UNIT 1 MILK LOSSES

Structure

1.0 OBJECTIVES

After reading this unit we shall be able to:

- Define the terms milk losses;
- List out level of milk losses during various processing operations;
- Identify factors responsible for milk losses in a dairy plant;
- Identify various points of losses in milk plant;
- Identify various sources of losses during manufacture of milk products; and
- Prepare plan for controlling milk losses in a dairy plant.

1.1 INTRODUCTION

Manufacturing cost of milk and milk products normally comprises 80 to 85% of raw material-milk solids cost. Therefore, effective utilization of milk solids (Fat & Solid-Not-Fat) would be of greater importance/concern to cost control and profitability. Milk (milk solids) losses is the difference of total milk solids inputs and net utilization. Arithmetically, it is determined by subtracting sum of total dispatches and closing stock of milk solids from the sum of milk solids input and opening stock. Properly managed dairy plants normally have very less milk losses during entire processing operations. However, in poorly managed dairy plant, the losses can be very high. Therefore, you can see that an increment in the milk losses directly adds to the production cost.

There are other important implication of milk (milk solids) losses in a dairy plant. The milk loss has impact also on hygiene and ecology. The production hygiene has direct influence on the microbial quality of the product, whereas pollution management requires additional cost burden. In this way, we find that cost addition due to losses makes the product costlier, whereas adverse effect on microbiological quality shortens shelf life and influence food safety aspect. The milk and milk solid losses, therefore, affect the product marketability and so the business viability.

1.2 MILK LOSSES IN DAIRY PLANTS

Let us look at the milk losses in dairy plant with more objectivity. You will be surprised to note that there is no standard limit fixed for milk losses that can serve as target. Only we can compare losses of similar plants for motivating the poor performing one. However, many studies have been undertaken to evaluate process wise and product wise losses. A generalized scenario is being discussed below for reference.

i. **Present Scenario of Milk Handling Losses**: According to available data from industries, the milk losses vary greatly. Fat loss in dairy plant varies extremely from 0.4 % to 5%. Most of the plants have fixed certain maximum tolerable limits after a long period of experience. These may vary from 1% to 2% for ideally operated plant. In our country, the handling performance is evaluated on the basis of recovering of milk solids. For example recovery of fat in the manufacture of fat rich products like butter and ghee; and total solids recovery in the manufacture of milk powder. An efficiently operated plant should account for 98% to 99% recovery.

ii. **Losses During Various Stages of Processing**: Let us look at various dairy operations and areas with regard to possibility of milk loss.

   a) Loss of raw milk occurs during its reception, generally, in the form of spillage and leakage at unloading and loading, lid opening, grading, tilting operations, dump vat, valves, filters, unions and pipeline, raw milk chiller and raw milk storage tank. The other form of milk loss during reception would also take place due to quality deterioration on account of delay caused by machine break down, power shedding, human negligence and insufficient dock space etc. Milk loss during reception process may also occur due to improper weighing, sampling and testing. The losses in reception may vary from 0.1%

to 1.01%. In developed countries it is about 0.025%. Use of different constant factor in Richmond formulae of SNF determination may be one of the factors responsible for variation in reading at receiving and sending end.

b) During processing operations, milk solid losses would be in various forms depending upon composition of milk at the point of losses. We can observe that fat rich milk will be lost if leakages are at cream separator's cream outlet, cream pasteurizer to cream storage line, whereas at skimmed milk outlet low fat milk will be lost. Similarly, milk leaking from pasteurizer, storage tank, pipeline and packing section has the same composition. A moderate figure of 0.1% may be appropriate for good plant. However, in some plants it may be as high as 0.5%.

c) During manufacturing of milk products the milk solids are lost directly in the form of milk, cream, residue, byproduct and final product. In these area 0.5% to 1.5% losses may be considered as moderate. In cream handling, loss to the extent of 0.1% to 0.2% may occur.

d) Powder Manufacturing: Generally powder manufacturing has the milk solids loss of 1%. But in old plant, where there is no proper powder recovery arrangement or more breakdowns, the losses may be higher.

e) Packing operation: In the packing operation, losses are mostly due to over filling, spillage and failure of packing. In milk packing, the loss of 0.5 to 1.0% is general. The general reason for losses during packing is negligence, carelessness and safety margin due to stringent laws and machine sensitivity.

iii. Identification of Milk losses: Let us look at the general dairy operations involving various equipment and processes. If you walk through the entire unit operations from reception of milk through processing and packing to final dispatches, the potential areas susceptible to milk or milk solids losses would be perceived. In order to account the potential losses, these are presented in table 1.1.

