CHAPTER III

METHODOLOGY

1.] METHOD ADOPED

The present investigation is aimed at studying the existing systems of milk procurement, processing and distribution of composite milk plant and to optimize them for maximization of the profit. For this a milk plant was required having a well developed milk shed area, a factory with multiproduction system and well set network of its products distribution. For consideration of these aspects a milk plant with installed capacity of handling two lac. liters milk per day was selected in Maharashtra State which was performing all the three operations viz milk procurement, processing and distribution. This plant is situated in Kolhapur District at Amrutnagar.

There is significant seasonal variation in the production of milk and consumers demand affecting the production scheduling of the plant.

2.] SURVEY OF LECTRETURE AND FORMULATION OF MODEL

First optimization technique for dairy plant is applied by Dr.K.K. Karala, NDRI Karnal for optimization of all the three sub-systems procurement, processing and distribution.

Under maximization problem the decision required to be taken were what and how much of the dairy products giving hightest covering contribution were to produce and distributed for sale subject to various restrictions.

Under minimization problem what and how much of different intermediate ingradients should be manufactured in linkage with maximization problem and used individually for different products subject to their respective quality standards.

Refering the journals, research papers except Dr.K.K. Karala no one has written any paper on optimization technique for dairy industry. So far as no research work is done with respect to maximize the objective function under certain conditions.

However there are some researchers who have tried for maximization in agriculture. They have defined objective function and using certain formulae it can be optimized.

This is the first attempt in formulating the real situation problem converted in terms of mathematical one. A problem is consider to maximize the profit of dairy plant. Researcher has tried to develop a linear programming model to maximize objective function subject to certain restrictions.

Whatever data made available is used. Sometimes it is directly taken from observations and interviews. Data collected for labour hours, machine min. resources, working

capital may be need to modify. Collected data is put up in tabular form. One may require to revise partly or fully. This data may vary from a dairy plant to dairy plant.

The dairy plant authorities volunteered to provide all possible co-operation and help for the collection of information

Linear Programming model developed for profit maximization of dairy plant subject to restrictions such as resources, labour hours, machine hours, working capital , transportation system etc.

3.1 DEFINITIONS OF VARIABLE AND PARAMETER

For the purpose of a linear programming model it is necessary to define the variables and parameters. These parameters play an important role in the model. To develop relations between these following variables are defined.

1. C_j's means covering contribution. In other words Net gain after sale or sales price minus variable cost of production. Sales price includes transportation, discounts, tanes, etc.

2. b_j's beings parameters indicate the availability of resources. It also denotes the restrictions such as total man hours, machine minutes, related to processing and production of milk products.

3. a_{ij}'s technological coefficients or parameters defining per unit requirements of products and other activities for resources and restrictions.

4. X_j's are decision variables in the linear programming model. Decision variables X_j's are quantity of milk and milk products. How much the milk products to be produce to a maximize the obejective fuction.

Commensurate with the objectives the procurement, processing and distribution were considered collectively, for optimization of operations.

Under minimization problem, the decision required to be taken were what and how much of the dairy products giving highest covering contribution were to be manufacture, packaged and ultimately sold and distributed through different marketing systems subject to various restrictions.

There are two types of milk one mix to std (standardized) and second whole milk or blended form the milk. All the milk collected can't be sale off. Therefore it is necessary to use for milk products. Under minimization problem what and how much of the different intermediate products, ingredients should be manufactured in linkage with maximization problem and be used individually for different products subject to their respective quality standards of fat and SNF.

For this purpose a linear programming model was specially designed and is presented in following matrix form.

4.3 DATA COLLECTION

The data were collected for the financial year 1992-93 on all the three sub-system of the dairy by using the records, personal interviews and taking observations. The details of the data collection on procurement, processing and distribution are discussed below.

Milk Procurement

The information with respect to milk procurement was collected on milk collection, payments made, commission paid transportation cost, miscellaneous items.

Milk Processing

The data on milk processing at the factory of the plant were collected on general information raw material and final products, Quality control test performed, machine minutes and man-hour used, electricity, steam refrigeration, cold storage, Labour water supply, equipments, workshop maintenance items etc.

The observations were taken on products manufactured along with the fat and SNF recovery during processing. The observations were also taken where-ever possible to obtain the information on losses in various products manufacture such as handling losses, SMP losses through chemani.

The information was recorded on the monthly basis and it is

considered for the financial year 1992-93. The milk procured, processed and distributed for one year span is considered for the this investigation, supplementary data of the preceding and subsequent year is also recorded.

5.1 WORKING CAPITAL

Working capital is defined as the current Assets minus current liabilities.

The dairy plant has fixed supply of raw materials, given capacities of machinery and equipments, fixed availability of Labour and working capital. In the manufacture of different dairy products the plant had to maintain its quality control standards, besides, there were some other restrictions like supply of standardise milk to general public.

Working capital for each activities is considered with respect to the 100 units. For instance 100 litres of milk procurement cost is allocated on W/M and C/M. Working capital require for milk purchasing 100 litres is Rs. 130/- each, which includes processing cost also. working capital for STD Milk is just Rs. 45/-. Since once milk received on dock the capital is required only for processing. Processing average cost per lit is Rs. 0.45/- . Therefore, for 100 litres of milk processing requires Rs. 45/- as working capital.

Milk supplied is utilized in the product manufacture. The products manufactured were transferred to the suppliers for

their implicit use. The optimization is done only for one year, the opening and closing balances of milk and milk products were taken at zero level. i.e. the explicit supply levels of milk and milk products were assumed at zero levels. Working capital for each product is as follows. Let 100 litres of milk is to use for milk product having 6.5% fat and 9.00% SNF. The yield will be shown as per following flow chart.

