

## A Case Study of Milk Processing Plant of Parag Dairy Faizabad

Rakesh B. Gautam\*, Raj Mani Maurya, Ramjeet Singh Sangam Ram, Satish kumar Verma, Sandeep Agrahari, Sudheer Kumar, Sri Prakash Maurya and Atul Kumar Verma

Dept. of Agro-Processing and Rural Industries, Mahamaya College of Agricultural Engineering & Technology, NDUAT, Kumarganj, Faizabad, U.P. (224 122), India

### Corresponding Author

Rakesh B. Gautam  
e-mail: rksh\_gautam@yahoo.co.in

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### Abstract

India is endowed with a largest livestock population in the world having a total bovine population of 304 million compared to the world total bovine population of 1400 million. There has been a major improvement in milk production, which increased from 17 mt in 1951 to 127.9 mt during 2011–12. Per capita availability of the milk has reached a level of 290 g day<sup>-1</sup> during the year 2011–12, which more than the world average of 284 g day<sup>-1</sup>. Most of the milk in the country is produced by small, marginal farmers and landless laborers. In order to increase milk production, the government has approved national dairy plan phase-1 (NDP-1) in February, 2012 with a total investment of about ₹ 2242 core to be implemented from 2011–12 to 2016–17. Department of animal husbandry, dairying and fisheries, ministry of agricultural Government of India is also implementing “national program on bovine breeding and dairy development (NPBDD) from 2013–14 to 2016–17 through the state implementing agencies/end implementing agencies/participating agencies. The organized dairy sector (both cooperative and private) is presently handling about 15% of the total milk production in the country. Dairy products form one of the fastest growing segments in livestock product export. India's export of dairy product was 25928.52 mt to the world for the worth of ₹ 4318.53 cores during the year 2015–16.

**Keywords:** Milk, milk product, production, livestock, dahi, khoya and cheese

### 1. Introduction

India is endowed with a largest livestock population in the world having a total bovine population of 304 million compared to the world total bovine population of 1400 million. It account for 56.3% of the world's buffalo population and 14.7% of the cattle population. As per 18<sup>th</sup> livestock census, 2007 the country has 33.06 million cross breed cattle, 199.07 million indigenous cattle and 105.34 million buffaloes. (Srivastava, Singh and Mohan, 2008). The cross breed cattle are predominant in Tamil Nadu, Maharashtra, West Bengal, Karnataka, Andhra Pradesh, Uttar Pradesh, Madhya Pradesh, Gujarat, Punjab, Haryana, and Bihar. There has been a major improvement in milk production, which increased from 17 million tones in 1951 to 127.9 mt during 2011–12. Uttar Pradesh, Punjab, Madhya Pradesh, Haryana, Rajasthan, Gujarat, Bihar, Maharashtra, Andhra Pradesh and Tamil Nadu contribute to the extent of 80% of the total milk production in India. Per capita availability of the milk has reached a level of 290 grams per day during the year 2011–12, which more than the world average of 284 g day<sup>-1</sup>. Most of the milk in the country is produced by small, marginal farmers and landless

laborers (Anonymous, 2017).

Recognizing the importance of the sector, several key initiatives were taken by the govt. In the past ranging from operation flood program, intensive dairy development program (IDDP), strengthening infrastructure for clean milk production, assistant to cooperatives, venture capital fund (VCF) for dairy, dairy entrepreneurship development scheme etc.

In order to meet the rapidly growing demand for milk with a focus to improve Milch animal productivity and increase milk production, the government has approved national dairy plan phase-1 (NDP-1) in February, 2012 (Padhi, 2014). with a total investment of about ₹ 2242 core to be implemented from 2011–12 to 2016–17. NDP-1 will help to meet the projected national demand of 150 million tons of milk by 2016–17 from domestic production through productivity enhancement, strengthening and expanding village level infrastructure for milk procurement and provide producer with greater access to markets. NDP-1 would focus on 14 major milk producing states- Uttar Pradesh, Punjab, Haryana, Gujarat, Rajasthan, Madhya Pradesh, Bihar, west Bengal, Maharashtra, Karnataka,

Tamil Nadu, Andhra Pradesh, Orissa, and Kerala which account over 90% of the country's milk production. Coverage of NDF-1 will however be across the country in terms of benefits accruing from the scheme.

Department of animal husbandry, dairying & fisheries, ministry of agricultural Government of India is also implementing "national program on bovine breeding and dairy development (NPBBDD) from 2013–14 to 2016–17 through the state implementing agencies/ end implementing agencies/ participating agencies.

