	29,938.75 ± 20,399.66	20,725.37 ± 17,294.44	26,281.52 ± 19,727.49
Labour (People)	2.94 ± 1.31	2.70 ± 1.42	2.84 ± 1.36
Area (Hectare)	2.93 ± 2.21	2.46 ± 1.85	2.75 ± 2.08
Pruning (Times/year)	1.82 ± 0.54	1.86 ± 0.71	1.84 ± 0.61
Fertilizing during the fruit development (Times/year)	4.37 ± 1.31	4.01 ± 1.36	4.23 ± 1.34
Fruit thinning (Times/year)	2.12 ± 0.71	2.28 ± 0.75	2.19 ± 0.73
Sex (%)			
Male	74.26	64.10	70.23
Female	25.74	35.90	29.77
Training attendance (%)			
Yes	78.90	62.18	72.26
No	21.10	37.82	27.74
Soil texture (%)			
Loam or sandy loam	70.04	48.08	61.32
Otherwise	29.96	51.92	38.68
Spread of pest (%)			
Hazard	40.93	63.46	49.87
Otherwise	59.07	36.54	50.13
Maturity Inspection (%)			
Days after bloom	91.14	92.31	91.60
Otherwise	8.86	7.69	8.40

Table 4: Factors affecting potential farmers to produce quality durians for export.

Variables	B	S.E.	Wald	Sig.	Odd ratio
Sex	0.26	0.25	1.11	0.29	1.30
Age	-0.01	0.02	0.08	0.78	0.99
Experience	0.01	0.02	0.12	0.73	1.01
Income	0.00	0.00	9.25	0.00***	1.00
Labour	0.05	0.10	0.28	0.60	1.06
Area	-0.01	0.01	1.09	0.30	0.99
Training attendance	0.69	0.28	5.99	0.01**	1.98
Soil texture	0.82	0.24	11.51	0.00***	2.27
Spread of pest	-0.47	0.26	3.28	0.07*	0.63
Pruning	-0.45	0.20	5.22	0.02**	0.64
Application of fertilizer during fruit development	0.18	0.09	3.97	0.05**	1.19
Fruit thinning	-0.27	0.16	2.89	0.09*	0.77
Maturity inspection	-0.74	0.43	2.97	0.09*	0.48
Constant	0.80	1.10	0.53	0.47	2.23

Correctly predicted (Count R²) = 69.72

***, ** and * significant at $p \leq 0.01$, $0.01 < p \leq 0.05$ and at $0.05 < p \leq 0.1$, respectively.

On other applications, it was found that the results did not differ much for both groups of farmers fertilizing about 4-5 times per year, pruning 1-2 times per year and fruit thinning 2-3 times per year. In addition, 91.14% of potential farmers and 92.31% of the other group had inspected the maturity of durians by counting 120days after bloom (for Monthong durians). Other characteristics which were popular for inspection were attributes of branch and fruit, colour of peel and colour of durian pricker, peel knocking or fruit punching to inspect flesh colour and seed colour as shown in Table 3.

Factors Affecting the Potential of Farmers to Produce Quality Durians for Export

Thirteen factors affect the potential of farmers to produce durians for export: gender, age,

experience, income, labour used, size of farms, training attendance, soil texture, spread of pest, pruning and application of fertilizer during fruit development, fruit thinning and maturity inspection. Table 4 shows that there were 8 variables which significantly influence the potential farmers to produce good quality durians for export at 90 per cent or higher level of significance using the logit model which includes spread of pest, fruit thinning, maturity inspection, training attendance, application of fertilizer during fruit development, pruning, income and soil texture.

Soil Texture

Soil texture was highly significant ($p \leq 0.01$) and positive indicating that, if farmers grow durians on loam or sandy loam, the probability to be potential farmers producing quality durians

for export will be 2.27 more than farmers who grow durians on other types of soil. Soil texture is affected by humidity in the soil which is very important for growing durians. Durians need a period of drought or summer to activate flower buds and fertilization (Department of Agricultural Extension, 2000).

Subhadrabandhu and Ketsa (2001) stated that durians are unique in that the roots, known as fungus roots, absorb nutrients and water. The roots are shallow and grow only 45 - 50 cm from the soil surface so that if the soil texture is too sandy, water would pass through easily and this would cause a lack of water for the durian fruits. However, if the soil texture is too clayey, the soil compacts too easily causing the roots to lack air, causing root rot. Pusiri (1984) stated that durians grown in clay tend to grow slower and have less fruits than durians grown in loam or sandy loam soil.

