SUPPLY CHAIN NETWORK DESIGNING STRATEGY: A CASE STUDY OF LILY FLOWER

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Abstract. Lily flower cultivation industry in Vietnam has developed in recent years expressed by the increase of both the cultivation area and productivity. However, the supply chain network of this product is not effective, which carries along a variety of obstacles such as an uncertain forecast demand quantity, storing condition with low efficiency and high total cost. The paper will focus on providing a suitable strategy by applying Holt-Winter exponential smoothing additive method and mixed integer linear programming (MIP) for designing a more effective supply chain network.

Keywords: supply chain design, Lily flower, MIP

I. INTRODUCTION

Roses, Chrysanthemums, Orchids are considered to have the highest economic value in comparison with others. However, Lily flower farming is also regarded as the potential field which has been developed in recent years. Lily flowers farming carries along a lot of benefits which not only contribute to the development of economy of local people but also promote the development of national flowers farming.

Currently, Lily flowers farming plan has been conducted in several places such as Song Hong delta, the region of Central. In the Southern region, having a similar weather condition with Lam Dong province which is considered a biggest area of producing flowers, Konplong district of Kontum province is an suitable place for farming Lily flowers.

However, a variety of difficulty which affects the Lily flowers farming. One of the most noticeable problems is lack of an effective supply chain network which has capability to shorten the distance between suppliers and customers. Furthermore, there are some related problems could be list:

The method and process of producing Lily flower are still simple. Cultivation techniques, shaping depend on experiences, which are impacted by the weather conditions a lot. Therefore, the standard of quality of flowers of each place is not synchronous.

Another problem of farming is farmers do not have an effective forecasting plan of demand before having a new farming season. The fact is that the number of farmer participate in growing Lily flowers are small and do not have strong connection, which leads to the low productivity. The connection between important nodes of the supply chain network is weak.

The final remarkable problem should be taken in to consideration is the high investment costs. Especially, all of farmers have to buy Lily bulbs from other provinces with a very high price instead of importing directly from foreign bulbs manufacturers and the price accounts for a highest proportion of the flowers price. Therefore, the cost of buying bulbs has not been optimized. Furthermore, cost for transporting is high. Hence, all of these factors are reasons which make the investment cost of Lily flowers increase significantly and farmers do not receive a level profit as they desire.

With some challenges mentioned above, the objective of the study will focus on the factors that influence to a supply chain network based on the analysis of the market demand in order to design an effective production planning. Concurrently, the study will research and propose the potential solutions to promote the development of the Lily flowers farming in Kontum province. Finally, the study will focus on design a supply chain network including all necessary components, the role and the relationship between suppliers and customers to ensure the successful flow of product to the market with optimal costs.

II. LITERATURE REVIEW

Solution for pushing of the vegetables and flowers exporting of the North areas [1] reported the actual situation of the cultivation of the vegetables and flowers. Base on the given difficulties, the report also proposed some potential solutions in order to have an effective supply chain for flowers not only in domestic market but also in foreign markets.

Sunil Chopra and Peter Meindl [2] point to the important role of the forecasting demand step which is extremely essential for designing a supply chain. The handbook gave a variety of methods to forecast. Then, a quantity of methods for facilities and location are proposed in order to maximize the profitability of a supply chain.

Bui Duy Tan [3] used winter's model to forecast the demand of milk-apple which is one of the agriculture product of Viet Nam because this method is considered the most accurate method of forecasting demand of products

Dinesh [6] introduced a method for optimizing allocation of land cultivation of annual agriculture plan for different crops that is fuzzy goal programing (FGP). This method was considered a better technique for solve problem which had multiple conflicting objectives.

Omar Ahumada .J. Rene Villalobos [7] presented an integrated tactical planning model for production and distribution of fresh product. The decisions obtained are based on not only traditional factor such as price estimation, resource availability but also price dynamic, product decay, transportation, inventory cost.