The organized dairy sector (both cooperative and private) is presently handling about 15% of the total milk production in the country. Thus it indicates, there is a wide scope for processing of milk and manufacture of milk products for domestic consumption as well as export.

Dairy products form one of the fastest growing segments in livestock product export. India's export of dairy product was 25928.52 mt to the world for the worth of ₹ 4318.53 cores during the year 2015–16. The major export destinations are Bangladesh, Egypt, UAE, Algeria, Yemen Republic, Pakistan, Saudi Arabia and Malaysia. The major products exported were butter and other milk fat, cheese, whole milk powder, skimmed milk powder, fresh cream, ghee, butter milk etc.

## 2. Materials and Methods

### 2.1. Raw material

The principle raw material is milk. The extent of milk procurement area milch animal population, average milk yield, percentage of animals in milk, marketed surplus etc will determine the size of the plant. The method of procurement, transportation of milk and input supply to the farmers is required to be highlighted. The availability of other inputs such as packing materials, disinfectants and consumables should be ascertained.

### 2.2. Layout and buildings

The civil works comprise of main processing building, which include raw milk reception dock. Main processing hall, provision for manufacture of other products, cold storage, CIP, laboratory, Quarters, office, garages, security post etc. The factory building for the milk reception, quality control, processing, packaging and storage of milk products should be as per BIS specification, the quantity of milk handled and the equipment chosen product manufacturing. About 4000 sq. Ft, area of building is required for handling 10000 l of milk. The essential section of milk processing plants is given in below.

The milk processing plant shall have the following essential facilities.

#### 2.2.1. Raw milk reception dock (RMRD)

consisting of can conveyor, can washer, weighing balance, dump tank etc.

**Processing hall:** cream separator, chiller, homogenizer, pasteurizer and other related machinery are installed.

**Storage area:** For milk storage tanks.

**Products manufacturing area:** depends upon the type of products, quantity of milk handled and the machinery to be installed.

**Packaging area:** For packing of liquid milk and other products.

**Cold storage:** For keeping the milk and milk products before sending of market.

**Quality control laboratory:** For testing the quality of milk and milk products.

**Utilities area:** For installing boiler, generator set, water treatment plants, maintenance and store area for spares.

**Waste water treatment plant area:** For treating the dairy effluents before releasing to the fields.

**Quarters and office area:** for all the essential staff.

**Vehicle parking area:** Both for the milk procurement and distribution vehicles.

**Input supply area:** for providing veterinary service, supply of feed, fodder seed, etc

### 2.3. Plant and Machinery

Different machinery are required for the processing plant based on the type of milk received and products proposed. The machinery should be as per the BIS specifications. The section wise equipment required, their specifications and quantity for 10000 liters capacity milk processing plant are given below (Table 1).

Table 1: list of machine used in milk processing

Sl. No.	Description	Qty
<b>A. Reception section</b>		
1.	Can roller conveyor 3 m	1-No.
2.	Can tip bar	1-No.
3.	Electronic weigh scale S.S. weigh bowl 500 L	1-No.
4.	S.S. dump tank-1000 l	1-No.
5.	Disc filter	1-No.
6.	Can drip saver suitable for 6 cans	1-No.
7.	S.S. can scrubber (40 l)	1-No.
8.	S.S milk pump-1.5 H.P.	1-No.
9.	Set of lab equipment (including Milkoscan/ milkotester/ density meter/Cryoscope/ emulsion quality analyzer/ HPLC etc.	1 set
<b>B: Process section</b>		
1.	S.S. balance tank with float, 100ltrs	1-No.
2.	S.S. milk pump 2 H.P.	1-No.
3.	S.S. milk Chiller, capacity 3 KLPH make GEA	1-No.
4.	S.S flow control valve manual	1-No.
5.	Milk pasteuriser-2.5 KLPH	1-No.
6.	S.S. simplex filter	1-No.

Continue...