GHEE AND SMP PRODUCTION

100 litres milk if it used for milk products it gives intermediate products as follows.

Weight of milk in Kg. = volume x sp. Gravity

= 100 x 1.028

= 102.8 Kg

Thus 100 liters of milk is equivalent to 102.8 kg milk, having 6.5% fat and 9.0% SNF.

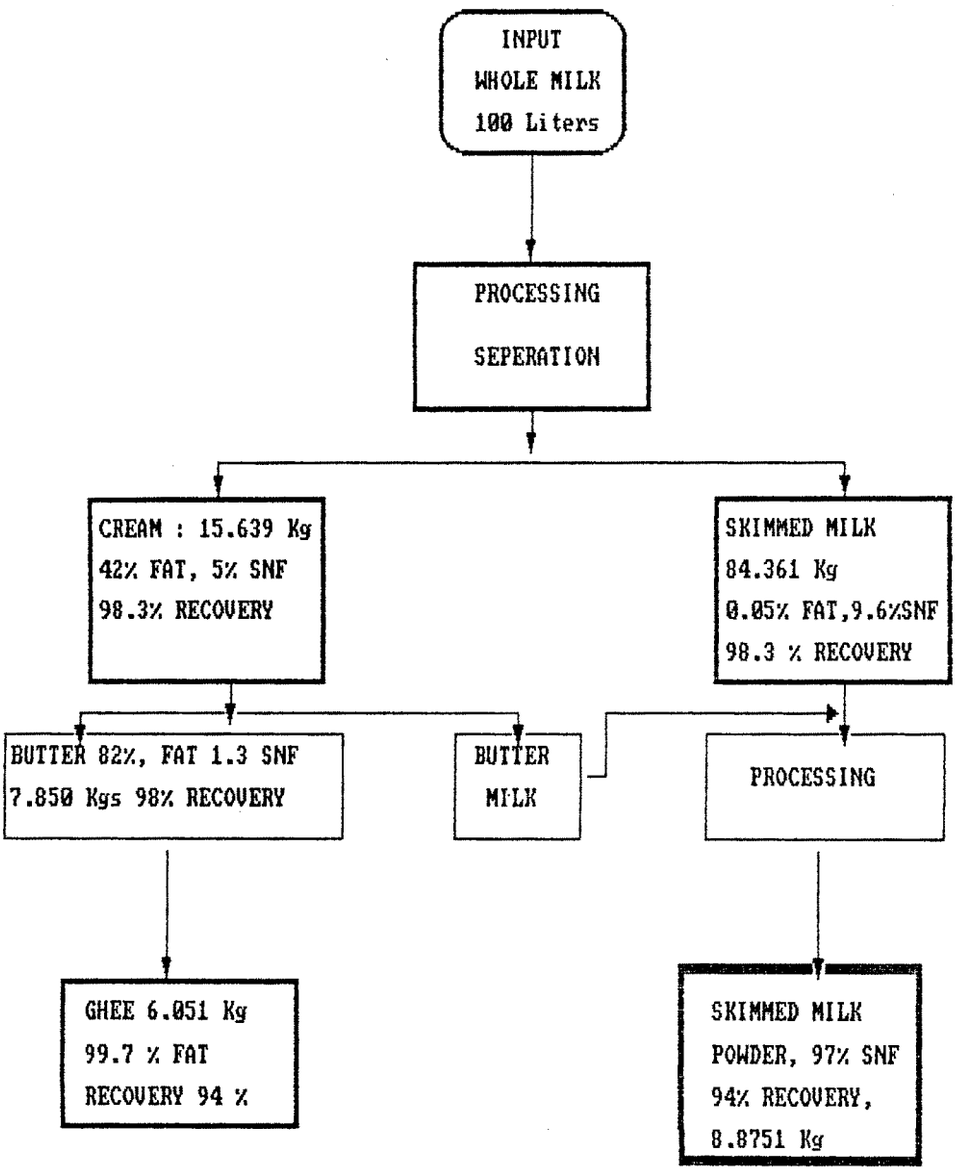
Cream production If we desire a cream having fat percentage 42 (which varies as per requirement) and 5% SNF at 98.3% recovery.

$$\text{Cream} = \frac{\text{Milk (kg)} \times \text{fat} \times \text{Recovery (fat kg)}}{\text{Cream having 42\% fat}}$$

$$= \frac{102.8 \times 6.5\% \times 98.3\%}{42\%}$$

$$= \frac{102.8 \times 0.065 \times 0.983}{0.42}$$

$$= 15.639062$$


INPUT
WHOLE MILK
100 Liters
PROCESSING
SEPERATION
CREAM : 15.639 Kg
42% FAT, 5% SNF
98.3% RECOVERY
SKIMMED MILK
84.361 Kg
0.05% FAT,9.6%SNF
98.3 % RECOVERY
BUTTER 82%, FAT 1.3 SNF
7.850 Kgs 98% RECOVERY
BUTTER
MILK
PROCESSING
GHEE 6.051 Kg
99.7 % FAT
RECOVERY 94 %
SKIMMED MILK
POWDER, 97% SNF
94% RECOVERY,
8.8751 Kg

BUTTER PRODUCTION

For butter production cream having 42% fat is used.

Thus butter having 82% fat and 1.3% SNF say at 98% recovery

$$\text{Butter} = \frac{\text{Kg fat} \times \text{recovery of cream}}{\text{Butter having 82\% fat}}$$

$$= \frac{15.639 \times 42\% \times 98\%}{82\%}$$

Butter = 7.850 Kg.