Jose Vicente Caixeta – Filho [8] used LP model to design a production planning for lily flower with objective to maximize the farm's total contribution margin.

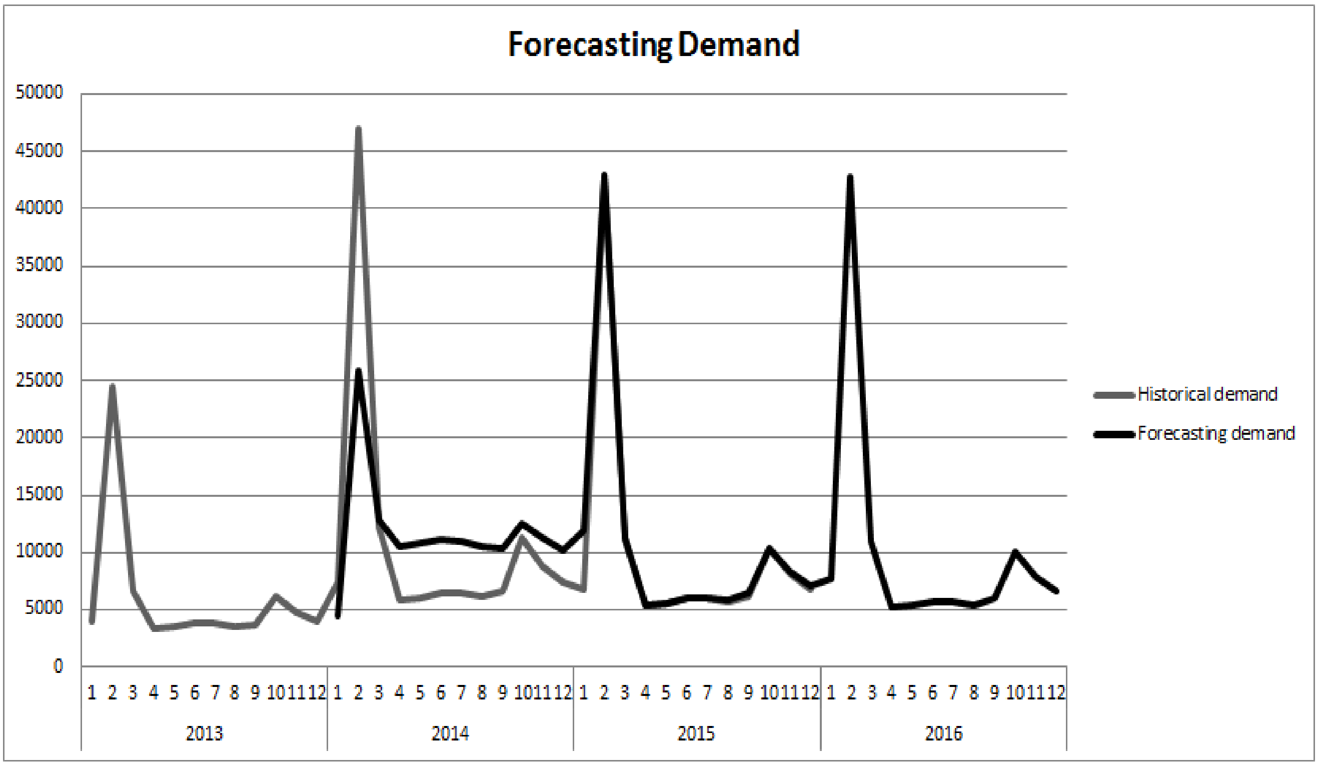
having seasonal demand. He also used linear programming model for the combination of location and capacity decision making.

Morris [4] introduced a model of framework and an analytic procedure for evaluating the performance of the components in supply chain network. A quantity of models which is suitable for each part of the supply chain network was used.

Nhieu Nhat Luong [5] presented a supply chain design model for Ngoc Ling ginseng of Vietnam by using stochastic model. He designed a two-stage supply chain under uncertain demand starting with market study to make decision in product design. Then, he determined the location of production plant, retailers by multiple profit stochastic models based on linear programing model.