Table- 1.1: Identification of Milk Losses in Dairy Operations

Sr.No	Name of Operation	Type of Losses
1	Milk reception	Raw milk spillage, leakage, wrong weight, wrong sampling & testing Milk Souring of due to developed acidity
2	Milk storage	Raw milk, processed milk
3	Milk processing	Milk chiller, pasteurizer, pipelines, milk tank, milk packing and cold store.
4	Cream separation	Leakage at cream outlet Leakage at skimmed milk outlet Milk solids loss in slime

5	Butter manufacture	Spillage in churn loading Washings, drainage /spillage of butter milk Spillage during unloading of churn and transferring Butter packing losses (over filling, less overrun, spillage)
6	Ghee manufacture	Spillage in loading of P.S. Vat, Ghee Boiler, clarifier, settling and storage tank Packing losses in the form of over filling, leakage and non-recovery from damage packs. Losses through ghee-residue
7	Paneer production	Losses in loading & heating in the from of spillage and sticking. Discarding of whey serum During pressing & cooling Cutting & Packing of blocks /cubes (wastage and over filling)
8	Milk Powder production	Milk leakage in the pre-concentration, concentration stages. Milk loss in the form of burning in dryer chamber Milk sticking on the chamber surface Milk powder loss along with air from exhaust, pneumatic conveying duct line Milk powder losses as spillage during filling and bagging operation Excess filling during packing operation Storage- weight loss, spillage
9	Cultured products (Dahi/ Lassi etc.)	Spillage in loading and heating Spillage in culture dosing and incubation Packing & Storage losses
10	Ice creams & Ice-Candies	Mix preparation- spillage & improper standardization Milk processing, Ageing & Flavouring vats spillage, and sticking losses Freezing and packing: spillage, over filling and less over run Hardening & Storage- Loss due to damage of packs.
11	Quality control	Incorrect testing, calibration for composition of milk and milk products.
12	CIP of storage tank, chiller pasteurizer and pipe lines	Improper recovery of sticking materials before draining of flush water.
13	Plant equipment maintenance	- Spoilage due to careless action - Break downs

Check Your Progress - 1

1. Identify various points during milk reception and milk pasteurization operation having potentiality of milk losses?

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2. How much milk solids are lost during manufacturing of milk powder?

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3. Which are the sources of milk losses during separation of cream from milk?

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iv. Factors Responsible for Milk Losses

There are number of factors that contribute to losses. Knowledge of these minor or major factors would be of help to dairy professionals in exercising effective controls. Most prominent factors are discussed below:

i) Capacity Utilization: Volume of milk and milk products handling in milk plants has impact over losses. It is observed that some of the losses are more or less constant. For example, losses in the milk pasteurizer are dependent on the number of times it is put On and Off and cleaned by CIP. Therefore, irrespective of quantity of milk pasteurized, the losses ought to be there depending upon scheduled number of batches and un-expected power failures. Similarly, number of milk types in the dairy plant will decide use and cleaning of milk tanks or silos. Depending on the number of cleanings, the losses in the form of sticking and flushing will result. Here again the important factor is number of tank or silo depending on the milk types and not truly the quantity of milk. If you know this fact, then, to bring down the losses, one need to plan pasteurizer operation to reduce number of batches and increase plant throughput.

ii) Product Mix: The quantum of milk solids loss in a dairy plant is associated with number of products and nature of products. More the number, higher will be the milk solids losses. Products with rich in milk solid content are normally have higher losses, whereas lower milk solids content product result in lesser losses. It is observed that dairies with only liquid milk handling is having less than 0.5 % handling losses, whereas product manufacturing dairies has as large as 2.5%

milk solids loss. To have a greater feel, a product-wise milk solids loss is presented in Table-1.2.