GHEE PRODUCTION

For Ghee production Butter having 82% fat is used with recovery 94%. It produces Ghee having 99.7% fat. Thus Ghee production is as follows :-

Ghee = Butter Kg x Butter fat x Recovery

= 7.850 x 82% x 94%

= 6.05078

= 6.051

SMP

Skimed milk having 0.05% fat and 9.5% SNF is obtined after the sepration of Cream from the Whole Milk. So the total Skim Milk is

Milk quantity	=	102.8 Kg
Less Butter quantity	=	7.850
Skim milk quantity	=	94.95 kgs
	=	91.3947 litres

(1 litres SKM = 1.0389 Kg SKM)

9.8 litres SKM gives 1 kg SMP

Therefore 91.3447 litres gives 9.3259898 Kg. SMP

Provided 94% recovery if it is 97% SN F recovery then 91.3947 litres of SKM gives 8.875 Kg SMP (10.298 litres of SKM gives 1 kg SMP)

Butter conversion cost Rs. 4.20 per Kg. Butter production is 7.850 per Kg. and requires Rs. 32.97 as working capital.
Ghee conversion cost is Rs. 4.95 per kg. Ghee manufactured is 6.051 kg and require Rs.29.95 as working capital.
SMP conversion cost is Rs. 8.40 per Kg. WMP conversion cost is Rs. 8.40 per Kg.

After production of Butter remaining milk is called Butter milk which is added in Skim Milk having Low fat and high SNF percentage. The SMP product obtained is 8.875 Kg. For 8.875 kg SMP working capital required is Rs. 74.55.

FOR CULTURED PRODUCTS

If 100 litres of milk is used for chakka production yield is 28.57 Kg. For 1 Kg chakka conversion cost is Rs. 2.00. Therefore for 28.57 Kg. Chakka conversion cost is Rs. 57.1428.

Shrikhand production require additional raw material such as sugar and flavored. Observation made through personal interview with production managers 100 kg chakka gives 180 kg Shrikhand. Since we have 28.57 Kg. Chakka available for production. This amount must give 51.426 kg.

Shrikhand Production.

Since 100 kg chakka gives 180 kg Shrikhand

Therefore 28.57 Kg Chakka gives $= \frac{28.57}{100} \times 180$

$= 51.426$

Material cost of Shrikhand per Kg. is Rs. 7.722 + .55 conversion i.e. Total conversion cost is Rs. 8.272.

For 1 Kg Shrikhand production working capital require is 8.272 Therefore for 51.426 kg Shrikhand production cost is Rs. 425.3958.

Thus working capital for Shrikhand is 425.39

LASSI PRODUCTION COST OR WORKING CAPITAL.

Lassi produced is made by using cow milk most of the time. For the lassi preparation raw material such as suger syrup, flavours etc. is required. If 100 litres milk is used for lassi production it gives rise to 130 lit of lassi conversion cost of lassi per litres is Rs.3.723. Therefore 130 litres of Lassi requires Rs. 483.99 includes packing, transportation, manufacturing cost etc.

6.3 DETERMINATION OF VALUES OF PARAMETERS

The values C_j's of the parameters used in the objective function of the model represented the cost of material purchasing, manufacturing, packaging and hiring and transfer activities. The net gain after sale or sales price minus the

production cost of Milk or Milk products. Sale price includes transportation discounts ect.

Milk purchasing cost included the variable costs incurred on all the activities of milk procurement, salary and benefits, transportation, veterinary expenses, Quality control, general administration cost, Ice cost, commission for society, depreciation and Interest. Plant's milk collection cost per lit is Basic cost of milk plus other expanses. In financial year 1992-93 milk procurement cost per litres is Rs. 0.85 and Basic cost of milk is Rs. 9.15 and pocessing cost is Rs. 0.45 per litre. i.e. total cost of Milk is Rs. 10.45 per litres average cost in year under consideration. After pasteurization Standardized Milk is sold at Rs. 10.65 per litres.

At the same time Whole Milk (6.5% Fat-9.5% SNF) is purchased at Rs. 11.00 including procurement and processing and sold at rate Rs. 12.00 per litre. Like wise cow milk purchase cost is Rs. 8.60 including procurement and processing cost and market price is Rs. 8.70 per litre having 3.5% fat and 8.5% SNF.

Thus the covering contribution for standerdized Milk, Whole Milk and Cow Milk after sale is Rs. 0.20, Rs. 1.00 and Rs. 0.10 per litre.

In present investigation production cost or variable cost, net sales prices and covering contribution were used to maximize the value of objective function Z, under certain restrictions.

Prices of milk is also depends on the milk supplied by milk suppliers. Milk received is in the three forms namely good, sour and curd each with separate fat and SNF.

MILK AND MILK PRODUCT PRICES

Marketing departments, sales section were used to obtain the information regarding procurement costs of milk and sale price of milk and also processing costs of milk products including all taxes, discounts, transporation etc.

Marketing costs vary from the one place to another depending on distance from the plant. For instance standardized milk per it letter cost is Rs. 10.65 per litres at local sale while Rs. 11.50 is charged at Bombay since the distance is approximately 600 km. from the dairy plant. However dairy plant gives services to their agent through their network system.

Milk received from storage is taken to processing unit where the milk is pasteurized, fat and SNF percentage is maintained and at the same time high percentage of fat is separated. For production the fat is separated through separator is nothing but cream and remining Milk is SKM. The cost of

processing is Rs.19.50 and 110.50 allocated on cream and skimed milk as working capital respectively.

