CHAPTER I

INTRODUCTION

1.1 DAIRY INDUSTRIES AND OPTIMIZATION

Milk is a versatile commodity, which could be processed into an amazing range of food products. The major constituents of milk viz. butter fat, proteins and carbohydrates can be processed into a variety of products through partitioning.

Milk can be processed as such or fermented or blended with other foods to field a vast range of products. Even though potential for product diversification is so immense, it is paradoxical to see that the most of the milk products factories continue to thrive with a very limited 'product mix'. The shortages in meeting the consumer demand for milk products in general, are mainly responsible for the success of this otherwise narrow based strategy. It is unlikely that this situation would change in the foreseeable future. [see Mathur, May 1988]

This invites the researcher to investigate or develop an efficient computerized system to meet the demands of consumers and at the same time dairy plant operations should be optimized.

In dairy industry the efficiency and development mainly depends on procurement of milk, processing and marketing

whole milk as well as milk products. The important factors of milk procurement are collection, transportation and chilling. The efficiency heavily relies on the efficiency with which each of these operations are performed.

Efficiency depends on location, capacity of the plant, sources of utilities and services, models of transporation employed, number of routes and area of milk shed, losses spoilage, etc.

Present study attempts to develop a linear programming model for optimization i.e. profit maximization through mathematical model and emphasis will be given to increase efficiency of the dairy plant.

The major decisions of the management to be taken for efficient operation of business firm are related to time, quantity and place of the purchase of row material, i.e what, how much, when and how to produce and when and where to sale. All these decisions are equally applicable to a dairy plant engaged in all the three operations of procurement, processing and product distribution. This invited the attention of research workers to formulate efficient plans for the said operations particularly in the countries where dairying is a commercially developed enterprise.

Operation flood project launched in India in early seventies emerged as a highly successful an a very promising programme of Indo-EEC co-operation in the last 15 years. [see A.A.Alam, 1988]

The success of operation flood creates the problem of what to do with the milk procured. It can't be kept as it is. This is an attempt to use available milk in best possible manner so as to profit will be maximized.

2.1 DEFINITIONS

MATHEMATICAL MODEL AND LINEAR PROGRAMMING MODEL

Mathematical Model is a set of statements about a set of variables. These statements are normally in the form of mathematical relationships between the variables. Analyzing the relationship it is possible to make further statements about the variables in the model.

Introduction to linear programming models :

The present and truly useful development of the linear programming method is due to the work of Dr. George B. Dantzig, an American mathematician, who in 1947 introduced some basic mathematical formulations. Later, other mathematicians gave their important contribution to this analysis. Dantzig and Marshal wood studied mathematical techniques related to military planning problems and defined the relationships between the optimization of programs in minimizing linear objective functions.

Linear programming models are referred to as a scientific method of solving problems in which an optimum solution is

sought from among the many possible ones which are shaped by the observation of certain restraining conditions, for example, problems of determining the optimal product mix under given selling prices and known purchasing investments, problems concerned with productivity in relation to Labour and machine capacities problems involved with the determination of the optimum storage or distribution of commodities problems seeking to minimize the time usages of existing machines, problems of maximizing the enterprise's profit, or of optimizing labor allocation, and many other business production or economic problems, and recently problems in the natural sciences, can all be handled by linear programming techniques.

Very frequently production costs vary among plants, departments and shops of the same enterprise, Productivity changes because of the dynamics of the external and internal environment in which a firm operates. Profitability is influenced by nonconstant standard cost. Even production schedules must be continuously adjusted in order to obtain better, quicker, more prottable product mix. Managers are seeking from mathematical models a way of analyzing these variables and a tool which will enable them to pass from a subjective solution to an objective one whenever a problem arise.

From industrial and business point of view, the application of mathematical models in general, and of linear programming

in particular, ranges from an analysis of the overhead expenses of an enterprise to the investigation of a small problem in which a few operations are involved.

A businessman may look upon linear programming techniques as useful tools for seeking from among many solutions one which matches his clearly defined objectives. A mathematician may be more technical in defining linear programming by saying that it is a process of solving specific problems in which an objective function must be maximized or minimized, considering a set of definite restrictions and limited resources. In fact the word 'Programming' stands for 'computing' or, 'calculating' the values of some unknowns of a set of equations and/or inequalities.

Definition of objective

A well defined objective is the target of the solution for instance to find the way of obtaining the highest profit by utilizing only the resources available under certain conditions, or to determine the best distribution of the productive factors over a fixed period of time. Mathematically speaking, this means that an objective function must be clearly defined in order to meet, by applying the technique, the desired ultimate goal expressed by this function.

A quantitative measurement is needed for each of the elements described in the problem. This is one of the essential

conditions for applying mathematical models. Numerical data must depict the problem in terms of relationships involved among the elements considered. Physical and real measurements must be the media for stating the problem. Thus accurate means of measurement, such as Rupees, hours, pounds etc. must be brought into the computation.

From among the elements considered for instance, the six classic productive factors men, materials, machinery, money, methods and markets (sometimes referred to as six M's) It must be possible to make a selection for reaching a soluation, which satisfy the objective function.

