The Design of a Forecasting Support Models on Demand of Durian for Export Markets by Time Series and ANNs

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Abstract

Nowadays, Durian is the most important exported fruit of Thailand. The export value of durian is approximately 144.87 million USD per year and growing increasingly. The problem in this durian product has been oversupply since the product has been brought out into the market simultaneously; causing durian growers sell their product lower than cost price. In order to avoid the problem of durian exceeds the needs of consumers. Therefore, the objective of this research is to design the forecasting model of the demand of durian in export markets. This research is to find for forecasting demand of four kinds of durian: fresh durian, frozen durian, durian paste and durian chips in the next year. Firstly, applying Output models the four Time Series by Moving Average, Deseasonalised, Exponential Smoothing and Double Exponential Smoothing, secondly, applying Input models: Regression model and Artificial Neural Networks (ANNs) model. The forecast model which has the least value of Mean Absolute Percentage Error (MAPE) is the most accurate forecast model. The results of Output models reveal that the most accurate forecast model is Deseasonalised model which gives the least value of MAPE in three kinds of durian: 1) durian paste at the percentage of 8.66, 2) frozen durian at the percentage of 9.78 and 3) fresh durian at the percentage of 19.24 while Input models reveal that the most accurate forecast model is Artificial Neural Networks (ANNs) model gives the least value of MAPE of durian chips at the percentage of 29.76. After attaining the accurate forecasting model, this is applied with the Linear Programming (LP) model to assess the value of appropriate quantity for domestic and export markets of four kinds of durian for the maximum profit in the following year. The maximum profit quantity of each kinds of durian able to helpful to the durian growers are able to sales planning and processed durian that are the most profitable.

Keywords*: Durian, Forecasting, Moving Average, Depersonalized, Exponential Smoothing, Double Exponential Smoothing, Artificial Neural Networks (ANNs) model and Linear Programming (LP) model*

1 Introduction

At present there are more than 290,000 acres growing durian in Thailand and 266,975 acres produced good production. Two regions are of Thailand such as 1) The Eastern part of Thailand namely Chantaburi, Rayong and Trad 2) The Southern part of Thailand namely Choomporn, Surat Thani, and Nakorn Sri Thammarat. Beside Thailand is the world biggest exporter of durian as fresh durian, frozen durian, durian paste and durian chips, as shown in the Figure 1. Percentage of quantity demand of each type of durian in export markets in 2008, from The Cooperation of the Office of Agricultural Economics and the customs year [1].

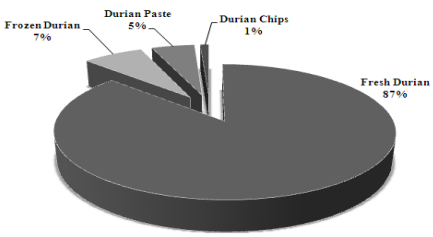

Figure 1: Percentage of quantity demand of each type of durian in export markets in 2008

The main export markets of durian are the Republic of China, Hong Kong, Indonesia and other, from the Office of Agricultural Economics [2] as shown in Figure 2.

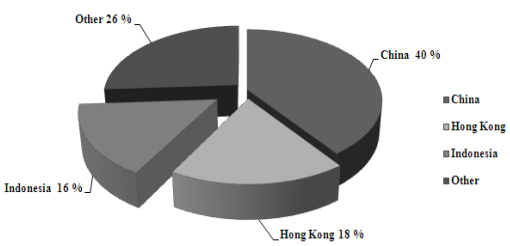

Figure 2: Percentage of durian export for each country

In 2008 the export volume is 222,559 tons as the amount of 122.26 million USD and 2009 the export volume is 272,200 tons as the amount of 144.87 million USD comparatively. The volume and value of export of 2008 to 2009 are found that the export volumes in the export markets are less than the domestic market gradually. The export value increased very few amount that from The Cooperation of the Office of Agricultural Economics and the customs year [1]. The farmers get the lower price at the increasing of cost of production that from the Office of Agricultural Economics [3] as shown in the Figure 3.

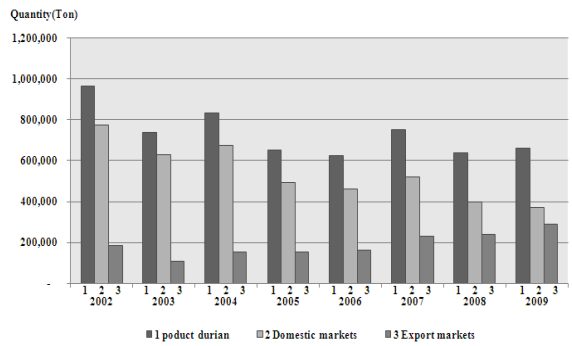

Figure 3: The comparison of domestic and export sale volume of durian production quantity

The Markets structure of the sale of domestic and export markets as shown in Figure 4.

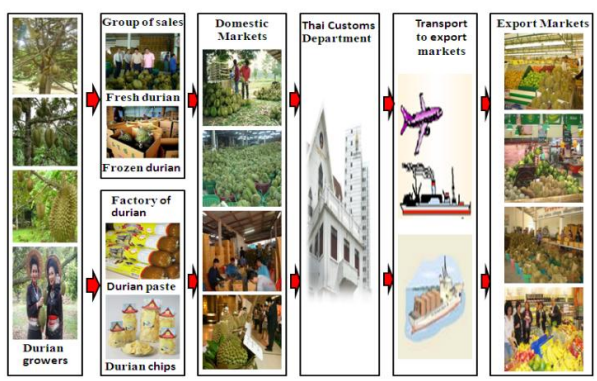

Figure 4: The marketing system of the sale in the domestic and export markets

The domestic and export marketing systems of durian in Thailand are start from the durian growers harvest durian and sell to the buyer group. Afterwards the buyer groups will sell the fresh durian and frozen durian for the domestic market. Accordingly, the durian paste and durian chips are made by processing fresh durian from the factory. Finally the exporters will send the fresh durian, frozen durian, durian paste and durian chips to export markets. The exporters must contact to the Department of customs for taxation and data entry for each type of durian before freighting or airways as shown in Figure 4. There are four types of durian to be export such as fresh durian, frozen durian, durian paste and durian chips as shown in Figure 5.