Sl. No.	Description	Qty
7.	S.S. holding coil for 16secs	1-No.
8.	Flow diversion valve manual	1-No.
9.	S.S. remote control panel	1-No.
10.	Inter connecting S.S. pipeline and valves	1 set
11.	Cream separator capacity 500ltrs par hour	1-No.
12.	Cream tank – 1KL	1-No.
13.	Ghee boiler-250Ltrs	1-No.
14.	Ghee balance tank and pump	1-set
15.	Gee settling tank – 250 lt	1-No.
16.	CIP unit	1-set
<u>C. Storage and packing section</u>		
1.	H.M.S.T-M.S Outer 5KL, single comp.	1-No.
2.	H.M.S.T-M.S. Outer 10KL, double comp.	1-No.
3.	S.S. milk pump-1H.P.	1-No.
4.	Pouch packing machine, 5000 PPH	2-No.
5.	S.S. overhead tank capacity 200ltrs.(INSU)	1-No.
6.	Interconnecting SS pipe and valves	1-set
7.	Spare S.S. pump for tanker filling	1-No.
8.	G.I pipeline and controls, driers for air	1-set
9.	Stabilizer for packing machine	1-No.
<u>D. Refrigeration section</u>		1-set
<u>E. Utilities</u>		
1.	How water generator capacity 50000 kcal Hr. Wood fired	1-No.
2.	Chimney 3mt high above	1-No.
3.	Makeup water tank and valves.( FRP- 200ltr)	1-No.
4.	Water softener suitable duty	1-No.
5.	G.I pipeline, valves and water pump	1-No.
<u>F. Electricals</u>		
1.	MCCB panel for above equipments	
2.	All cables armoured, flexible, and other	1-set
3.	Generator 3 KVA	
<u>G. Erection and commissioning</u>		1 job

#### 2.4. Pasteurization

Pasteurization is the first step in milk processing. Pasteurization means heating every particle of the milk or milk product to a specific temperature for a specified period of time (63 °c for 30 minutes). This destroys bacteria and other micro-organism that may affect consumer health. It makes the milk safe and healthy, and also improves the keeping quality. So that milk and milk products can be stored for longer periods without being spoilt.

#### 2.4.1. Method of pasteurization

1. Batch pasteurization: 63 °C for at least 30 minutes. This is suitable for small-scale producers and farmer cooperatives.
2. High temperature short time (HTST) pasteurization: 72 °C for at least 15 minutes. This is suitable for processing large quantities of milk. E.g. more than 250 liters at a time.
3. Ultra high temperature (UHT): 135 °C this is used by big factories. It requires special machinery. UHT milk can be stored for 6 month even without refrigeration.

#### 2.5. Data and methodology

An ISO-9002 dairy plant installed capacity of 60000 liter per day situated in Uttar Pradesh state, Faizabad dairy was selected for the study. The data for the period October-November 2016 on various aspect works collected from the records of the dairy plant, by interviewing the personal working in the plant and by observation method. During the study period the dairy plant manufactured Ghee, ice cream, fully cream milk, standardized milk, toned milk, double toned milk and skimmed milk.

For working out the economics of manufacturing of different Dairy products, the plant under study was classified into two departments namely Main departments and Auxiliary department (Raju, G. Rama Mohan, 1980). The farmer was directly related to the manufacturing of dairy products, where-as the later provided service like steam generation, refrigeration, water supply, maintenance quality control etc.

Cost on services provided by the Auxiliary department work apportioned to the main department by using the appropriate burden rates. Depreciation of the building/equipment was worked out by straight-line method. While allocating and apportioning the expenses, due care was take into identify the fix and variable cost items for break-even analysis.

The break even quantity, steam requirement, electrical energy and refrigeration requirement were worked out as discussed below.

#### 2.5.1. Break-even output

$$\begin{aligned}
 TR &= TC \dots\dots\dots(1) \\
 P \times Q &= TFC + (AVC \times Q) \dots\dots\dots(2) \\
 (P \times Q) - (AVC \times Q) &= TFC \dots\dots\dots(3) \\
 (P - AVC)Q &= TFC \\
 Q &= TFC / (P - AVC) \dots\dots\dots(4)
 \end{aligned}$$

Where,

TR=Total revenue

TC=Total cast

P=Price of product

Q=Break even output

TFC=Total fixed cost

AVC=Average variable cost

#### 2.5.2. Steam requirement

$$\text{Steam requirement (kg)} = (\text{MST}) / L$$



Where,

M=Quantity of product to be heated

S=Specific heat

T=Temperature difference

L=Latent heat

### 2.5.3. Electrical consumption

Electrical consumption=(hours watts)/1000=KW

Electricity under single phase system =  $(V_L \times I_L \times \cos\theta)/1000=KW$

Electricity consumption was computed using the formula (Theraja, 1992)

$(\sqrt{3} \times V_L \times I_L \times \cos\theta)/1000 = KW$

Where,

$V_L$  = line voltage

$I_L$  = line current

$\cos\theta$  =Power factor

### 2.5.4. Refrigeration requirement

Refrigeration load= $M \times S \times T$  (in kcal)