3.1 GENERAL LINEAR PROGRAMMING PROBLEM

Linear programming technique is generally used either for maximization or minimization problem. The optimization model was specially designed to determine how much intermediate products should be manufactured and individually be used at the least possible cost. The optimal product mix problem depends on various constraints like what, how much and where of each product be manufactured and sold at different locations.

With the consideration of milk procurement network, what products to be processed and distributed optimally are complicated decisions faced by dairy management. The linear programming model was used for two decisions,that is for

optimization of processing milk into milk product and rationalization of products distribution and sales systems.

Linear Programming Model

Under general linear programming model such as diet problem, a problem can be to find a set of optimal values of decision variables.

$X_1, X_2 \text{------} X_n$ such that

Maximize

$$Z = C_1X_1+C_2X_2+C_3X_3+\text{----------}+C_nX_n \qquad (1)$$

$$= \sum_{j=1}^{n} C_jX_j$$

Subject to constraints,

$$\sum_{j=i}^{k} a_{ij} \quad X_j \quad = < \quad b_i \quad (i=1,2\text{---}m) \qquad (2)$$

$$x_j = > 0 \qquad (3)$$

Where

Z= Total contribution value

C_j= Covering contribution per unit of jth activity

= (Sales prices - variable cost)

X_j = jth decision variable

a_{ij}= Amount of ith input per unit of jth activity

b_i= Available quantity of ith restriction

m = No.of restrictions or equations

k = No. of decision variables

4.1 OBJECTIVES AND ASSUMPTIONS

OBJECTIVES

1. To study the existing procument, processing and milk product manufacture system.
2. To study the existing production programme and fluid milk sales of the dairy plant and formulate the optimal product mix subject to resources and restrictions.
3. To formulate the mathematical model viz linear programming model for profit maximization of dairy plant.
4. To study the seasonal factors affecting the profitability of the plant.

ASSUMPTIONS

The present investigation is based on certain assumptions because all the parameters of the real world situation cannot be incorporated in a single case study. The following are the assumptions made for the Dairy Plant under study.

i) Milk procured is of Buffalo and cow having fat 6.682 and 9.252 SNF (Solids Not containing Fats) and 4.05 Fat and 8.6 SNF respectively.

ii) Milk and Milk Products are packed and sold in 1 liter and 1 kg. polypack bags respectively.

iii) The suitable cost incurred in milk procurement, processing and selling and distribution are considered to vary with quality and level of sales through different

marketing networks.

iv) The cost of milk procurement is governed by other allied factors such as milk prices, seasons etc.

v) It is assumed that the plant has sufficient number of direct and indirect Labour.

vi) Skim milk and Milk Products fat percentage or SNF percentage recovery is considered as and ideal.

vii) Data available for the financial year 1992-93 is considered for the research.

5. PROBLEMS IN DAIRYING :

A) A dairy industry management facing the problem of what and how much of the milk and different intermediate products should be manufactured so as to profit maximization, subject to their respective quality standards of Fat and SNF.

B) Milk supply is increased due to the "Operation Flood Project I, II, III, " Which is world's largest dairy development programme. It is proposed to expand milk marketing from 6 milion litres to 10.3 million litres. The milk processing capacity will also be expanded. There was a positive contribution and excellent support by the dairy equipment manufactures in indigenisation and modernisation of dairy plant equipment in the country. For manufacturing a complete range of equipment for handing and processing of milk and milk products. Still the dairy firms managements are not taking risks to produce more and various qualities of

milk products because they are afraid of market. Whether the milk products manufactured sold or not. Will it be profitable ?

C) The liquid milk trade is still in the hands of private vendors and the organised dairy sector has not been able to make a major dent in their market share. This is due to following factors.

1) Problem of Non acceptance of dairy milk by urban consumers due to its flavor and peculiar dairy tastes, like stale, sanitizer taste and flavor etc.

2) Irregular and erratic supplies of liquid milk marketed by Govt. dairies

3) Problem of irregularity of sales staff at milk booths and absence of sales incentive to these fixed wages salesman in organised dairy sector.

4) Non availability of home delivery liquid milk supply system and monopoly practices by liquid milk dealers wherever appointed.

5) Problem of daily cash payment against delivery of milk and milk products.

6) Inadequate sales commission to dealers appointed for the distribution of milk.

7) Periodical and day to day variations in the smell and taste of milk and occasional curding of milk.

The above problems may vary from place to place depending upon the efficiency and approach of the local plant

management but these problems necessaryly do not apply for all the dairy plants.

D) The recent spurt in the prices of milk products has given a severe blow to the liquid milk supply system as most dairy executives find marketing products more profitable and less cumbersome as with the daily rising product market, the products are usually sold out before production and are also lifted in bulk quantities. Thus there is no real effort at marketing of liquid milk and also milk products.

E) In some dairy plants even the cost of milk collection exceeds the cost of its processing. Therefore, to achive economic efficiency, milk plants have to exercise in minimizing the cost of milk procurement. This problem is still present in some of the dairy plants.

The cost of procurement depends upon the average volume of milk handled, mode of collection and transportation seasonal fluctuations, milk density of the area of collection, number and spread of producers in the milk shed areas, frequency of milk collection etc. These are all factors affecting the efficiency of dairy plant. It is necessary to study and estimate the cost of procurement, reception and chilling operations in co-operative sector milk plant.