Fresh durian

Frozen durian

Durian paste

Durian chips

Figure 5: The kinds of durian for domestic and export markets

As can be seen from the comparison of production and domestic market sale volume is higher than value to export markets as shown in Figure 3. The reason of durian is the seasonal fruit and usually concentrate especially from June to August. The durian of the Eastern and the Southern part of Thailand are promptly sold to the markets that cause excess supply and other problems as follows:

1.1 *Main problems of Production and Marketing*

The main problems of production and marketing for durian from the Agricultural Information Center, the Office of Agricultural Economics [4].

1.1.1 Durian of the East and the South are ready to sell in June and August that cause excess supply. The consumption of domestic market is less than the production therefore; the durian growers sell durian at the low price continuously.

1.1.2 The export markets on demand is durian farm guarantee for Good Agricultural Practice (GAP) but the durian growers had few planting areas certified by GAP of Department of Agriculture.

1.1.3 The domestic market management is inefficient because the important are as in the East and the South had problems of over-supply of durian production that causes the decreasing price of durian, the data is from the Agricultural Information Center, the Office of Agricultural Economics [4].

1.1.4 The export durian in to the export markets increased but the decreasing price according to the situational problems of durian demand in domestic and export markets, there are few researches in this field, the gap and problem of the research and are not solved efficiently so the research methodology for an appropriate design of a forecasting support demand of durian for domestic and export markets is necessary. The new methodology able to help marketing system efficiently for forecasting at optimal demand durian in order that durian in domestic and export markets will not be over demand.

1.2 *The research questions*

1.2.1 Since previous time until present, its have the forecasting models of durian demand been in domestic and export markets.

1.2.2 What is an appropriate model for forecasting on durian demand to conform to domestic and export markets.

1.3 *Aims of the study*

1.3.1 This research is designed for forecasting support models on demand of durian export markets.

1.3.2 This research plans the selling appropriate fresh durian, frozen durian, durian paste and durian chips to conform to domestic and export markets.

1.3.3 This research is found the result of forecasting durian demand in domestic and export markets for the Office of Agricultural Economics and durian growers.

2 Literature Reviews

There are several researches that are related to apply the mathematical models to construct forecast models for many kinds of work. The detail of techniques using mathematical models to forecast durian demands are consists of two types: the Output models are Time Series models and the Input models are the Regression model and Artificial Neural Networks (ANNs) model. The literature reviews are as follows: Park *et al.* [5] study the comparative forecasting of three methods such as ANNs model, General Linear model and Regression trees model. The forecasting of the quantity of corn production from the different growing is found that the ANNs model is the most accuracy forecasting model. Co and Bossarawongse [6] study about the three comparative forecasting models such as the ANNs model, Exponential Smoothing model and Auto Regressive Integrated Moving Average (ARIMA) model to predict the quantity of Thai rice export and it is found that the ANNs model is better than other model to predict the data of the trend and the seasonal data. In addition to study of the Segura and Vecher [7] which apply the Holt-Winters' trend and Seasonality method (HWS) model to predict the sale volume on the management table. It can be seen that the HWS model provides the accuracy results of the short-run. A part from the study of Alon *et al.* [8] predict that the total sale volume of the retailer by comparison the forecasting in advance for one time unit and various time unit between the ANNs model and HWS model, Box-Jenkins model and the Multiple Regression analysis. It can be seen that during the recession the forecasting of the various time unit provide the average error from the various forecasting models at lower rate than the one monthly forecasting model. The result of the ANNs model produces the most correctly forecasting. Linear Programming (LP) is first used by Badri [9]. Linear Programming (LP) is a technique that achieves the optimal solution. It can be thought of as an extension of Linear Programming (LP) that normally has a conflict in the objective function. In the LP, maximum or minimum objective function is set for only one quantity to manage on its optimal value. Chachiamjane and Kengpol [10] develop the mathematic model in the form of Linear Programming for the production planning to get the maximize benefit and the limitation of production capacity and inventory. The improvement of production planning increases the profit of an organization. Kengpol and Kaoien [11] develop the Linear Programming model to calculate the appropriate level of inventory to increase the efficiency of purchasing power. The research is found that the mathematic model can be adjusted for the planning of purchasing raw material and increasing the inventory policy at the level of 88.33%. Apart from revising the related research study of the forecasting demand of durian in the export markets are forecasted by Time Series for the Output models and Artificial Neural Networks (ANNs) for the Input models. The both model to find the model of forecasting the demand for durian in each type which is the best type for export. After that it will be processed by the Linear Programming models to calculate the demand for each type of durian as the domestic and export markets for the marketing system in Thailand to get the maximize profit.

3 Research Methodology

The objective of this study is to forecast the demand of each type of durian in the export markets. The methodology of forecasting composes of two models namely 1) The Output models to forecast the export volume and 2) The forecasting model to find the impact to export volume by Input models. The forecasting models of demand durian finding the best model related to MAPE accuracy. After using the Linear Programming models to calculate the optimal demand of each type of durian as the domestic and export demand for maximum profit by the step of research that results as shown in Figure 6.

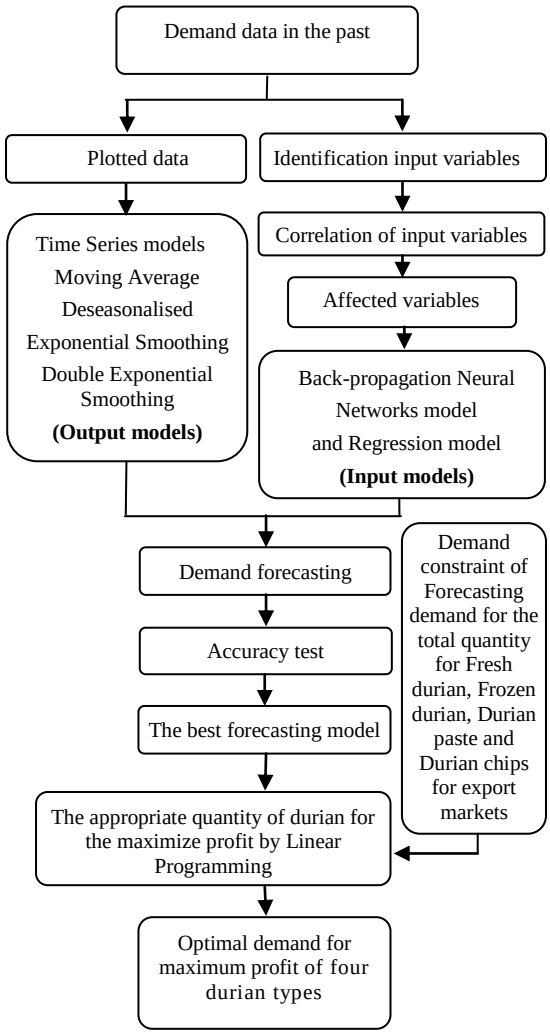

Figure 6: Steps of the research model

3.1 *The steps of research model*

3.1.1 This forecasting research is carried out by studying the demand of four durian types: fresh durian, frozen durian, durian paste and durian chips between 2002 and 2008, from the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives in Thailand [1] for forecast durian export demand in 2009.