The milk products are either sale or store at cold storage and stores depreciation and interest of such cost is included in manufacturing. Following table shows the variable cost and Market price of each product and totle income i.e. covering contribution C_j's corresponding to each Milk and Milk products.

Sr. No.	Milk Product Name	Sales Price per kg Rs.	Variable cost per kg Rs.	Difference per kg Rs.
01	STD [per lit.]	10.65	10.45	0.20
02	W/M [per lit.]	12.00	11.00	1.00
03	C/W [per lit.]	08.70	08.60	0.10
04	CREAM	33.00	32.50	0.50
05	BUTTER	70.00	69.00	1.00
06	GHEE	85.00	95.00	-10.00
07	SKIMED MILK[per lit]	6.70	5.30	1.40
08	CHAKKA	30.00	27.00	3.00
09	SHRIKHAND	35.00	29.00	6.00
10	LASSI [per lit.]	10.50	9.25	1.25
11	SMP	56.00	55.00	1.00
12	WMP	66.00	64.50	1.50

Variable costs are those that vary with the rate of the plant, as output increases or decreases, variable cost

increase or decrease. When a plant begins putting raw material through the production processes, certain costs are incurred that do not change as more raw material is processed.

Total product cost or variable cost.

= manufacturing cost + general expenses

Gross earnings = Sales price - Total product cost.

GHEE AND SMP PRODUCTION

100 litres milk if it used for milk products it gives intermediate products as following.

Specific gravity of milk = 1.028

Mass of Milk in. kg = Volume X Sp. Gravity

= 100 X 1.028

= 102.8 kg

Thus 100 litres of milk is equivalent to 102.8 kg milk, having 6.5% fat and 9.05% SNF.

CREAM PRODUCTION

If we desire a cream having fat percentage 42 [which varies as per requirement] and 5% SNF at 98.3% recovery

$$\text{Cream} = \frac{\text{Milk [kg.] X Fat X Recovery [fat kg]}}{\text{Cream having 42\% fat}}$$

$$= \frac{102.8 \text{ X } 6.5\% \text{ X } 98.3\%}{42\%}$$

$$\text{Cream} = \frac{102.8 \times 0.065 \times 0.983}{0.42}$$

$$= 15.639062$$

Separating cream remaining milk is called is skimmed milk which contains low fat and high percentage of SNF.

BUTTER PRODUCTION

Butter [cream containing 4.2% fat]

Butter having 82% fat and 1.3 % SNF

say at 98% recovery

$$\text{Butter} = \frac{\text{kg. fat of cream} \times \text{Recovery}}{\text{Butter having 82\% fat}}$$

$$= \frac{15.639 \times 42\% \times 98\%}{82\%}$$

$$= 7.850 \text{ kg.}$$

GHEE PRODUCTION

Ghee having 100% fat and 97%

recovery = Butter kg X Butter fat X Recovery

= 7.850 X 82% X 97%

= 6.05078

= 6.051

SMP

Skimmed milk having 0.05% fat and 9.5% SNF

Milk quantity = 102.8 kg.

Lass Butter quantity = 7.850

Skim milk quantity = 94.95 kgs

= 91.3947 litres

[1 lit SKM = 1.0389 kg SKM]

9.8 litres SKM gives 1 kg SMP

91.3947 litres SKM gives 9.3259898 SMP

provided 100% recovery

if it is 97% SNF recovery then 91.3947 litres of SKM gives 8.875 kg SMP [10.298 litres if SKM gives 1 kg SMP].

7.] MAN AND MACHINE TIME

Time studies and functional hour analysis were used to take observations on actual labour hours and machine minutes used in different operations, processing, product handling, cleaning and storage of each product. At the same time information was collected on packing material used and packing system. Factory having fill packing units for fluid milk, Ghee pack and SMP packing of different units.

Time requirements for each operation for different product manufactured were obtained through functional hour analysis. The functional hour analysis based on the information through enquiry, shift performance, total production per day of each

section. Labour hours are obtained with respect to those labour who were directly involved in the production of milk products.

Procurement of milk labour hours recorded with respect to how much milk collected pre day by using plant owned and contract trucks in two session morning and evening. The total quantity of milk collected for the year 1992-93 is consider for the calculation of labour hours used.

Labour hours are also calculated with the information collected form each production section. Production rate, is taken into consideration. In addition machine restriction is also considered while calculating labour hours.

8.1 LABOUR HOURS

In general practice in a year 360 days are considered as actual working days for dairy plant. It induced total days of permanent and daily wages staff or on contract basis. While computing these labour hours, technical staff and supervisory staff members time was not considered as they were engaged in supervising the operations of the firm. In food industry the number of working days are considered as 360 day in a year, days thus arrived at were finally converted into labour hours. These hours are jointly used by all the manufacturing and packing activities.

Following is the labour hours coefficients per 100 units as much production of milk products manufacturing, packing and

other activities. Labour employed in production department only was used. Actual observations were taken to estimate the labour requirements in preparation, sterilization and operation i.e. Labour used in all respect such as rinsing, washing, cold room etc. Labour constraint was supplemented by contract basis at prevalent wage rate.

LABOUR HOURS PROCUREMENT OF MILK

In procurement of milk 185 labour are working on one shift i.e. 8 hours. They work for 360 days then

Total workin hours = Labours x Hours x Days

= 185 x 8 x 360 = 53,28,000 hours.

Milk procured is 61358702 litres in financial year 1992-93. The total working days are 360. There fore time required for 1 litre of Milk is

$$\frac{5328000}{61358702} = 0.08683 \text{ hours}$$

Therefore time required for procurement of 100 litres of Whole Milk is = 0.8683 hours

Similarly Time required for procurement of 100 litres of Cow Milk is = 0.8683 hours

Labour Hours for Milk Products

At main dairy plant 198 direct Labour are working in 3 shifts in a day. Direct Labour those who actually involved in

production of different milk products. The workers used as different combination at main dairy plant. Since, this process is continuous one. The labour allocation is made as optimum requirement at production sections.