Training Attendance

Attendance at training courses had a positive influence on potential farmers to produce durians for export ($p \leq 0.05$), which means that if farmers had attended training courses, the probability for them to produce quality durians for export would be 1.98 times more than farmers who had not attended training courses. If farmers had complete information, knowledge and experience in proper management of durian orchards from training courses including production technology, Q-GAP standard and pest management, they could produce more quality durians for export. In addition, Srisopaporn *et al.* (2015) reported that farmers who attended seminars and training courses benefitted from information exchange, knowledge, learning, sharing of experiences between farmers and government officers and they could apply all the knowledge to their farms.

Ripening Check

Ripening check by counting 120 days after full-bloom had a significant and negative effect ($p \leq 0.10$) indicating that farmers who checked durian ripening by counting 120 days after full-

bloom as the only method had the probability to be potential farmers producing quality durians for export 0.48 times less than farmers who checked the ripening using multiple methods. Although the Department of Agricultural Extension (2000) recommended that farmers check ripening of durians by counting 120 days after full-bloom, some researchers found that Monthong durians could be ready for harvest when they were 106 days after full-bloom (Kunjet *et al.*, 2002), while Sangwanangkul (1998) found that they were ready 113 days after full-bloom. While counting the days after blooming of durian flowers is a basic and easy method to check the ripening of durians before harvest, there are many factors which may cause errors such as cultivar, age of tree, variation of fruit set, farm management (fertilizing, pruning, thinning) humidity, quantity of rain and temperature (Kosiyachinda, 1995).

Spread of Pest

The spread of pest had a negative effect on the potential of farmers to produce durians for export ($p \leq 0.10$), which means that with a severe spread of pest, the effect would be on a fewer potential farmers who could produce durians for export than farmers who did not have a severe spread of pest. Since farmers did not have proper management skills, the severe spread of pest caused damage to the durian products both in quality and quantity (Visarathanon, 1999) through improper cultivation such as cutting durians and leaving them down to the roots which are the sites for disease to spread and therefore, durian products had a high possibility of getting root disease (Ruamngow, 2000).

Branch Pruning

Branch pruning had a significant but negative effect ($p \leq 0.05$) on farmers to be potential durian farmers. This indicates that if farmers increased the frequency of branch pruning, the probability of farmers being potential farmers would decrease by 0.64 times compared to farmers who performed less frequent pruning. Normally, productive branches should be 4-10 cm in

diameter and are in position to photosynthesis, thus pruning is necessary to encourage growth of strong and productive durian trees. After fertilizer and manure are applied following harvest (Hirunpradit *et al.*, 2003), farmers should remove unused, dried, diseased and damaged branches to promote the emergence of new shoots. The main trunk and primary branches can be trimmed regularly to obtain a good shape (Surmsuk Salak patch, 2005; Department of Agricultural Extension, 2000). But there was an interesting evidence showing that some farmers who had pruned more than four times per year produced export durians of lower quality than average.

Fruit Thinning

Fruit thinning had a significantly negative effect ($p \leq 0.10$), *i.e.*, if farmers thin small or deformed fruits once, the probability of being potential farmers would decrease by 0.77 times. The first thinning should be done at 4-5 weeks after flowers fully bloomed and fruits on the trees should be 2-3 times more than farmers expect trees to be able to hold then. About one week after the first thinning, slow-growing fruits, damaged fruits and small fruits should be thinned. However, thinning should not be done more than 5 times (Surmsuk Salak patch, 2005). Furthermore, if farmers could not thin all useless fruits, they should be allowed to grow and fall before maturing.

Application of Fertilizer During Fruit Development

Application of fertilizer during the fruit development stage has a positive influence on farmers being potential durian farmers ($p \leq 0.05$), which means that, if farmers increased one-time fertilizer application during fruit development period, there would be an increase of 1.19 times for them to be potential farmers. During the fruit development period, farmers were likely to use fertilizers which had high phosphorus and potassium but low nitrogen content (12-12-17 or 8-24-24 or 13-13-21). This would be applied when fruits were 5-7 weeks after full bloom

(Surmsuk Salakpatch, 2005). Also, during this period, decreasing the level of nitrogen would keep durians from having new leaves, so durian fruits would not fall down, durian shape would not be changed or distorted and they would have regular quality of flesh (Hirunpradit *et al.*, 2003). In addition, the fertilizer applied two months before flowering should have a low N, high P and K content with the aim of preventing the appearance of new leaves and helping existing leaves to mature. This is to avoid competition for nutrients and enhancing flower initiation. Moreover, using fertilizers to create a long, dry period after the completion of leaf development to limit vegetative growth of the tree, then applying plenty of water would induce flowering.