Where,

M=Quantity of product to be cooled

S=Specific heat

T=Temperature difference

### 2.6. Components of milk

Milk contains many different components like water, fat, protein, lactose, and ash. The most important components is butterfat, which gives milk its special creamy taste and colour. Butterfat is used to make many different products such as cream, butter, butter oil, and ghee. The amount of butterfat in milk depends on species (cow, goat etc) and the breed. Goat milk contains 3 to 5.6% butterfat. Cow milk contains 3.2 to 5.5%.sheep milk contains 6.4 to 9%

### 2.7. Milk storage

The plant will need bulk storage tanks for milk and milk products of a total capacity approximately equal to the daily through output. The calculation requirements of storage capacity are rate and time at which the contents will be used and the time required for cleaning before re-use. It is usually advisable to make provision for alternative usage for each tank. It will help in the later stages of planning if the number of different size is kept to the minimum.

It is helpful in planning to prepare a tank utilization schedule. This schedule is based on assumption regarding the rates of milk reception and utilization.

### 2.8. Cream separation

Cream separators may be required for standardizing the fat content of milk before processing for liquid consumption, and for producing cream for butter making. The number and capacity of the separator required depends on the average fat content of the incoming milk and the amount of cream required. (Bourton H., 1988) As in the case of clarifiers, duplicate or stand by machine or necessary in case of breakdown.

### 2.9. Heat treatment

Where the rate of processing is less than about 1000 hour<sup>-1</sup> Batch treatment is usually adopted. For higher rates HTST method are necessary in order to keep the flow space required within reasonable limit and to improve efficiency by regenerative heating and cooling. If the HTST plant is required to run for longer period, cleaning will be necessary after about 5 hours operation. To prevent the accumulation of deposit on the heating surface and to control Thermophilic bacteria (Ahmed Tufail, 1997). Milk of different qualities or for different purpose can be treated successively in the same machine.

### 2.9. Butter manufacture

Butter is obtained from cream. In butter making the oil in water emulsion of cream is converted by the process of churning into the water-in-emulsion of butter.

### 2.10. Cheese manufacture

The manufacture of cheese has become a major activity in many dairy processing plants. Cheese made from the curd obtained from whole milk or skim milk. The coagulation may be effected either by acid or enzyme. Most of the protein and fat is retained by cheese. Cheese can be divided into lactic cheese and rennet cheese (Alganesh, 2002 ).

### 2.11. Ice cream

Ice cream can be made on either a batch or a continuous basis, depending on the scale of production. Demand of ice cream is seasonal and liable to great fluctuation. It is necessary therefore to have the maximum flexibility of production and to make provision for storage.

## 3. Results and Discussion

The process-wise costs for different products were calculated by dividing the manufacturing costs of product into different major process in consultation with the production manager of the plant (Glover, 1986). The information is presented under below under different sub-sections.

### 3.1. Process-wise costs of milk and milk products

The process-wise costs worked out for different dairy products are presented below for each product manufactured during the study period.

#### 3.1.1. Ghee

Ghee was manufactured by direct boiling of cream and was packaged after settling and clarification. The cost of ghee manufacturing worked out to be ₹ 120.97 kg<sup>-1</sup> the maximum cost (94.01%) was shared by the raw material. Out of the five processes of Ghee manufacturing, the highest cost was on 'packaging' (3.60%), followed by boiling of cream, (0.89%), settling and clarification (0.74%), storage (0.63%) and reception of cream (0.13%) (Table 2).

### 3.2. Processing of milk

The process-wise costs of full-cream milk, standardized milk,



Table 2: Process-wise cost of Ghee manufacturing; 2015-16

Items	Total annual expenditure (₹)	Unit cost (₹ kg <sup>-1</sup> )	Costs (%)
Raw material	9607748	113.72	94.01
Reception of cost	13705	0.16	0.13
Boiling of cream	91386	1.08	0.89
Settling and clarification	75415	0.89	0.74
Packaging	367622	4.36	3.60
Storage	63950	0.76	0.63
Overall	10219826	120.97	100
Total quantities produced	84486 kg annum <sup>-1</sup>		

toned milk, double toned milk and skimmed milk have been presented below the table.