Dock and Can washer Labour Hour

Totally 24 Labors working at this station where milk is scaled and weighted at the same time empty can's are washed using hot water and put up at the respective places.

This work is done in two shifts ic. 16 hours. mainly in morning and evening hours.

Total hours = Labour x hours x days

= 24 x 16 x 360

= 138240 hours

138240 hours are available for scaling the milk procured is good, sour, curd quality with fat and SNF. In the year 1992-93 total milk collected is 61358702 litres

61358702 litres requires 138240 hours

Therefore 100 litres requires

$$\frac{100 \times 138240}{61358702} = 0.225298 \text{ hours}$$

= 13.5178 mins.

= 13.52 mins

Packing and Dispatches

Fill pack machine rate is controlled as such there is minimum wastage of milk and packing material such as poly pack 100

litres of milk will be packed in 3.125 min or 0.05208 hours.

In packing and discipatch section 4 labours, 2 clearks, and 1 operator are working. The total hours in this section is

Total hours = Total Labours x Hours x Days

= 7 x 16 x 360

= 40320 hours

Labour hours for Milk and Skimed Milk Packing is 0.05208 hours.

Tanker Filling :

Pasteurized milk is sent to Bombay plant through factory owned and hired trucks. Loose milk is filled in tanks which are installed on chess of trucks using electric motors.

Total hours = Labour x hours

= 4 x 8 = 32

No. of tankers = 14

$$\text{Hours available for each tanker} = \frac{\text{Total hours}}{\text{No. of tankers}} = \frac{32}{14} = 2.2857$$

= 2.2857 hours

Capacity of tanker is 9,000 litres

To fill 9,000 litres requires 1 hour.

$$\text{Therefore, 100 litres requires } \frac{100 \times 1}{9000} = 0.0111 \text{ hours}$$

= 0.666 min.

Skim Milk Powder or Whole Milk Powder

In this section there are 4 labours working in 3 shifts. Skim Milk Powder is manufactured in flush sesson. Whole Milk Powder is produced only when there is an advance order for the productions.

Total hours = Labour x hours x Shifts

= 4 x 8 x 3 = 96 hours

In 24 hours 4, 000 Kg SM P is possible to manufacture using highest capacity of plant.

4000 Kg. 96 hours

8875 Kg. ?

$$\frac{8.875 \times 96}{4000}$$

= 0.213 hours

Packing SMP for 1 kg requires 0.1 min.

Therefore for packing 8.875 kg SMP is 0.8875 min.

Processing Labour hours

Lab hours used = Labour x hours x snifts

= 8 x 8 x 3

= 192

Milk received per day is 1,68,106 lit,

Pasteurized Machines Pasteurize the

Total milk 22,000 (14,000 + 8000) two pasteurized machines available) in one hours. Therefore 100 litres of milk will be

Pasteurized in $\frac{100 \times 1}{22000} = 0.004545$ hours

Total Labour hours = Labour x Hours x Days

= 18 x 16 x 360

= 103680

61358702 litres milk processed in 103680 hours

Therefore 100 litres " ?

$\frac{100 \times 103680}{61358702} = 0.1690$ hours = 10.1384 min.

0.1690 x 15% hours for cream separator

= 0.02535 hours = 1.521 min.

Cream separation labour hours 0.02535

0.1690 x 85% hours for skimmed milk separation

= 0.14365 hours = 8.619 min.

Skimmed milk separation Labour hours = 0.14365

GHEE AND BUTTER LABOUR HOURS

In unit Ghee and Butter total number of labours required are 9. Production of Ghee and Butter is done in 3 shifts.

Total labour hours = No. of Labour x hours x shifts

= 9 x 8 x 3 = 216 hours

Butter production in one day i.e. 24 hours is 4000 kg which requires 216 hours. Therefore for 1 Kg. of Butter requirs 0.054 hours.

Time required for 15.639 kg. of Butter is

$\frac{15.639 \times 216}{4000} = 0.844506$ hours

Ghee production in 24 hours is 2300 kg. requires 216 hours.

Therefore 6.051 kg Ghee will be produced in

$$\frac{6.051 \times 216}{2300} = 0.56826 \text{ hours}$$

Packing Ghee hours.

32 kg Ghee is packed in 1 min.

Therefore 6.051 Kg. Ghee is packed in $\frac{6.051}{32}$ =0.1890 min.

Thus for packing 1 Kg. Ghee time required is 0.03125 min.

Lassi

Total Labour hours = No.of Labour x hours x shifts

= 10 x 8 x 3

= 240 hours.

Packing time 32 bags of 200 ml in 1 min. 130 litres will be packed in

$$\frac{230 \times 5}{32} = 20.3125 \text{ ,min}$$

= 00.3385 hours

5300 litres lassi production requires 240 hours. Therefore 130 litres of lassi will requires

$$\frac{130 \times 240}{5300} = 5.88679 \text{ hours}$$

Lassi production 130 litres = 5.8867 hours

Chakka

In 24 hours 2300 kg Chakka is produced. Therefore

$$\text{in 1 hour } \frac{2300}{24} = 95.833 \text{ Kg.}$$

Chakka will be produced. Manually

95.833 Kg chakka requires 1 hours

24.57 kg chakka ?

$$\frac{28.57}{95.833} = 0.29812 \text{ hours.}$$

Chakka is procude manually.