Table-1.2 : Product-wise Milk Solids Losses in Dairy Plant

Sr.No	Product	Milk Solids Loss (in %)
1	Liquid Milk processing	0.5
2	Cream production	0.5
3	Butter manufacturing	0.2
4	Ghee	2.5 to 4.0 (Fat loss high 4% and SNF loss 2.9%)
5	Ice-cream	2.0
6	Cheese	2.5
7	Milk Powder	1.0 to 4.0

iii) Pack Size: You will be surprised to know that pack size also affects the milk solids loss. Usually volume or quantity of milk and milk products packed is with a tolerance / margin as safety measure with respect to Weights and Measures Act. In such cases loss will comprise of product of the safety margin per pack and number of packs. Some times over filling of packs do occur due to improper machine adjustment. In this way, we can understand that extent of milk solids losses will be inversely proportion to the size of packs and directly proportional to the number of packs. In the bulk milk supplies by Road /Rail milk tanker, the losses are further lower. The bulk supplies are tested and measured in composite manner, which result in less chances of deviation from the real quantity /volume.

iv) Accuracy of Testing and Measurement: The testing of milk is normally done on samples. Test results would be wrong due to improper sampling /sampling method, poor quality of test apparatus, improper quality of reagents used and improper calibration of test equipments and apparatus. Some times cheaper glassware do have poor sensitivity or least count which gives inaccurate results. Wrong sampling of liquid milk is generally observed due to improper mixing before sampling, sampling from wrong point or sampling without proper mixing and ageing time. Milk made by powder reconstitution needs ageing time of at-least four hours to get proper hydration of powder particles. Testing before proper hydration gives inaccurate test result. This can be visualized by balancing milk solids of powder used and milk obtained.

It has been noticed that repeated test by same technician with same apparatus and chemical may show variations on account of technician skill, other external factors and sensitivity of apparatus or combination of all these. Therefore, in general 1% variation in testing is accepted in the industry. However, in-fact accepting this norm of 1% can itself give huge variation.

v) Inefficiency of Processes: Inefficient processing may lead to heavy losses. For example: Inefficiency in temperature control or over ageing, the cream will

get over ripened with high acidity. Churning of high acidity cream will result in high fat loss through buttermilk, whereas buttermilk of sweet scream has normal acidity and can be utilized by mixing in the raw milk. There are several examples of process inefficiency that has adverse bearing on milk solids losses. For operational awareness some of the inefficiency losses are listed in Table-1.3.

Table-1.3 : Operational and Inefficiency Losses in Market Milk

Sr.No	Particulars	Milk Solids losses, % (approximate)
Operational losses		
1	Weight to Volume conversion	2.0
2	Product spoilage	0.15
3	Leakage and spillage	0.25
4	Theft and pilferage	0.05
5	Unsalvaged / unsold / replacement form unsold products	0.2
6	Inadequate drainage, flushing from vessels	0.2
7	Separation losses	0.10
8	Failure or damage of packing	0.125
Inefficiency losses		
9	Weighing	0.1
10	Sampling	0.1
11	Testing	0.1
12	Inaccuracy in standardization	0.05
13	Overfilling and over weight	0.15

vi) **Preventive Maintenance**: Some times milk or milk products line develops leakage. Leakage would be at process equipment (from chiller or pasteurizer plate), pipe lines (pipe are damaged union/valve or joints) not properly tightened or gasket is damaged or vessel /tank is damaged. This all happens due to lack of attention in preventive maintenance. In such situation, attempting leakage control at first notice itself would minimize losses. Such instances would be minimized by timely preventive maintenance of process lines and equipment.

vii) **Pilferage and Spillage**: Pilferage is due to poor integrity of personnel, whereas spillage is entirely the outcome of negligence. There are critical factors that are related to human instinct and can alone be a major factor, if not dealt in time.

viii) **Packing Losses**: Some losses are linked with packing quality, whereas others relate to inefficiency of operations. In the former type, milk solids

losses occurs due to damage of packs. Prominent responsible factors in this form are: (a) Use of packing materials of less thickness or weight, (b) decrease in the pack size for the same volume or quantity, (c) increase of packing speed. The major factors in the form of operations inefficiencies to result increase in the leakage are due to poor power supply, machine maintenance, frequent break downs, too many packing breaks and improper setting / adjustment for filling quantity.

ix) Flushing Losses: Flushing is done at the end of operations of equipment and at every emptying of Storage tanks / vessels. Flushing contains residual / sticking portion of milk. Inadequate emptying or early flushing may lead to excessive quantity of milk going to waste.