Income

Income had a significant positive effect ($p \leq 0.01$) on farmers to be potential durian farmers. If farmers had higher income, they would have a 1.00-time higher probability of being potential farmers because income from the price of export durians was higher than regular durians in the market (Thanh & Yapwattanaphun, 2015). This is an important motivation to farmers to give more attention to growing durians. In addition, farmers who had higher income could afford higher quality inputs for producing durians than farmers who had less income (Phitthayaphinant *et al.*, 2015).

Conclusion

The quality of durians is an important factor which tends to build up more confidence among durian consumers and the durian importer countries. It can also solve the problems farmers face due to decreasing prices of durian products. Therefore, conducting research on factors which influence the production of higher quality durians will result in higher income for farmers and hence enhance their well-being. In this study, the researcher applied binary logistic regression to estimate these factors. The results show that in Chanthaburi province, potential farmers are defined as those who could export

at least 73.06% of the durian products, but in actual fact, on average, they could export 82.11% of their products. The others are non-potential farmers who could export only 59.32% of their products. Four significant factors affecting positively the probability of farmers becoming potential farmers are: soil texture, training attendance, application of fertilizer during fruit development and income. These factors are very important for durian cultivation. Quality fruit development, farm management before and after harvesting and higher durian price were important motivating factors that would encourage farmers to produce high quality durians for local consumption and the international market. Some factors that prevent farmers from converting to become potential farmers include ripening check by counting 120 days after blooming as the only method, the hazards of the spread of pest, frequency of branch pruning and fruit thinning. These factors are directly related to farm management. Farmers should manage their farms based on the recommendations and suggestions from academic researchers and agricultural technicians from the Department of Agriculture of Thailand. Farmers should check the ripening of durians using at least two methods, pest management needed under Thai regulations and pre- and post-harvest management for the next production period. Furthermore, farmers should attend training courses and follow the schedules of the standard of GAP to completely and consistently enhance the quality and safety level of their durian products. For solving the problem of young durian cuttings, government sectors should stimulate the mind of farmers to recognize the effects and social responsibilities of producing quality durians for export.

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References

- ACFS. (2013) Thai agricultural standard. The National Bureau of Agricultural Commodity and Food Standards [in Thai]. Retrieved from http://www.acfs.go.th/standard/download/DURIAN_new.pdf.
- Adesina, A.A., Mbila, D., Nkamleu, G.B. & Endamana, D. (2000). Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon. *Agriculture, Ecosystems & Environment*, 80(3), 255-265.
- Alwarrizia W., Nansekib T., & Chomeic Y. (2015). Analysis of the factors influencing the technical efficiency among oil palm smallholder farmers in Indonesia. *Procedia Environmental Sciences*, 28, 630-638.
- Angyurekul, N. & Soratana, S. (2014). Synthesis of longan and durian's supply chain towards support policy under ASEAN economic community. Project final report: The Thailand Research Fund [in Thai]. Retrieved from https://elibrary.trf.or.th/project_content.asp?PJID=RDG5520021.
- Climatological Center. (2014). Climate in Chanthaburi. Climatological Center, Meteorological Department [in Thai]. Retrieved from <http://www.climate.tmd.go.th/data/province>, Department of Agricultural
- Extension. (2000). *Handbook of Durian Production: A Guide to Good Agricultural Practices (GAP)*. Agricultural Co-operative Federation of Thailand, Bangkok [in Thai]. 54 pp.
- Department of Agricultural Extension. (2015) Agricultural production information system. Information Technology and Communication Centre, Department of Agricultural Extension [in Thai]. Retrieved from http://production.doe.go.th/report/report_main_land_02_A_new_2.php.
- Hirunpradit, H., Chandraparnik, S. & Salakpetch, S. (2003). *Durian Production Technology*,