Shrikhand Packing Manually

135 kg Shrikhand packing is done in 40 min. Therefore per kg

required time is $\frac{40}{135} = 0.2962$ min.

1 kg shrikhand packing required 0.2962 min.

Therefore 51.426 Kg. Shrikhand packing time is

$$= 51.426 \times 0.2962$$

$$= 15.2373 \text{ min.}$$

SHRIKHAND :

Labour hours available 240 shrikhand production in 24 hours is 4000 kg. Therefore in 1 hours 166.666 kg shrikhand will be produced 166.67.

166.67 kg Shrikhand proud. req. 1 hours
51.426 " ?

$$\frac{51.426}{166.67} = 0.30854 \text{ hours} = 18.51 \text{ min.}$$

Shrikhand production Labour hours = 0.30854 hours

SUBSTORE AND GODOWN :

In this department following are the labours and office barires.

Total Workers = 26

Clerks = 5

Keeper = 1

Total Labours = 32

Total hours available = No.of Labour x hours x days

= 32 x 8 x 360

= 92160 hours.

Milk products manufactured in year 1992-93 are handled by this department. Total kgs. of milk products are

Ghee	515232
Shrikhand	1129456
SMP	885725
WMP	20725
	2551138

In 92160 hours 2551138 kg milk products

$$\text{Therefore 1 hours } \frac{2551138}{92160} = 27.6816$$

= 27.68 Kgs.

In 1 hour 27.68 kgs. Milk products is handled by this department.

CHAKKA

27.68 kgs. Milk product handeled in 1 hour. Therefore

28.57 -"- ?

$$\frac{28.57}{27.68} = 1.023 \text{ hours}$$

Shrikhand Requires

$$\frac{\text{Shrikhand kg}}{\text{Milk product rate}} = \frac{51.426}{27.68} = 1.8578 \text{ hours}$$

SMP requires

$$= \frac{8.875}{27.68} = 0.3206 \text{ hours}$$

This labour hours is also used for supplying and maintaining raw material required for production of milk products whenever essential.

Dry Foods cutting

3 Labour + sweepers requires in three shifts

Totally 6 labours working under this department for 1 shift.

Total Hours available = Labours x Hours x Shifts

= 6 x 8 x 1

= 48 hours.

General cleaning Totally 3 Labour.

Labour hours available = No. of Labour x hours x shifts

= 3 x 8 x 1

= 24 hours

Solar system

Labour hours = No.of Lababour x hour x shifts

= 1 x 8 x 1

= 8 hours

These labour hours is used for cleaning and maintaining the wastages. Service of this system is required for 24 hours in a dairy plant.

MACHINE MINUTES

Milk is used for the production of main and intermediate products through various processes. These products further used along with milk for some other milk products. For the manufacture of various milk products, fat and SNF used along with their respective losses were taken as input output coefficients. The manufacturing activities take the fat and SNF from the intermediate products and would supply the outrun to the basis in the supply coefficients of individual product joint or multiproducts manufacture.

The actual time of the plant and machinery used in product manufacture was used as the coefficient for these resources. The actual time taken (machine speed or capacity) in the production of a product was lower than that under the installed capacity. Machine speed varies according the nature of product. Thus the coefficients of a particular machine capacity, were different for different products.

For instance pasteurised Milk packing is done by fill pack machine. Takes 0.03125 (32 liters in 1 min.) minutes to packing 1 litre of fluid Milk. Where as 1 kg skim milk powder packing requires 0.1 (10 kg SMP in 1 min) min. Machine operating time per unit of products was determined by time study and functional hour analysis, since machines are rarely operated at rated capacity.

Dairy plant has two pasteurization machines one having capacity 15000 litres Milk per hour and other 10,000 litres Milk per hour The two machines are used in packing simulatenously. Actual pasteurization of milk is 14,000 Milk per houron first machine Total 22,000 litres of milk pasteurized in 1 hour. Therefore 100 litres of milk will be Pasteurized in 0.2727 minutes.

While pasteurization the fat and SNF percentage for standardised milk is to be maintained (4.5% found and 8.5% SNF). Whenever higher percentage of Milk fat is received, higher percentage than requirement is separated through separator the product so obtained at this stage is a cream. Time required is same as that of standardized milk.

BUTTER MACHINE MILK

4000 kg Butter is produced in 24 hours. The rate of Butter production per hour

$$= \frac{4000}{24} = 166.67 \text{ Kg.}$$

For 166.67 Kg. time required is 60 min

Therefore 1 Kg. Butter production required

$$\frac{60}{166.67} = 2.778 \text{ min.}$$

For 1 Kg. Butter production time required is 2.778 min.

Therefore 7.850 Kg. Butter will required 7.850 x 2.778

= 21.8073 min.

GHEE MACHINE MINUTES

In 24 hours 2300 kg. Ghee is produced therefore

In 1 hour ?

$$\frac{2300}{24} = 95.8333 \text{ kg per hour}$$

95.833 Kg. Ghee production required 60 minutes

Therefore 6.051 Kg. Ghee is produced in

$$\frac{6.051 \times 60}{95.8333} = 3.7884 \text{ min.}$$

Ghee making machine minutes for 6.051 kg Ghee is 3.7884 min.

SMP MACHINE MINUTES

Evaporator unit is used in evaporating the water form the Skim Milk. Feeding rate is 2000 litres of milk per hour. i.e. 33.33 litres Milk conensed per min. Therefore, 100 litres of milk condensed in 0.3333 min. Then this Milk is sent to Dryer.

Dryer : condensed milk is send to drier unit where milk powder is manufactured.