3.1.2 The demand of the four types is similar, only the of fresh durian quantity that is used for forecasting are plotted graph as shown in Figure 7.

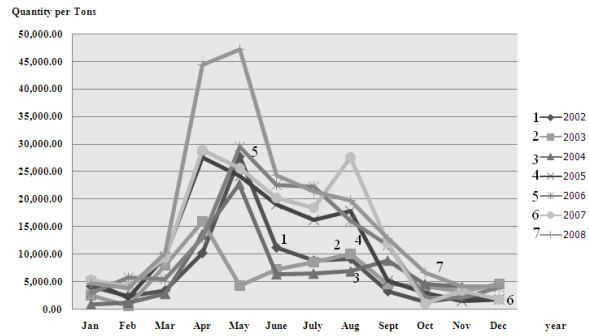

Figure 7: A plot of durian consumer demand from the year in 2002-2008 (tons)

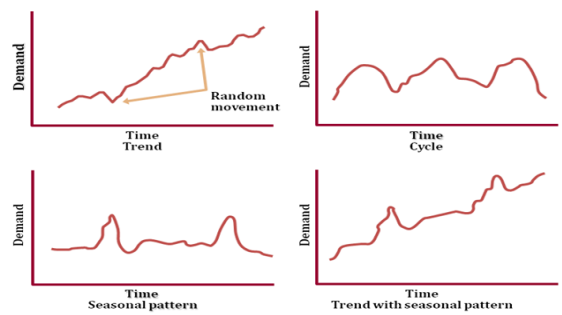

Figure 8: Forms of forecasting movement from Bernard [12]

Based on the data gained in Figure 7 which illustrates durian consumer demand, when compared with the forms of forecasting movement from Bernard [12] that are consist of four types, namely Trend, Cycle, Seasonal pattern and Trend with seasonal pattern as shown in Figure 8 the forms of movement in durian consumer demand are likely to be a Seasonal with trend pattern and Trend with seasonal pattern. Consequently, the forecasting model suitable for the data obtained is Time Series. The forecast demand of durian in this study, the researchers employ two models of forecasting: Output models and Input models. Output models mean the model that used customer durian demand for forecasting demand in next year that is the Time Series models consists of Moving Average, Deseasonalised, Exponential Smoothing and Double Exponential Smoothing. Input models are the model that used durian demand affect variables for forecasting demand in next year. The Input models are Regression and Artificial Neural Networks (ANNs) model. The

forecasting models of durian demand between the Output models and the Input models as appropriate to compare with the Mean Absolute Percentage Error (MAPE) as the most accurate. Its model is used to forecast the demand of durian in the export markets.

3.1.3 Output models are a Time Series Analysis containing 1) Moving Average 2) Deseasonalised, 3) Exponential Smoothing and 4) Double Exponential Smoothing. Time Series models are based on the assumption that the future is a function of the past. In other word, they look at what has happened over a period of the time and use a series of past data to make a forecasting.

1. Moving Average model forecast uses a number of historical actual data values to generate a forecast from Bernard [12]. This research designs for forecasting the Moving Average starting from 2, 3, 4, 6, 8, 9 and 12 months.

2. Deseasonalised model refers to the influence of seasonal variation that affects Time Series data which can be separated by seasonal index: weekly, monthly and quarterly from Heizer and Render [13]. This research designs for forecasting the Deseasonlised model starting from 3, 6, and 12 months is calculated and the results of the calculation are compared to find out the least MAPE.

3. Exponential Smoothing model is a sophisticated weighted Moving Average forecasting method that is fairly easy to use from Heizer and Render [13]. This model employs smoothing constant $0 \le \alpha \le 1$ starting from $\alpha = 0.0$ to $\alpha = 1.0$. The results of the calculation are compared to find out the least MAPE.

4. Double Exponential Smoothing denotes estimates for both the average and the trend that are smoothed. These procedures require two smoothing constants, α for the average and β for the trend. The model employs smoothing constant $0 \le \alpha \le 1$ starting from $\alpha = 0.0$ to $\alpha = 1.0$ where as smoothing constant $0 \le \beta \le 1$ starting from $\beta = 0.0$ to $\beta = 1.0$ and the results of the calculation are compared to find out the least MAPE.

3.1.4 Input models are derived from the analysis of the four forecast variables by using Regression and ANNs model. These variables are gained from three resources.

1. Interviews experts in the field of agricultural economics working at the Office of Agricultural Economics, Ministry of Agriculture and Cooperative and those in the Department of Export Promotion, Ministry of Commerce in Thailand.

2. Study previous models.

3. Study related researches.

1) Regression model is a forecasting technique that measures the relationship of one variable to one or more other variables. This model is designed by using the demand of each of the four durian types between 2002 and 2007 in Thailand as a training data used for forecasting the durian demand in 2008.

2) Artificial Neural Networks (ANNs) model is a forecasting technique consisting of three steps: input layer, hidden layer and output layer of which each step is determined by the researchers. Later, the data of durian demand between 2002 and 2007 are used as training data in ANNs programme for forecasting the demand of durian in next year to 2008.

3.1.5 The demand of each kinds of durian from each model are to found the error of Mean Absolute Percentage Error (MAPE). The least MAPE model is the good model for each kinds of durian.

3.1.6 Linear Programming is used in maximum profit of fresh durian, frozen durian, durian paste and durian chips appropriate for domestic and export markets to support the market system in Thailand and the information for durian demand to be distributing to durian growers.

3.1.7 Conclusion of the study and recommendations of the forecasting models of durian demand.

4 Modelling Forecast of Time Series for Output models

The researchers employ two models of forecasting: Output models and Input models. The Output models are Moving Average, Deseasonalised, Exponential Smoothing and Double Exponential Smoothing. This forecasting is brought the result of demand of durian in the export markets in the following year to apply for it.