III. DEMAND FORCASTING

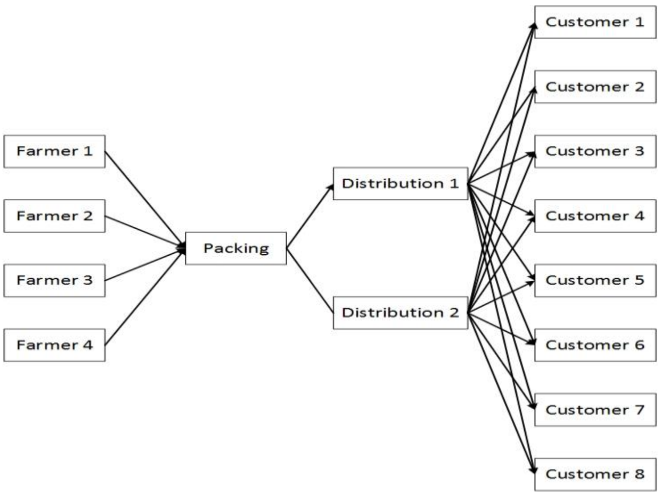
According to the statistic providing by department of Agriculture and Rural Development of Kontum province , the historical demand of the last 3 years are shown : This graph shows that the consumption level of lily flower has a cycle during 12 months, it normally reaches a peak in February. It can be observed that historical demand is seasonal, it also has trend and repeat every year. Therefore, suitable forecasting method should be applied that is Holt-Winter exponential smoothing additive. The goal is to supply the weekly quantity of lily flower in order to satisfy demand of customers.



IV. PRODUCTION AND DISTRIBUTION PLANNING

- **Assumption of the model:**

The supply chain network has 4 stages: Farms, Packing place (Warehouse), Distribution centers, Customers. The capacity of Warehouse and Distribution centers is known.



- **Notation:**

I : The set of Farms

V : The set of Lily varieties

T : The set of Weeks

D : The set of Distribution centers

C : The set of Customers

- **Parameters**

$AREA_i$: Available area of farmers i (m^2)

$DENS_i$: Density of bulb per m^2 of area ($bulb/m^2$)

$CBULB_v$: Cost of purchasing bulb for lily variety v (vnd/bulb)

$CMET_v$: Cost of each m^2 planting area (vnd/m^2)

CHW : Cost of worker in farm (vnd/worker/week)

CFP : Cost of transportation from farm to packing place (vnd/stem/km)

WCAP : Capacity of warehouse (box)

$CBPACK$: Cost of packing a box of lily (vnd/box)

$CHBPACK$: Cost of worker in packing place (vnd/worker/week)

COP : Cost of packing place operation (vnd/week)

COW : Holding cost of warehouse (vnd/box/week)

CPD_d : Cost of transportation from packing place to distribution center (vnd/box/km)

CDC_{dc} : Cost of transportation from distribution center d to customer c (vnd/box/km)

COD_d : Cost of distribution center operation (vnd/week)

$DEMAND_{tvc}$: Demand in week t of lily variety of customer c (box)

$PRICE_{tv}$: Price of lily variety v in week t

- **Decision Variables**

BQT_{ivt} : Quantity of bulbs of lily variety v plant in week t in farm i (bulb)

$LYQT_{ivt}$: Quantity of stems of lily variety v harvest in week t in farm i (stem)

$USEAREA_{ivt}$: Quantity of necessary area of farm i to plant lily variety v in week t (m^2)

$HARAREA_{ivt}$: Quantity of area of farm i to harvest lily variety v in week t (m^2)

$AVAIAREA_{ivt}$: Quantity of remain area of farm i to plant lily variety v in week t (m^2)

FQT_{it} :Quantity of necessary worker in farm i in week t (worker)

$SSFP_{vt}$: Quantity of stems of lily variety v ship from farm i to packing place in week t (stem)