Production rate 4000 Kg. per 24 hour i.e. 166.66 kg. per hour or 2.7778 kg. per min.

For production SMP 2.7778 kg require 1 min. Therefore 8.875 kg. SMP is produced in 3.1949 minutes

SMP or WMP Machine min. for 8.875 kg. is 3.1949 min.

CHAKKA

Production is made with the help of manual work, method discussed already.

In 24 hours 2300 kg. Chakka is manufactured. The rate of Chakka production is 95.833 kg. per hour (provided the 100 litres milk is used of 6.5% fat & 9.0% SNF. However for chakka production whole milk plus skimed milk 50% each may be used sometimes.)

So for the production 95.833 kg. Chakka

requires 1 hour therefore 28.57 Kg. will be

$$\text{manufactured in } \frac{28.53}{95.833} = 0.29812 \text{ hours.}$$

Thus to manufacture chakka 28.57 kg. manual hours required are 0.29812 hours.

Shrikhand Production Time 4000 Kg Shrikhand production in 24 hours. The rate of Shrikhand Production is 166.66 kg. per hour or 2.7778 kg. per min. Form 28.57 kg. Chakka using additional raw materal Shrikhand produced is 51.426 kg.

2.7778 kg Shrikhand production req. 1 min

51.42 kg. " "

$$\frac{51.426}{2.7778} = 18.5132 \text{ min}$$

Shrikhand production Machine time is 18.5132 min

LASSI

Lassi mainly manufactured using cow milk. 5300 litres of lassi production in a day i.e. 220.83 litres per hour or 3.68055 litres per min. Hence for the production of 130 litres of Lassi required min are 35.3208 min.

MILK PACKING AND DISPATCHES

Daily minimum 17000 litres milk was packed in polypack bags. In 1 min. 32 litres if milk packing is done. Req. timing for 17,000 litres of milk is 531.25 min i.e. 8.854 hours. (approximately 1 shift of 8 hours)

100 litres of milk packing requires 3.125 mins.
Approximately 80,000 + 24,000 = 1,04,000 litres of fluid of milk is dispatched through tankers to Bombay

Filling the milk tankers is a continuous process i.e. 24 hours. To fill the 1,04,000 + 15, 000 = 1,19,000 4958.333 litres filling rate is hours or 82.63 litres min 1,19,000 litres send to Bombay and 4,000 litres " indoor. Totally 1,23,000 litres of liquid milk is dispatched through 14 tankers.

$\frac{12,3000}{24}$ = 5125 litres per hours or 85.4166 lit/min 85.4166 litres of milk is filled hours 1 min

100 litres of milk is filled in $\frac{100}{85.4166}$ = 1.17073

100 litres of milk filling time = 1.17073 min

In addition to this if the 100 litres milk is packed in poly pack bags time required is 3.125 mins Totally for dispatch 100 litres of milk through tanks or bags is

3.125 + 1.17073 = 4.25573 min

Average time to dispatch milk

$$= \frac{3.125 + 1.17073}{2} = 2.147865 \text{ min}$$

packing or filling fluid milk 100 litres quantity requires 2.1478 min.

9.1 STEAM CONSUMPTION DURING PROCESSING

STEAM :- Steam requires for the purpose of milk product manufacturing and Milk processing. Mainly steam used in SMP or WMP production. 1 litre Furnish Oil produces 11.6 kg steam.

1. Milk

While processing milk the Amount of steam required is 1.2 to 1.35 Kg steam.

Assuming 1 Kg or 1 litre milk processing require 1.35 Kg steam.

Since in 1 hours. 1720 Kg steam is production

Thus 1720 Kg steam produced in 1 hours.

1.35 Kg. steam produced in

$$\frac{1.35}{1720} = 7.84883 \times 10^{-4} \text{ hours} = 0.047093 \text{ min perlit.}$$

for 100 litres of milk processing

time required = 0.047093 x 100 min. = 4.7093 min.

2. Cream having fat 42%

Amount of steam consumed 2.91 to 3.12 Kg.

1720 Kg steam produced in 1 hours.

3.12 --"-- ?

$$\frac{3.12}{1720} = 1.81395 \times 10^{-3} \text{ hours.}$$

$$= 0.108837 \text{ min}$$

Steam used for 15.639 Kg Cream.

is 0.108837 x 150639

= 1.7021018 min

3. Butter Having 85% fat

Amount of steam consumed 0.92 to 1.3 Kg

1720 Kg. steam produced in 1 hours.

1.3 Kg. --------"--------- in

$$= 7.55812 \times 10^{-4} \text{ hours}$$

= 0.0453488 min

Butter quantity produced = 7.850 Kg.

Time required for 7.850 Kg Batter

Production = 0.0453488 x 7.850 = 0.355988

4. SMP or WMP

For the production of 1 Kg SMP or WMP steam used is 7.5 Kg

1720 Kg steam production in 1 hr.

Therefore 7.5 Kg steam production will be in

$$\text{in} \quad \frac{7.5}{1720} = 4.36046 \times 10^{-3} \text{ hours} = 0.2616279 \text{ min.}$$

1 Kg SMP or WMP Production needs 7.5 Kg steam

for 8.875 Kg. SMP or WMP production How much steam will be required $7.5 \times 8.875 = 66.5625$

66.5625 Kg.steam required for 8.875 Kg. SMP or WMP production

1720 Kg. steam produced in 1 hr.

$$\frac{66.5625}{1720} = 0.0386991 \text{ hours} = 2.3219477 \text{ min.}$$

Hence for the SMP or WMP production 8.875 Kg steam required is used for 2.3220 min.