- 3rd edition. Kasetsart University, Bangkok [in Thai]. 206 pp.
- Kosiyachinda, S. (1995). *Durian fruit: Harvest and postharvest processes*. Horticulture Research Institute, Department of Agriculture, Bangkok [in Thai]. 90 pp.
- Krasachat, W. (2012). Organic production practices and technical inefficiency of durian farms in Thailand. *Procedia Economics and Finance*, 3, 445-450.
- Kunjet, S., Sangwanangkul, P. & Siriphanich, J. (2002). Effects of ethephon on development and quality of durian fruit cv. Monthong after harvested. *Agricultural Science Journal*, 33(6), 40-44.
- National Statistical Office. (2015). Information management for the area: Chanthaburi [in Thai]. Retrieved from http://chanthaburi.nso.go.th/index.php?option=com_content&view=article&id=189:10&catid=85&Itemid=513.
- Office of Agricultural Economics. (2015a). Export information of agricultural commodities [in Thai]. Retrieved from http://www.oae.go.th/fruit_report/export_import/export.php.
- Office of Agricultural Economics. (2015b). Thailand trade and trade partners [in Thai]. Retrieved from http://www.oae.go.th/oae_report/country_profile/t1.php.
- Office of Agricultural Economics. (2015c) Agricultural information from 2013 to 2015: Durian [in Thai]. Retrieved from <http://aginfo.oae.go.th/ewtnews/durian.html>.
- Office of Agricultural Economics. (2016). *Situation and trend of agricultural products in 2015*. Bureau of Agricultural Economic Research, Office of Agricultural Economics, Bangkok [in Thai]. 239 pp.
- Parichatnon, S., Maichum, K., & Peng, K. (2017). Application of the Malmquist Productivity Index on measurement of productivity trend of durian production in Thailand. *International Journal of Business Marketing and Management*, 2(4), 01-09.
- Phitthayaphinant, P., Somboonsuke, B., Eksomtramage, T. & Satsue, P. (2015). Factors determining farmers' choice of oil palm production system in Ao-luek district, Krabi province. *Journal of Liberal Arts*, 7(1), 126-142.
- Pusiri, S. (1984). *Durian*. Trang College of Agriculture, Trang [in Thai]. 237 pp.
- Ruamngow, S. (2000). *Control of Postharvest Fruit Rot of Durian Caused by Colletotrichum gloeosporioides, Lasiodiplodiatheobromae and Phomopsis sp.* M.S. Thesis. Kasetsart University, Bangkok, 64 pp.
- Sangwanangkul, P. (1998). *Growth and Development of Durian Fruit cv. Monthong and the Effect of Ethephon Pre-harvest Treatment*. M.S. Thesis. Kasetsart University, Bangkok, 116 pp.
- Son, T.V.H., Coelli, T. & Fleming, E., (1993). Analysis of the technical efficiency of state rubber farms in Vietnam. *Agricultural Economics*, 9(3), 183.
- Srisopaporn, S., Jourdain, D., Perret, S.R. & Shivakoti, G. (2015). Adoption and continued participation in a public good agricultural practices program: The case of rice farmers in the central plains of Thailand. *Technological Forecasting and Social Change*, 96, 242-253.
- Subhadrabandhu, S. & Ketsa, S. (2001). *Durian: King of tropical fruit*. CABI Publishing, New York. 178 pp.
- Surmsuk Salakpetch. 2005. Durian (*Duriozibethinus L.*) Flowering, Fruit Set and Pruning pp17-16. *Proceedings of 5th Annual International Tropical Fruit Conference October 21-23, 2005 Hilo Hawaiian*.
- Thanh, N.V. & Yapwattanaphun, C. (2015). Banana farmers' adoption of sustainable agriculture practices in the Vietnam uplands: The case of Quang Tri

- province. *Agriculture and Agricultural Science Procedia*, 5(2015), 67-74.
- Visarathanonth, N. (1999). *Durian disease*. Department of Plant Pathology, Faculty of Agriculture, Kasetsart University, Bangkok [in Thai]. 29 pp.
- Yamane, T. (1973) *Statistics: An introduction analysis*, 3rd edition. Harper & Row, New York. 919 pp.
- Yiemchawe, C. (2003). *Factors Influencing Quality of Durian Fruit cv. Monthong Exported to Taiwan*. M.S. Thesis. Kasetsart University, Bangkok, 84 pp.