### 3.2.1. Full-cream milk

The costs of manufacturing worked out to be ₹ 14.69 l<sup>-1</sup>, of which (91.98%) was on raw material. In different process of manufacturing the highest cost was on packaging (3.33%), followed by pasteurization/standardization (1.53%), separation (1.31%), storage (1.16%) and reception of milk 0.63% (Table 3).

Table 3: Process-wise costs of Full cream milk manufacturing, 2015-16

Items	Total annual expenditure (₹)	Unit cost (₹ kg <sup>-1</sup> )	Costs (%)
Raw material	135813208	13.51	91.98
Reception of milk	1005427	0.10	0.63
Separation	1942520	0.19	1.31
Pasteurization/standardization	2265138	0.23	1.53
Packaging	4919948	0.49	3.33
Storage	1711191	0.17	1.16
Overall	147657432	14.69	100

### 3.2.2. Standardized milk

Its manufacturing cost worked out to be ₹ 12.66 l<sup>-1</sup> with major cost on raw material (91.79%). In process of manufacturing the higher cost was on packaging (3.55%), followed by pasteurization/standardization (1.34%), storage (1.19%) and reception (0.71%) (Table 4).

### 3.2.3. Toned milk

Its manufacturing cost was found as ₹ 10.85 l<sup>-1</sup> with maximum raw material. Different process of manufacturing the highest cost was on packaging (3.78%) followed by separation (1.38%), pasteurization/standardization (1.29%), storage (1.29%) and reception of milk (0.64%) (Table 5).

Table 4: Process-wise costs of Standardized milk manufacturing, 2015-16

Items	Total annual expenditure (₹)	Unit cost (₹ kg <sup>-1</sup> )	Costs (%)
Raw material	16353965	11.62	91.79
Reception of milk	126665	0.09	0.71
Separation	253331	0.18	1.42
Pasteurization/standardization	239257	0.17	1.34
Packaging	633329	0.45	3.55
Storage	211109	0.15	1.19
Overall	17817659	12.66	100
Total quantity produced	1407398 l annum <sup>-1</sup>		

Table 5: Process-wise costs of Toned milk manufacturing, 2015-16

Items	Total annual expenditure (₹)	Unit cost (₹ kg <sup>-1</sup> )	Costs (%)
Raw material	31293973	9.94	91.62
Reception of milk	220380	0.07	0.64
Separation	472243	0.15	1.38
Pasteurization/standardization	440760	0.14	1.29
Packaging	1290798	0.41	3.78
Storage	440760	0.14	1.29
Overall	34158914	10.85	100
Total quantity produced	3148287 l annum <sup>-1</sup>		

### 3.2.4. Double toned milk

Its manufacturing cost worked out to be ₹ 9.46 l<sup>-1</sup> with maximum on raw material (91.12%). In manufacturing the highest cost was on packaging, followed by pasteurization/standardization, storage, separation, reception of milk (Table 6).

### 3.2.5. Skimmed milk

Its manufacturing cost was found as ₹ 7.27 l<sup>-1</sup> with maximum on raw material. Amongst process of manufacturing the highest cost was on packaging followed by storage, pasteurization/standardization, separation, reception of milk (Table 7).

### 3.3. Profit margins of different dairy products

The highest profit margin was in ice-cream followed by ghee. Amongst different types of milk, standardized milk provided the maximum profit, followed by the full cream milk and toned milk (Figure 1).





Table 6: Process-wise costs of Double toned milk manufacturing, 2015-16

Items	Total annual expenditure (₹)	Unit cost (₹ kg <sup>-1</sup> )	Costs (%)
Raw material	170562699	8.62	91.12
Reception of milk	1187211	0.06	0.64
Separation	2374423	0.12	1.27
Pasteurization/standardization	2572291	0.13	1.37
Packaging	7914742	0.40	4.23
Storage	2572291	0.13	1.37
Overall	187183658	9.46	100
Total quantity produced	19786856 l annum <sup>-1</sup>		

Table 7: Process-wise costs of Skimmed milk manufacturing, 2015-16

Items	Total annual expenditure (₹)	Unit cost (₹ kg <sup>-1</sup> )	Costs (%)
Raw material	3211539	6.51	89.54
Reception of milk	24666	0.05	0.69
Separation	49332	0.10	1.38
Pasteurization/standardization	54266	0.11	1.51
Packaging	187463	0.38	5.23
Storage	59199	0.12	1.65
Overall	3586465	7.27	100
Total quantity produced	493324 l annum <sup>-1</sup>		