4.1 *Moving Average model*

The forecasting by Moving Average model is found the average of durian demand in the past for a month and a year in advance that the important factor is index n from Bernard [12] and Heizer and Render [13].We can calculate by equation 1.

$$MA_{(n)}F_{t+1}^{k} = \frac{\sum_{t=m+1-n}^{m} A_t^k}{n} \quad (1)$$

Where

$MA_{(n)}F_{t+1}^{k}$ = Moving Average of n forecasted demand in period $t+1$

$t+1$ = The month of forecast

m = The last month in that period use for calculating

t = The first month in that period at start for calculating

n = Number of month in Moving Average at from 2, 3, 4, 6, 8, 9 and 12 months

k = Kind of durian if

k = 1; Fresh durian

k = 2; Frozen durian

k = 3; Durian paste

k = 4; Durian chips

A_t^k = Actual demand in period t

4.2 *Desesonalised model*

The forecasting by Desesonalised model to find the demand conforming to seasonal changes and differences each month and each year from Bernard [12] and Heizer and Render [13]. We can calculate by equation 2–5.

$$D^{k}{}_{MA(n)}p = \frac{\sum_{t=m+1-n}^{m} A_t^k}{n} \quad (2)$$

Where

$D^{k}{}_{MA(n)}p$ = Deseasonalised Moving Average of n for i in period p

p = The period of forecast for Moving Average

p = 1at start for calculating from the first month to last month of number Moving average

If p = 2at start for calculating from the second month to last month of number Moving Average

m = The last month in that period use for calculating

t = The first month in that period at start for calculating

n = Number of month in Moving Average at from 3, 6 and 12 months

k = Kind of durian if

k = 1; Fresh durian

k = 2; Frozen durian

k = 3; Durian paste

k = 4; Durian chips

A_t^k = Actual demand in period t

$$RcD^{k} = \frac{A_t^k}{n} \quad (3)$$

Where

RcD^{k} = Ratio cantered Deseasonalised

$$Si^{k} = \frac{n_m \times RcD^{k}}{\sum ma} \quad (4)$$

Where

Si^{k} = Seasonal index

$\sum ma$ = Total of monthly average

n_m = Number of monthly

$$DF^{k} = \frac{A_t^k}{Si^{k}} \quad (5)$$

Where

DF^{k} = Deseasonalised forecasting

4.3 *Exponential Smoothing model*

The forecasting by Exponential Smoothing model which smoothed with the moving data and the counterbalance using the efficiency of smoothing α to smooth the gained average the accurate forecast from Bernard [12] and Heizer and Render [13]. We can calculate by equation 6.

$$ESF_{t+1}^{k} = \alpha A_t^k + (1-\alpha) ESF_t^k \quad (6)$$

Where

ESF_{t+1}^{k} = Exponential Smoothing forecast of next month in that in period $t+1$

ESF_t^k = Exponential Smoothing forecast demand the each of k in period t

t = Present time when the forecasting of i value is calculated *t*-1, *t*-2 and *t*-3 are the past, *t*+1, *t*+2, *t*+3,…,*n* are the future

α_k^o = Smoothing constant an optimal of kind of durian

k = Kind of durian if

k = 1; Fresh durian

k = 2; Frozen durian

k = 3; Durian paste

k = 4; Durian chips

α = Smoothing constant when $0 \le \alpha \le 1$

A_t^k = Actual demand in period t

0 = An optimal of α for Exponential Smoothing

4.4 *Double Exponential Smoothing model*

The forecasting by Double Exponential Smoothing mode which counterbalanced the data by using the efficiency of smoothing α and β to find more accurate forecast of trend and season from Bernard [12] and Heizer and Render [13].We can calculate by equation 7-9.

$$DESF_{t+1}^{k} = ESk_{t+1}^{k} + T_{t+1}^{k} \quad (7)$$

Where

$DESF_{t+1}^{k}$ = Double Exponential Smoothing for next month in that period $t+1$

$$ESF_{t+1}^{k} = \alpha A_t^k + (1-\alpha) ESF_t^k \quad (8)$$

$$T_{t+1}^{k} = \beta (F_{t+1}^{k} - F_t^k) + (1-\beta) T_t^k \quad (9)$$

Where

ESF_{t+1}^{k} = Forecasting for next month in that period $t+1$ for Exponential Smoothing

T_{t+1}^{k} = rend factor for next month in that period $t+1$ for Exponential Smoothing

F_t^k = Forecast demand of k in period t

A_t^k = Actual demand in period t

k = Kind of durian if

k = 1; Fresh durian

k = 2; Frozen durian

k = 3; Durian paste

k = 4; Durian chips

α_k^o = Smoothing constant an optimal of kind of durian

β_k^o = Smoothing constant for trend an optimal of kind of durian

T_t^k = Exponential smoothed trend factor in period *t*

0 = Optimal of α and β for Double Exponential Smoothing

α = Smoothing constant when $0 \le \alpha \le 1$

β = Smoothing constant for trend when $0 \le \beta \le 1$

5 Modelling Forecast for the Input models

The Input models are Regression and Artificial Neural Networks (ANNs). Its is to forecast the related factors to forecast the export volume for the demand of durian in the export markets of the following year such as: 1) Export price Free On Board (FOB) 2) Consumer price index 3) Average Gross Domestic Product (GDP) and 4) Average exchange rate of Thai money and USD as follows: These variables are gained from three resources: 1) Interviews experts in the field of agricultural economics working at the Office of Agricultural Economics, Ministry of Agriculture and Cooperative and those in The Department of Export Promotion, Ministry of Commerce in Thailand 2) Study previous models and 3) Study related researches. In summary, variables pertaining to the forecast of durian demand in export markets comprise the following of this research start from 9 input variables as follows:

1. Durian fresh, Durian frozen, Durian paste and Durian chips export price Free On Board (FOB)
2. Packaging cost
3. Carrying cost
4. Farm price
5. Consumer price index
6. Average Gross Domestic Product (GDP)
7. Oil price
8. Transportation cost
9. Average exchange rate of Thai money and USD

After getting the input variables to get the correlation all of four variables.