4. SKIMMED MILK

2000 litres perhours. feed rate for the SMP or WMP production. The milk is used after separating fat percentage such is milk is noting but skim milk. SKM used for SMP or WMP production is of how fat and high SNF.

steam per hour steam production = 1720

1 lit milk required 1.35 Kg. Steam therefore 2000 litres of milk required

2000 x 1.35 = 2700 Kg. steam

1720 Kg. steam in 1 hours.

2700 Kg steam in ?

$$\frac{2700}{1720} = 1.5697674 \text{ hours.} = 94.186046 \text{ min.}$$

1 lit milk required 1.35 Kg steam

91.474 SKM required ?

1.35 x 91.474 = 123.4899

1720 Kg steam produced in 1 hours.

123.4899 ---"---- ?

$$\frac{123.4899}{1720} = 0.0717964 \text{ hours} = 4.3077872 \text{ min.}$$

for processing SKM steam required. is 123.4899 This much steam will be used for 4.307792 = 4.3078 min for evaporation of water from SKM.

5. Ghee

Ghee production in 100 litres of milk = 6.05 Kg. steam required for 1 Kg Ghee production is 1.5 Kg.

Total steam required for 6.051 Kg

Ghee = 6.051 x 1.5 = 9.0765 Kg

Time requried. for 1720 Kg. steam is 1 hours.

Therefore 9.0765 Kg ?

$$\frac{9.0765}{1720} = 5.27703 \times 10^{-3} \text{ hours.}$$

= 0.316622 min

Steam used for Ghee 6.051 Kg production for 0.3166 minutes.

6. For the preparation of 1 lit Lassi 0.3 Kg steam is used.

Therefore, for 130 litres of Lassi will required 130 x .3 = 39 Kg. Steam

1720 Kg steam produced in 1 hours.

39 Kg. ?

$$\frac{39\ Kg}{1720} = 0.0226744 \text{ hours.}$$

$$= 1.3604651 \text{ min}$$

Steam used for 130 litres lassi is 39 Kg in 1.3604651 minutes.

10.] REFRIGERATION AND COLD STORAGE

For 1,40,000 liters of Milk refrigeration [refrigeration is detrised as equipped to supply refrigerated water for cooling purpose.] requires 16 hours

Therefore 100 litres of milk will be refrigerated in

$$\frac{100 \times 16}{140000} = 0.01142 \text{ hours}$$

$$= 0.6857 \text{ min.}$$

Cold storage is used to keep pasteurised Milk and Milk products. For standardised it is used for / to 8 hours. For Whole Milk and Cow Milk it is used for 8 hours. Cold storage is used for Cream 24 hours, Butter 48 hours, Chakka 24 hours, Shrikhand 48 hours, Ghee 24 hours and Lassi 24 hours.

When products were released for sale they left the space and added values equivalent to those of their coefficients to cold room depending on space availability.

11.] QUALITY CONTROL

Quality control depart maintains the desire quality of fat and SNF for various product to product. This department is one of the important department because of it a itself. Now a days foods must be of 'good Quality' in modern world. So to maintain the quality of dairy is necessary. Also to carry out R & D work for improvement quality and new product development.

In this department totally 33 Labour are available and they work in shifts. Average there are 10 workers (Excluding Managerial staff)

Available Labour hours = No. of workers x hours x shifts

= 10 x 8 x 3

= 240 hours

Quality of milk testing, milk product testing is by time analysis, personal interview with managers.

i)	Milk testing fat and SNF	4 min
ii)	Milk product chakka	3 to 3.5 hours
iii)	Milk product shrikhand	3 to 3.5 hours
iv)	Milk product SMP or WMP	10 min.
v)	Milk product Butter or cream	12 min
vi)	Milk product lassi	3 to 3.5 hours

vii)	Packaging Materials, Plastic Cups, film, Poly bags, boxes etc	5 minutes to 4 hours depending on packing material to be tested
viii)	Testing of detergents, chemicals received.	3 hours.
ix)	Bacteriological Analyses of all products,steririty testing etc	10 - 15 min per sample
x)	Analysis of Water, Basler Water & Waste Water (efficient)	4-5 hours

12.1 DEMAND COEFFICENTS

Demand coefficients for each selling activity there was a corresponding coefficient against the market demand restriction. Some the milk products intermediate can't sale by the plant. It is assumed that all the milk products and milk is sold at corresponding rates. The demand quantity of cream, butter, chakka skimmed milk is obtained using reverse calculation as we known How much quantity of Butter require for Ghee production etc.

The main body of the L P P table is made of inequalities or equalities of production possibilities with restrictions levels on the extreme right. The objective function consists of maximization of total contribution value which is defined as the sales proceeds over variable costs to cover fixed cost.

Demand coefficients directly taken as production requirements of intermediate ingredients and also from the statistical information from the marketing department using standard results.

1 kg IMP is obtained from 10.30 litres of milk having 0.05% fat and 96% SNF. For the production of 593000 kg SMP, How much milk is required ?

Therefore 1 kg SMP 10.30 litres

593000 kg SMP 1

SKM demand 59300 x 10.30 = 6112009.5

7.850 kg Butter requires 15.639 kg cream

56950 " ?

$$\frac{569500 \times 15.639}{7.850} = 11,34,574.6$$

Cream demand = 1134600

6.051 kg Ghee require 7.850 kg Butter

43900 kg " ?

$$\frac{43900 \times 7.850}{6.051} = 569517.44$$

= Demand of Butter

51.426 kg Shrikhand regd. 28.57 kg chakka

1129000 kg Shrikhand " ?

$$\frac{1129000}{57.426} = 28.579 = 627222.22$$

= demand of chakka