### 3.4. Net profit of milk processing of different products

The cost of ghee manufacturing worked out to be ₹ 120.97 kg<sup>-1</sup>. The maximum cost (94.01%) was shared by the raw material and the actual selling price of the ghee is ₹ 390.00 kg<sup>-1</sup>, so the profit in processing of ghee is ₹ 269.03. The costs of Skimmed milk manufacturing worked out to be ₹ 14.69 l<sup>-1</sup>, of which (91.98%) was on raw material and the actual selling price of Skimmed milk is ₹ 30.00 l<sup>-1</sup>, so the profit in this product is ₹ 15.31. The manufacturing cost of toned milk was found as ₹ 10.85 l<sup>-1</sup> with maximum raw material and the selling price of toned milk is ₹ 38 l<sup>-1</sup>, so the profit in processing of toned milk is ₹ 27.15. Its manufacturing cost worked out to be ₹ 9.46 l<sup>-1</sup> with maximum on raw material (91.12%) and the actual selling price of ₹ 35 l<sup>-1</sup>, so the profit in this process is ₹ 25.54 (Table 8 and Figure 2).

profit margin in manufacturing of different milk products, 2015-16

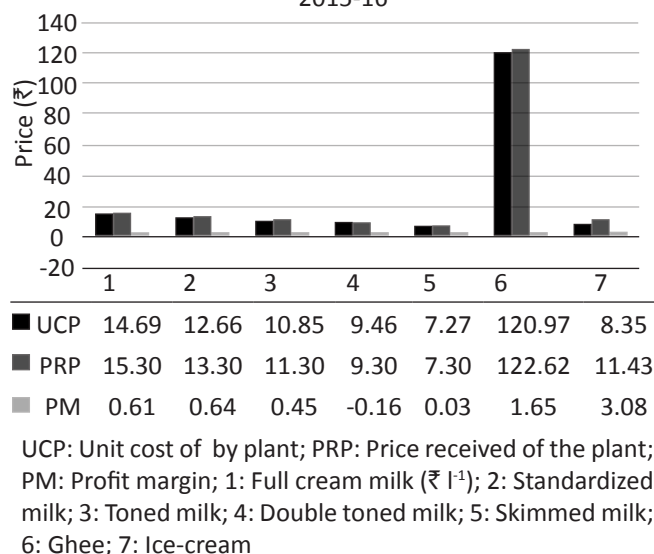


Figure 1: Profit margins in manufacturing of different dairy products, 2015-16

Table 8: Increasing milk production in India

Year	Production (mt)	Year	Production (mt)
1951-55	17.0	1986-90	63.8
1956-60	19.0	1991-95	78.3
1961-65	20.0	1996-00	80.6
1966-70	21.2	2001-05	97.1
1971-75	23.2	2006-10	110.3
1976-80	30.4	2011-15	117.0
1981-85	41.5	2016-17	124.5

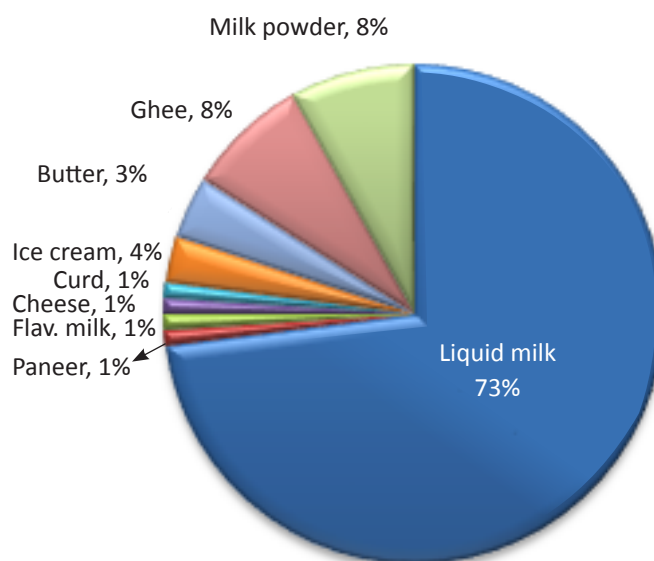


Figure 2: Market share of milk and milk product

#### 4. Conclusion

The comparison of unit manufacturing cost with price received by the plant for different products has shown that ice-cream manufacturing is the most profitable proposition. The standardization milk has been found most profitable among all types of milk pouches. The double toned milk has revealed a loss of ₹ 0.16 l<sup>-1</sup>. Therefore, the study has suggested that the double toned milk should be raised at least to the break-even level to avoid losses in this product.

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