1) Variable 1: Durian fresh, Durian frozen, Durian paste and Durian chips export price Free On Board (FOB) of each type of durians in each month of the year

2) Variable 2: Consumer price index of Thailand in each month of the year

3) Variable 3: Average Gross Domestic Product (GDP) of the world in each year

4) Variable 4: Average exchange rate of Thai money and USD of each year

There are four variables as shown in Table 1 which are collected during the period of 2002-2008.

5.1 *Regression model*

A Regression model attempts to represent the relationship between a set of a dependent variable and independent variables using a multivariate mathematical function in this study, the Regression model from Makridakis *et al.* [14] and Spyros *et al.* [15]. We can calculate by equation 10.

$$RF_{t+1}^{k} = \beta_0 + \beta_1 A_{1,t}^{k} + \beta_2 A_{2,t}^{k} + \beta_3 A_{3,t}^{k} + \beta_4 A_{4,t}^{k} \qquad (10)$$

Where

β_0 = The constant

$\beta_1,...,\beta_4$ = Parameters representing contributions of the independent variables

RF_{t+1}^{k} = Forecasting demand in Regression in period t

F_t^k = Forecast demand of k in period t

k = Kind of durian if

k = 1; Fresh durian

k = 2; Frozen durian

k = 3; Durian paste

k = 4; Durian chips

A_t^k = Actual demand in period t

$A_{1,t}^{k}$ = Export price Free On Board (FOB) in period t

$A_{2,t}^{k}$ = Consumer price index in period t

$A_{3,t}^{k}$ = Average Gross Domestic Product (GDP) for export markets in period t

$A_{4,t}^{k}$ = Average exchange rate of Thai money and USD period t

5.2 *Artificial Neural Networks (ANNs) model*

The model of Artificial Neural Networks (ANNs) as the type of Back Propagation Neural Networks (BPN) is the model of the relationship between the independent variables and dependent variable for the gradually study consisting of the processing unit or Neural which composing of three layers such as the input layer, the hidden layer and the output layer which are fully connected feed forward. Each neural layer linked to every neural in the next layer to send the signal each other. In each linking line will be included the weight. The study of networks is the adjustment and finding the appropriate weight to forecast the lowest error and accuracy results, from Zhang and Qi [16].

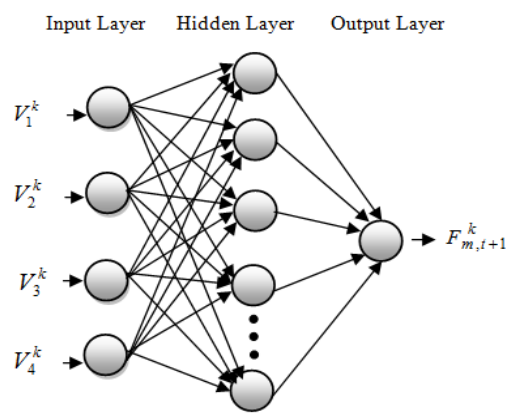

Figure 11: Structure of Artificial Neural Networks as the type of Back Propagation Neural Networks

The architecture of Artificial Neural Networks model in this study is fully connected, feed-forward and a multiple layer perception neural networks. It consists of three layers: an input layer, a hidden layer, and an output layer. Each of these layers contains neurons. In addition, the back propagation paradigm has become the most popular for demand forecasting. Figure 11 shows the topology of the neural networks used in this paper. The independent variables $V_1^k, V_2^k, V_3^k, V_4^k, ..., V_n^k$ are designed as input data for kind of durian and $F_{m,t+1}^k$ as demand forecasting for kinds of durian. All input data are inserted to each neuron at an input layer. The neurons at an input layer are connected to every hidden neuron and every hidden neuron is connected to the output neuron. Connections between neurons have numerical weights and these are adjusted in training process.

Each neuron has two main functions: the first function is the summation function. The second function is the activation function. The value for a neuron in the hidden or output layers is typically the sum of each incoming activation level times its respective connection weight. Each neuron in the hidden layer calculates m_j when $j = 1, 2, ..., n$ from Martin *et al*. [17]. We can calculate by equation 11.

$$m_j = \sum_{i=1}^{n} v_i^k w_{ji} \tag{11}$$

Where w = weight which becomes to a mathematical value for the relative strength of connections to transfer data from one layer to another layer j is number of neural in the hidden layer and i is the number of input layer. Also, a sigmoid function m_T in the following form is used to transform the output so that it falls into an acceptable range. This transformation is done before the output reaches the next level. The purpose of a sigmoid function is to prevent the output value from being too large, as the value of m_T must fall between 0 and 1. We can calculate by equation 12.

$$m_T = \frac{1}{1 + e^{-m}} \tag{12}$$

Finally, $F_{m,t+1}^k$ in neuron of the output layer in Figure 11. We can calculate by equation 13.

$$F_{m,t+1}^k = \sum_{i=1}^{n} m_{Ti} w_i \tag{13}$$

Where n = the amount of neuron in the hidden layer is w which is weight returns a mathematical value for the relative strength of connections to transfer data from one layer to another layer and i is number of input layer. The ANNs modelling for demand forecasting for each kind of durian is developed by using MATLAB. The data is applied with the Artificial Neural Networks model.

Input variables for Artificial Neural Networks model are:

V_1^k = Fresh durian, Frozen durian, Durian paste and Durian chips export price Free On Board (FOB) (At the time *t*-1)

V_2^k = Consumer price index (At the time *t*-1)

V_3^k = Average Gross Domestic Product (GDP) (At the time *t*-1)

V_4^k = Average exchange rate of Thai money and USD (At the time *t*-1) as shown in Table 1 for example.

k = Kind of durian if
k = 1; Fresh durian
k = 2; Frozen durian
k = 3; Durian paste
k = 4; Durian chips

Output variable for Artificial Neural Networks model is:

F_m^k = Forecast durian demand quantity of year (At the time *t*)

Table 1: The data of durian demand for fresh durian to input variables in year 2002

Month	Export Price (USD/tons)	Comsumer Price Index	Average GDP of the wolrd	Average of Exchange Rate of Thai money and USD
Jan	446.01	55.59	3.331	41.21
Feb	399.91	78.94	3.331	41.21
Mar	681.74	156.37	3.331	41.21
Apr	449.65	110.49	3.331	41.21
May	464.35	44.76	3.331	41.21
Jun	468.50	57.42	3.331	41.21
Jul	467.47	55.09	3.331	41.21
Aug	392.14	44.09	3.331	41.21
Sep	494.23	61.03	3.331	41.21
Oct	794.54	61.03	3.331	41.21
Nov	955.56	61.03	3.331	41.21
Dec	980.32	61.03	3.331	41.21

In this research, the data is divided to be two series which are the training series containing 72 data sequences and the testing series containing 12 data sequences. The infrastructure consisted of four inputs variables, one hidden layer, changing 1 until 10 hidden nodes and the parameter of learning. The error goals are 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 07, 0.8, 0.9 and 1.0. The results of Artificial Neural Networks forecast model for durian chips and the forecast error by comparing MAPE as shown in Table 2 for example.