$BPACK_{vt}$: Quantity of packed boxes of lily variety v in packing place in week t (box)

IW_{vt} : Quantity of boxes of lily variety v stored in warehouse in week t (box)

$BSPD_{vtd}$: Quantity of boxes of lily variety v ship from packing place to distribution center d in week t (box)

$HPACKQT$: Quantity of worker in packing place (worker)

BD_{vtd} : Quantity of boxes of lily variety v in distribution center d in week t (box)

$BSDC_{vtdc}$: Quantity of boxes of lily variety v ship from distribution center d to customers c in week t (box)

BC_{vtc} : Quantity of boxes of lily variety v demanded by customers c in week t (box)

- **Model formulation**

Objective function is to maximize the expected profit:

Maximize Profit = Total revenue – Total cost of cultivation – Total cost of packing place – Total cost of distribution centers

Total revenue = $\sum_v \sum_t \sum_c PRICE_{tv}\ .BC_{vtc}$

Total cost of cultivation = $\sum_i \sum_v \sum_t CBULB_v.BQT_{ivt} + \sum_i \sum_v \sum_t CMET_v.USEAREA_{ivt} + \sum_i \sum_t CHW.FQT_{it} + \sum_v \sum_t CFP.SSFP_{vt}$

Total cost of packing place = $\sum_v \sum_t CBPACK.BPACK_{vt} + \sum_t CHBPACK.HPACKQT_t + \sum_v \sum_t COW.IW_{vt} + \sum_v \sum_t \sum_d CPD_d.BD_{vtd} + COP.68$

Total cost of distribution centers = $\sum_d COD_d.68 + \sum_v \sum_t \sum_d \sum_c CDC_{dc}.BC_{vtc}$

Constraints :

(1) $HARAREA_{iv(t+1)} = USEAREA_{iv[(t+1)-1-p(v)]}$ $(t \geq p(v))$

(2) $AVAIAREA_{i(t+1)} = AREA_i - \sum_{(t+1)-1-p(v)}^{(t+1)-1} \sum_v USEAREA_{iv(t+1)} + \sum_v HARAREA_{iv(t+1)}$

(3) $\sum_v USEAREA_{iv(t+1)} \leq AVAIAREA_{i(t+1)}$

(4) $LYQT_{ivt} = 0.9\ .BQT_{iv[t-p(v)]}$

(5) $\frac{BQT_{ivt}}{DENS_v} \leq USEAREA_{ivt}$

(6) $SSFP_{vt} = \sum_i LYQT_{ivt}$ (t≥ 11)

(7) $BPACK \leq \frac{SSFP_{vt}}{5}/10$

(8) $IW_{vt} = BPACK_{vt} + IW_{v(t-1)} - \sum_d BSPD_{v(t+1)d}$

(9) $\sum_v IW_{vt} \leq WCAP$

(10) $BD_{v(t+1)d} = \sum_d BSPD_{vtd}$

(11) $\sum_c BSDC_{vtdc} = BD_{vtd}$

(12) $BC_{vtdc} = BSDC_{vtcd}$

(13) $BC_{vtcd} \leq DEMAND_{vtdc}$

(14) $FQT_{i(t+1)} \geq \frac{AREA_i - AVAIAREA_{i(t+1)}}{100}$

(15) $FQT_{it} = FQT_{i(t-1)}$

(16) $HPACKQT_t \geq \frac{\sum_v BPACK_{vt}}{\frac{7.(60)}{200+10}.(5)}$

(17) $HPACKQT_t = HPACKQT_{(t-1)}$

Constraint (1) determines the quantity of harvest area in week + 1 which is equal to the quantity of plant area. Constraint (2) calculates remain available area after planting. Constraint (3) shows the quantity of area used to plant which is equal or less than remain available area. Constraints (4) (5) calculate the productivity. Constraints (6) (7) determine the quantity of box that packed in packing place. Constraints (8) (9) (10) determine the inventory level and shipping quantity boxes of lily from packing place to distribution centers. Constraints (11) (12) (13) determine the quantity of boxes of lily need to ship from distribution centers to customers which has to satisfy the certain demand. Constraints (14) (15) show the necessary required workers who work in farms. Constraints (16) (17) show the quantity of workers who work in packing place.

