

**DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING
OPERATIONS RESEARCH – I**

COMPUTER-BASED ASSIGNMENT

CASE STUDY: KALPAVRUKSHA SILK COMPANY¹

The Kalpavriksha Silk Company has been engaged in the production and marketing of high quality silk for the last four decades. The company was market leader in the field of quality silk. However, in recent years, it has been struggling to stay afloat due to increased costs, obsolescence of machinery and reduced profit margins. The company's mounting losses have forced the General Manager to re-examine the entire working of the company in the framework of yearly planning, right from the purchase of "cocoons," a raw material for reeling silk, to the processing aspects and the sale of silk yarn. With a view to improve the effectiveness and efficiency of the company, the General Manager has decided to examine the purchase, production scheduling and sales plan for the company. To start with, he has decided to develop a plan for the forthcoming quarter to decide how much of raw material to purchase and at what time point, how much of each type of silk produce and when, how much of raw material and silk inventory to carry during various periods as well as when and what quantity of silk yarn to sell. Once successful in developing an appropriate methodology, his objective is to extend the rationale for annual operating plans.

Briefly, the process of manufacturing silk yarn involves stifling, reeling and re-reeling. The stifling process kills the pupae within the cocoons so that the cocoon can be stored for a few weeks before being taken for further processing known as reeling. The stifling process has an important bearing on the quality of raw silk. Reeling is the process of producing the raw silk from the cocoons. The company has two kinds of reeling mechanisms, namely Charaka and Filature (reeling on a multi-end machine). The raw silks produced from them differ in respect of quality as also productivity. Filature silk is finer as compared to the Charaka silk. Before reeling, cocoons are sorted as good and bad cocoons (includes "double" cocoons). Good quality cocoons can be used for producing filature silk, while double cocoons can be used only for producing dupion silk on the charakas. Of course, dupion silk can be produced using good cocoons also; in the past this was considered an inefficient practice. However recent trend, indicating better margins for dupion, had resulted in some companies using good quality cocoons for dupion silk also.

The details collected by the General Manager from the managers-in-charge of various departments are as follows:

The Marketing and Purchase Manager, based on his past experience and information, has developed a Regression model by which he has estimated the likely prices of cocoons and the two types of silk for the forthcoming 3 months (12 Weeks). The details regarding the purchase price of cocoons and the selling price of filature and dupion silk are given in Table 1. Besides, according to him, no limits – neither upper nor lower – need to be put on the quantity of silk to be sold and the quantity of cocoons to be purchased, as the sale or purchase takes place in the open auction markets and the company by itself cannot influence the prices. Further, the company has adequate storing space for storing cocoons and silk. Budget is not a serious limiting factor in quarterly operations.

The Production Manager has prepared details regarding operations of the factory and the estimated productivity, which are described in the following sentences. Any lot of purchased cocoons, generally consists of 95% good cocoons, 4% double cocoons and 1% bad cocoons. There are 70 filature basins and 5 charaka units in the company. The reeling productivity for filature silk is 0.8 Kg of raw silk/day/basin (the basin is a part of reeling unit, where the cocoons are placed in hot water while being reeled), while for dupion silk, it is 1.2 Kg/day/basin. The company works for 6 days in a week and reelers for both filature and dupion silk are interchangeable. A reeler could work on one basin or one charaka: as a result he can reel 0.8 Kg of filature silk per day or 1.2 Kg of dupion silk per day. The entire quantity of filature silk reeled is further re-reeled to bring uniformity and strength to the material. About 2.4 Kg of silk could be re-reeled by each re-reeler in a day. There are 60 reelers and 20 re-reelers in the company. Both reelers and re-reelers earn Rs. 50 per day as wages. The opening inventory for the first week for

¹ Based on *A Case Study on the Application of Linear Programming in a Silk Filature Unit* by S. Venugopal and B. G. Raghavendra, Department of Management Studies, IISc, Bangalore.

cocoons, filature silk and dupion silk could be considered as zero. The interest rate on material held in inventory is 15% p.a.

The quality of cocoons is assessed based on the its estimated 'Renditta'. The Renditta, expressed in simpler terms is the quantity of cocoons in kg required to produce 1 kg of silk yarn. For the quarter under consideration, the Renditta varies with season due to the moisture content of cocoons. The average Renditta, based on past observations is 9.4 for filature silk (for good quality cocoons) and 6.5 for dupion silk (for both good quality and double cocoons).

The bad cocoons go for producing silk waste, a by-product, which is sold at Rs.10 per Kg. Additionally, the quantity of silk waste produced is 25 grams for every Kg of cocoon used for producing filature silk. Further, the dead pupae obtained after the cocoons are unwound as silk yarn is also sold as a by-product. The quantity of dead pupae is approximately 20% by weight of cocoons used. The silk waste sells at Rs.50 per Kg while dead pupae could be sold at 60 paise per Kg. As is traditional in operational planning, other variable costs like power, fuel, administrative overheads, etc., could be ignored for this planning exercise.

With these details, the General Manager thought of developing quarterly operating plan. This operating plan is intended to specify the optimal purchase, production scheduling and sales plan for the company for the next twelve weeks.

QUESTIONS:

1. Formulate the problem discussed in the case in the framework of a Linear Programming model.

Use a computer-based program to answer the following question:

2. Interpret the L.P. results, by providing the recommendations in the form of simple tables/reports that could be easily understood by the management and supervisory staff.
3. What should be the quantity of cocoons purchased, utilized and inventory held for different weeks?
4. What should be the quantity of filature silk produced, sold and inventory held for the different weeks?
5. What should be the quantity of dupion silk produced, sold and inventory held for different weeks?
6. What is the ideal number of reeler and re-reeler days required for filature and dupion silk?
7. Suppose wages for reelers and re-reelers are considered as fixed cost, what is the resulting net profit?
8. Suppose the Renditta for filature and/or dupion silk changes, what are the changes in the solution?
9. If the productivity for filature and/or dupion silk changes, what are the associated changes in the solution?

Table 1: Estimated Average Purchase Price of Cocoons and Estimated Average Sales Price of Silk for the Forthcoming Twelve Weeks

Week	Estimated Purchase Price of Cocoons (Rs./Kg)	Estimated Sales Price of Silk (Rs./Kg)	
		Filature	Dupion
1	81.94	932.17	561.79
2	75.00	849.37	518.35
3	77.15	825.25	483.14
4	74.72	828.46	488.30
5	76.96	851.64	496.92
6	76.18	859.94	509.17
7	70.63	811.56	488.22
8	67.95	770.58	454.57
9	61.69	729.73	431.33
10	63.68	713.91	413.20
11	64.79	731.70	420.72
12	67.23	783.02	447.84