Table 2: MAPE calculated by Artificial Neural Networks forecast model for durian chips

Hidden Node / Error goal	**1**	**…**	**6**	**10**
0.1	43.50	…	**29.76**	57.57
0.2	100.03	…	160.99	154.14
0.3	138.08	…	192.41	163.30
0.4	166.16	…	213.37	173.00
0.5	194.77	…	233.51	179.00
0.6	220.01	…	249.59	186.65
0.7	246.61	…	261.90	191.14
0.8	272.37	…	273.86	196.09
0.9	299.31	…	285.27	207.15
1.0	326.23	…	290.73	213.16

6 Comparison of model efficiency

The forecast model efficiency compares the forecast error by comparing Mean Absolute Percentage Error (MAPE) resulting from forecast models from Zhang *et al.* [18]. We can be calculated by equation 14.

$$MAPE = \frac{1}{n}\sum_{t+1}^{n}\left|\frac{A_{t+1} + -F_{t+1}}{A_t}\right| \times 100 \qquad (14)$$

Where

F_t = Forecasted of durian demand quantity in period t

A_t = Actual of durian demand quantity in Period t

t = Period at consider

n = Total number of periods

In general, the selected models are not very accurate in the most of the measuring dimension. The classified forecasts with MAPE values of less than 10% as high accurate for forecasting, between 10% and 20% as good forecasting, between 20% and 50% as reasonable, and forecasting, larger than 50% as inaccurate forecasting from Frechtling [19].

7 Research results of forecasting models

The research result of forecasting using Moving Average model, the mean of forecasting used are 2, 3, 4, 6, 8, 9 and 12 months, respectively. When n is 3 months at frozen durian the lowest MAPE is 64.14%, durian paste is 85.36% and fresh durian is 161.26%. When n is 6 months at durian chips, the lowest MAPE is 86.02%, respectively. The result of forecasting using Desesonalized model, the mean of forecasting used is 3, 6 and 12 months, respectively. When month is 3 months at frozen durian the lowest MAPE is 9.78%, fresh durian is 19.24%, and when the times is 6 months at durian paste the lowest MAPE is 8.66%, durian chips is 34.47%, respectively. The result of forecasting using Exponential Smoothing model the mean of forecasting used is α between 0.0 until 1.0, respectively. When α is 0.9 at frozen durian lowest MAPE is 43.66%, durian paste is 67.54%, and fresh durian is 85.23%, and when α 0.1 at durian chips the lowest MAPE is 118.31%, respectively. The result of forecasting by using Double Exponential Smoothing model, the mean of forecasting used is α and β between 0.0 until 1.0, respectively. When $\alpha = 0.5, \beta = 0.9$ is frozen durian the lowest MAPE is 43.19%, when $\alpha = 0.5, \beta = 0.9$ durian paste is 67.04% and durian fresh is 82.85% and when $\alpha = 0.1, \beta = 0.1$ at durian chips lowest MAPE is 168.46%, respectively. The result of forecasting by using Regression model is forecasted as follows. When MAPE at durian paste the lowest MAPE is 55.73%, frozen durian is 82.26% durian chips is 95.74% and fresh durian is 200.91%, respectively. The result of forecasting using Artificial Neural Networks model, the mean of forecasting used is Artificial Neural Networks (ANNs) as the type of Back Propagation Neural Networks (BPN) model uses four inputs respectively. When we compare hidden layer and error goal, the mean of input four variables, hidden layer since to 1, 2, 3, ... , 10 and error goal variables since to 0.1 to 1.0 is forecasted as follows. When input four variables, hidden layer is 6 and error goal is 0.1 at frozen durian the lowest MAPE is 21.61%, when input four variables, hidden layer is 4 and error goal is 0.8 at fresh durian the lowest MAPE is 25.35%, when input four variables, hidden layer is 6 and error goal is 0.1 at durian chips the lowest MAPE is 29.76%, and when input four variables, hidden layer is 9 and error goal is 0.3 at durian paste the lowest MAPE is 48.71%, respectively. When we compare forecasting models the mean of model an optimal is Deseasonlised model as follows. At durian paste the lowest MAPE is 8.66%, frozen durian is 9.78%, fresh durian is 19.24%, and Artificial Neural Networks (ANNs) model an optimal at durian chips the lowest MAPE is 21.76%, as shown in Figure 12 and Table 3.

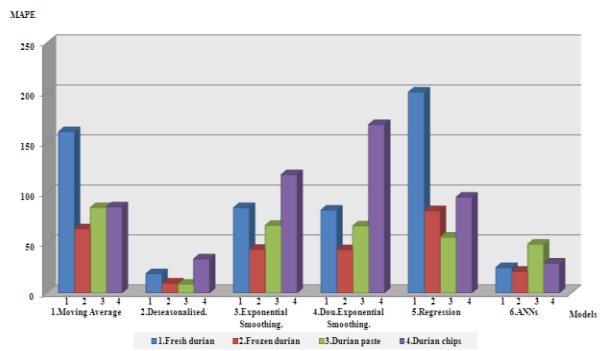

Figure 12: The result of six models comparing of MAPE and the kinds of durian

Table 3: The result of models comparing MAPE for kinds of durian

Model	Type of durian			
	Fresh Durian	Frozen Durian	Durian Paste	Durian Chips
	MAPE	MAPE	MAPE	MAPE
1. Moving Average	3 month	3 month	3 month	6 month
	161.26	64.14	85.36	86.02
2. Deseasonalised	3 month	3 month	6 month	3 month
	19.24	**9.78**	**8.66**	34.47
3. Exponential Smoothing	α = 0.9	α = 0.9	α = 0.9	α = 0.1
	85.23	43.66	67.54	118.31
4. Double Exponential Smoothing	α =0.6 β = 0.9	α = 0.5 β = 0.9	α = 0.5 β = 0.9	α = 0.1 β = 0.1
	82.85	43.19	67.04	168.46
5. Regression	200.91	82.26	55.73	95.74
6. ANNs	25.35	21.61	48.71	**29.76**

The conclusion of the research, to study of the forecast of durian demand in the export markets of four durian types; there are six forecasting models that used two forecasting types as follows.