V. RESULT

Table 1 : Sample result of BQT in 10 weeks (bulb)

Farm 1	Variety					
week	1	2	3	4	5	6
1	3500	2667	0	0	0	0
2	2778	0	0	0	389	0
3	0	778	0	0	389	0
4	2389	0	1334	0	1834	0
5	0	0	0	0	1334	223
6	4112	0	0	0	1723	0
7	0	3112	0	0	6112	3445
8	1834	0	0	0	5667	0
9	0	0	1834	0	0	2834
10	2112	0	0	945	2834	0
Farm 2	Variety					
week	1	2	3	4	5	6
1	778	0	0	0	0	0
2	0	0	0	1278	0	0
3	0	0	0	0	0	0
4	0	1612	0	0	0	2112
5	0	0	0	0	1001	0
6	0	1278	2334	0	2223	0
7	0	0	0	2056	0	0
8	1889	2834	1945	0	0	3056
9	0	2667	0	1778	0	0
10	0	0	0	0	0	0
Farm 3	Variety					
week	1	2	3	4	5	6
1	0	0	0	0	0	0
2	0	0	945	0	1056	0
3	1056	0	0	0	2667	500
4	0	0	0	2167	0	0
5	0	1500	0	0	0	0

6	0	0	0	0	2945	1112
7	3889	0	0	0	0	0
8	0	0	0	0	0	0
9	2000	0	0	0	5334	0
10	0	1445	945	0	0	2723
Farm 4	Variety					
week	1	2	3	4	5	6
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	501	0	0
5	0	0	0	1278	0	0
6	0	0	0	0	0	0
7	0	0	2112	0	0	0
8	0	0	0	1889	0	0
9	0	0	0	0	0	0
10	0	0	0	0	0	0

Table 2 : Sample result of BSPD in 10 weeks (box)

DC 1	Variety					
week	1	2	3	4	5	6
17	16	4	4	0	16	6
18	22	10	14	12	14	12
19	24	12	8	12	8	14
20	16	20	8	8	16	10
21	102	16	34	30	16	28
22	26	64	40	16	16	38
23	60	16	36	44	16	16
24	74	16	40	16	16	16
25	30	12	18	14	16	4
26	28	16	14	20	8	14
DC 2	Variety					
week	1	2	3	4	5	6
17	16	20	4	16	36	12
18	40	34	12	18	76	30
19	36	32	16	16	78	28
20	42	24	16	20	68	30
21	64	110	50	56	232	96
22	122	48	36	58	204	72
23	80	86	34	24	188	86
24	60	80	26	48	176	82
25	42	40	16	20	86	50
26	48	38	22	18	98	40

Table 3 : Result analysis of demand in 2015

Demand in 2015					
Total			Price components per box		
Revenue	2426000000	vnd	Average price	500000	vnd
Profit	124866000	vnd	Profit	25735	vnd
Cultivation cost	1997884000	vnd	Cultivation cost	411765	vnd
Packing place operation cost	0	vnd	Packing place operation cost	0	vnd
DC operation cost	0	vnd	DC operation cost	0	vnd
Transportation cost	303250000	vnd	Transportation cost	62500	vnd
Total cost	2301134000	vnd			

VI. CONCLUSION

Lily flower cultivation in Kontum province has developed in recent years which carry along several benefits as promote the economic development in general and help farmers increases their income. This study started with determine the demand of market before execute the production plan. Finally, the more efficient production and distribution planning is scheduled by applying mix integer linear programing. With this result, the cost for whole supply chain network could be minimized in the future and farmers will understand clearly about the market.

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