1. The data of durian demand taken from the Office of Agricultural Economics are analysed by means of the four models: Moving Average, Deseasonlised, Exponential Smoothing, and Double Exponential Smoothing. The results gained from each of the four models analysis are compared to find out error rate of MAPE. It is revealed that Deseasonlised model has the best result since it has the least MAPE. This means that the model has the most accuracy of all the other five models used to forecast demand of four durian types: fresh durian, frozen durian, durian paste and durian chips. The first three durian types have the least MAPE (the most accuracy) while the last durian type has the least accuracy.

2. The variables influencing the forecast are analysed by Regression model and ANNs model. The results are then applied to forecast the demand of durian by using input models type. The results gained from each of the two models analysis are compared to find out error rate of MAPE. It is revealed that, in contrast to the above forecast type, the most accuracy of the MAPE's error rate is gained from the calculation of durian chips. Both of the two forecast models, Output and Input models have different advantages which will be presented in detail below. According to the Output models type which has four models: Moving Average, Deseasonlised, Exponential Smoothing and Double Exponential Smoothing, Deseasonlised model is the best forecast model due to the fact that durian product has yielded into export markets in season. On the other hand, the remaining models which are not the Deseasonalised model have the least accuracy. The Input models type which has two models: Regression and ANNs, the latter is the best forecast model of export durian demand. The disadvantage of input models is that if there is no relationship among the variables influencing the forecast, the forecast will give the least accuracy. With respect to the findings of the appropriate durian demand, this study apply the Linear Programming for calculating the amount of the demand for fresh durian, frozen durian, durian paste and durian chips in domestic and export markets for the maximum profit for the durian growers. The results of the findings benefit durian growers in that they are possibly able to make the most profit of durian product. Moreover, the findings also support the forward export planning devised by the Ministry of Agriculture and Cooperative, particularly the Office of Agricultural Economics including ten official areas located in different parts of Thailand.

8 Maximum Profit of Durian Product

As can be seen the appropriate forecasting models of durian demand of each type of durian to get each type of durian demand to forecast the production of durian. The profit per ton of each type of durian from the government agencies such as 1) Office of Agricultural Economics 2) Bureau of Agricultural Economic Research 3) Garden plant research division and 4) Department of Export Promotion by applying the Linear Programming to calculate the appropriate quantity of durian to get the maximize profit and offer each type of durian both domestic and export markets under the limitation and sending the information of durian demand to the Office of Agricultural Economics, the Office of Agricultural Economics of each area and durian growers. The Linear Programming model is the technique which developed from the problem of the resource allocation. The objective of the program is to gain the optimal benefit by minimizing cost of maximum profit by the condition of the limitation of the relationship of linear program of various resource by composing the optimize problem which composing four parts such as form Taha [20]. There are two system of selling durian in Thailand namely 1) the domestic market 2) the export market. Therefore the quantity of selling durian of both systems will get the whole quantities of durian. As we expect to sell durians in the export market and the forecasting durian quantity after exporting then there will be consume in the domestic market.

1. Objective Function in the form of Max or Min: $f(X_1, X_2, ..., X_n)$ form Ragsdale [21]
2. Constraint Function
3. Decision Variables in the equation and the limitation of the linear program. There are written by $X_1, X_2, ..., X_n$
4. Decision Variables more than zero value

This research is related to the factors and mathematic model by the targeted equation with the maximize profit.

Where

X_1 = Quantity fresh durian for export, tons

X_2 = Quantity frozen durian for export, tons

X_3 = Quantity durian paste for export, tons

X_4 = Quantity durian chips for export, tons

X_5 = Fresh durian for domestic, tons

X_6 = Frozen durian for domestic, tons

X_7 = Durian paste for domestic, tons

X_8 = Durian chips for domestic, tons

a_j = Profit coefficient of four durian types in domestic and export markets, USD per tons

$$Max\ Z = a_1X_1 + a_2X_2 + a_3X_3 + a_4X_4 + a_5X_5 + a_6X_6 + a_7X_7 + a_8X_8 \quad (15)$$

Subject to

$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 \leq$ Total supply

$X_1 + X_2 + X_3 + X_4 \leq$ Supply for export

$X_1 + X_2 + X_3 + X_4 \leq$ Supply for export

$X_5 + X_6 + X_7 + X_8 \leq$ Supply for domestic

$X_1 + X_5 \leq$ The total quantity of fresh durian

$X_2 + X_6 \leq$ The total quantity of frozen durian

$X_3 + X_7 \leq$ The total quantity of durian paste

$X_4 + X_8 \leq$ The total quantity of durian chips

$X_j \geq 0 \qquad j = 1, 2, 3, ..., 8$

The Linear Programming is the mathematics model that is applied to survey the durian demand quantity in tons, of four durian types: fresh durian, frozen durian, durian paste and durian chips by using the forecasting data of demand and the Linear Programming is the mathematics model that is applied to survey the durian demand quantity in tons, of four types such as fresh durian, frozen durian, durian paste and durian chips by using the forecasting data of demand by Linear Programming that is the tool for calculating the demand of durian in each type as appropriate quantities to get the maximize profit. The total of durian production in 2008 from forecasting result durian supply is 693,640 tons. The durian demand of domestic market is 467,953 tons and 209,487 tons for export markets. As the limitation of the quantity demand of durian for domestic and export markets. The quantity demand of durian for domestic and export markets are as follows: 1) there are 632,992 tons of fresh durian from the total quantity of fresh durian sold from the total volume of 190,554 tons for export markets (forecasting result from Deseasonalised model) and the rest of the 442,437 tons for the domestic markets. 2) There are 35,140 tons of frozen durian from the total quantity of frozen durian sold from the total volume of 15,955 tons for export markets (forecasting result from Deseasonalised model) and the rest of the 19,185 tons for the domestic markets. 3) The total volume of durian paste is 8,448 tons from the total quantity of durian paste that will be sold for the export market at 2,647 tons (forecasting result of Deseasonalised model) and the rest of the 5,801 tons for the domestic markets. 4) There are 858 tons of durian chips from the total quantity of durian chips that for exporting at 329 tons (forecasting result from the Artificial Neural Networks model) and the rest of 529 tons for the domestic market. The profit per ton of selling durian for domestic and export markets are as follows: 1) The profit of fresh durian for the domestic market is 49 USD per ton and 157 USD per ton for export markets 2) The profit of frozen durian for domestic market is 59 USD per ton and 167 USD per ton for export markets 3) The profit of durian paste for domestic market is 69 USD per ton and 177 USD per ton and 4) The profit of durian chips for the domestic market is 80 USD per ton and 186 USD per ton for export markets. As can be seen that this limitation can be calculated for the appropriate quantity of each type of durian for the maximize profit in 2009 the Office of Agricultural Economics receives the information of the appropriate quantities of domestic and export demand for durian then the farmers will get to know about this information through the Regional Office of Agricultural Economics for sales planning and processed durian by Linear Programming. We can calculate with the equation 15. The purpose of the Linear Programming model is to find the appropriate quantity by each kinds of durian in order to achieve a suitable price for the durian. The maximized profit cannot be less than the demand cost, a forecasting of four durian types: fresh durian, frozen durian, durian paste and durian chips of quantity in the demand-side and the result of durian demand of four durian types to get the less than profit at 65 USD per ton which is

the good price for durian growers to get the maximum optimal profit. The total durian demand for domestic and export markets able not be more than 693,640 tons. The quantity of durian demand part for domestic and export markets able to as follows:

Fresh durian in domestic market = 442,437 tons
Frozen durian in domestic market = 19,185 tons
Durian paste in domestic market = 5,801 tons
Durian chips in domestic market = 529 tons
Fresh durian in export markets = 190,555 tons
Frozen durian in export markets = 15,955 tons
Durian paste in export markets = 2,648 tons
Durian chips in export markets = 329 tons

The net profit is equal to 50 million USD related to the real value of profit from selling durian in 2009 is 58 million USD. The increasing of profit by the country's total is 8 million USD and equivalent to 16 %.

9 Summary and Recommendations

The objective of this research is to design forecasting on demand of durian for export markets. The value of this research is in methodology for forecasting durian demand in monthly of fresh durian, frozen durian, durian paste and durian chips. Which can be implemented forecasting demand durian in export markets and the methodology of this research is apply by forecasting method. Then the results from the analysis of the two models types are compared to find out the error rate of MAPE.

1. The Output models are the forecasting of previous year export volume to apply. The models are calculated by Moving Average, Deseasonalised Exponential Smoothing and Double Exponential Smoothing to compare each variable by the last target of forecasting the demand of durian. The result of Mean Absolute Percentage Error (MAPE) must be less error by forecasting the export demand of durian such as fresh durian, frozen durian, durian paste and durian chips. The objective of this research is find the best model to compare with the accurate of the minimum MAPE of Output models type which consist of the Deseasonalised model. 1) The findings are found that the durian paste has the least error at the percentage of 8.66 and giving the high accuracy 2) The frozen durian has the error at the percentage of 9.78 3) The fresh durian has the error at the percentage of 19.24. The good point of the Deseasonalised model is the qualification of the seasonal forecasting which is consistent to the durian production as the seasonal fruits to domestic and export markets in one year. The analysis of the seasonal alteration by the seasonal index from Vichaisin and Chaweesuk [22]. Therefore the Deseasonalised model is to forecasting the fresh durian, frozen durian and durian paste which are more accuracy than other methods. As the reason of the agricultural products are influential by the season which can be measured from Vichaisin and Chaweesuk [22].

2. Input models are the forecasting model to find the affect to export volume next year. The Input models are Regression and Artificial Neural Networks (ANNs) to forecasting demand of durian of each kinds of durian such as fresh durian, frozen durian, durian paste and durian chips to get the best model. The comparison of the minimum value of MAPE is Artificial Neural Networks (ANNs) model that found that the durian chips have the least error at the percentage of 29.76% and giving the high accuracy. The good point of the forecasting by Artificial Neural Networks is to find out the short run and long run of the forecasting data. Besides the ANNs can get the right value in the many forms which is better than other models from Siripanich *et al.* [23]. Especially the durian chips are different from the fresh durian, frozen durian and durian paste. This preservation can store durian for long time. The export product has related by many factors. In conclusion these two models can forecast the export demand of durian. The difference between two models is as follows; the Output models type can forecast the export volume of next year's production. However the Input models are the forecasting models which find out the impacted factors to the export volume and to forecast the export volume next year. The Output models type can forecast the export volume of next year's production which is good for forecasting the appropriate demand in export market. It is the Deseasonlised model. The forecasting of the appropriate demand of durian from 3 types of durians such as fresh durian, frozen durian and durian paste. The information of the data in 2008 for the forecasting of demand for durian in 2009. However the Input models are the

forecasting models which find out the affect factors to the export volume and to forecast the export volume next year. The Input model namely the Artificial Neural Networks Model is the suitable model to forecast the appropriate demand in export market. It is good for forecasting the demand for durian chips in the year 2008 which is the data for forecasting the demand for durian in 2009. The forecasting method of output model and input model are good and suitable model. However the volume of export demand from the forecasting does not get the maximize profit but it still need the Linear Programming to find the sale volume of each type of durian in domestic and export market. The result of this forecasting is applying for the durian growers, domestic and export merchants. The Office of Agricultural Economics has known the demand for durian in the following year relate to present year. How much demand for durian at the same time the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives can select the forecasting model the demand for durian easily. The comparison of six forecasting models of the demand of durian can be seen that the model of the less error and more accuracy is the model of Deseasonilsed model and Artificial Neural Networks model as shown in Table 3. Moreover, the researchers have constructed the Linear Programming model to find the appropriate demand of each type of durian for the domestic and export markets to support the market system in Thailand for maximizing profit. This research is beneficial to the related people like durian growers, retailers, wholesalers, food processors, the related business and government agencies such as the Office of Agricultural Economics, the Ministry of Agriculture and Co-operative, the Ministry of Commerce and the Ministry of Industry etc. The result from the forecasting model able to applied for other fruits in Thailand and export markets. Further, the next step of the research able to produce a computer software package for calculating the forecasting of demand for each of the types of durian in the following year that able input the selling price or the domestic price, the export price or the exchange rate into the programme for calculating the results of quantity demand of each types of durian. These data will help to make a decision to export durian at the appropriate volume and the good price for maximize profit.

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