x) Marketing Policies: In order to cover up internal plant inefficiencies or to provide higher advantage to retail network /consumers as a pro-marketing policies, unsold or damaged milk packs are taken back and /or replaced with good one. In this case, there is physical loss of milk solids because the returned milk /product is of rejected quality and unsuitable for reprocessing. Also liquid milk packs if allowed by transporter crew to check before loading, then due to exercise of over pressure, higher cold store leakage may cause increased milk losses.

xi) Loss due to non-utilization of by-products: During manufacture of various products like *paneer, channa, rasogolla* and cheese, the whey is generated, which contains significant amount of milk solids. Non-utilization of the by-product leads to direct loss of milk solids. You will be surprised to know from the following table that a significant quantum of milk solids are present in by-products, which may be lost, in the event of their non-utilization.

Table-1.4 : Composition of By-products of Milk

Sr.No	By-product	Composition, %	
		Fat	SNF
1	Butter milk	0.1 to 0.5	6.5 to 8.0
2	Skim milk	0.05 to 0.2	9.0 to 9.2
3	Whey on channa, paneer, cheese, caseine preparations.	0.2 to 0.5	6.5 to 6.8
4	Ghee residue	50 to	30 to 40
5	Cuttings of paneer blocks	Same as paneer composition	
6	Cuttings of cheese	Same as cheese composition	

Check Your Progress-2

1. A dairy plant sales 1000 lit double toned milk in 200 ml pack size, 1000 lits toned milk in 500 ml pack-size and 1000 lit standard milk in 1000 ml pack size. To be safe from legal provision and take care of machine sensitivity, 5ml quantity is consider as safe margin. Find out actual losses in each type of milk and compared the variation with average loss.

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2. A dairy plant receives 50000 Kgs milk with challan testing of 6% fat and 9% SNF through road milk tanker. The sample is taken for testing at the receiving end, which finds 5.9% fat and 8.9% SNF. In Industry 1% difference is considered allowable and payment is made on the basis of sender's test, whereas receiving plant records their test for dairy's accounting. Find out the actual loss of milk solids in this case?

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3. A milk plant manufactures white butter for ghee. Daily ghee production of the plant is 13500 Kg. In order to maintain high acidity for traditional taste, cream is over aged. Dairy has no mean to utilize the butter milk. Find out the actual loss on monthly basis if daily 34000 Kg cream of 40% fat and 5% snf is used.

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1.3 MILK SOLIDS LOSSES CONTROL

Now we have understood that it is very important to reduce milk solids losses in a dairy plant. Concerted efforts are required to control these losses. Unplanned commitments are not enough to have judicious control and therefore, systematic approach has to be adopted. Following approaches are most prominently adopted in the well efficient milk plants:

i) Milk Losses Accounting: In order to exercise control over the routine operations, timely measurement and testing of all the incoming, in-process stock, transferred stock /sale and closing stock is recorded. At the definite interval, say shift, day, week, and month, quarter of year or annual, records are analysed to determine milk solids losses. Accounting of section or product or operation

wise will help in determining exact point of loss to take accurate step for preventing losses.

There could be three ways to account milk or milk product losses; these are:

a) **Comparing Input with Output**: In this method of losses account, the milk solids received by the dairy is accounted on actual basis, say it is "A". Now the actual output for realization /sale is also accounted; say it is "B". The quantum of milk solids losses would be calculated by comparing B with A. Thus milk solids losses in percentage would be (A-B)*100 / A

b) **Comparing Input with Standards**: The milk solids received by the dairy is compared with the standards and gap is calculated to determine the milk solids losses.

c) **Usage and Production System**: This is time consuming and costly procedure to determine milk solids handling losses. In this method, all the inventories, inputs, intermediary and finished products are accounted for their milk quantities and solids contents. Based on the actual quantity at a point of time, say shift, daily or periodically (milk bill payment period, month, quarter, six month or annual), the difference between " milk solids from receipt and opening inventories" and " milk solids in milk / products sale, stock, in process stock" is calculated. Handling losses are determined as percentage of the above difference with the sum of input and opening quantities. In this method laboratory tests for input, in-process and finished product are considered. However, in some cases required product standards as per weight and measure or PFA are considered for finished product

ii) **Modernization of Processes**: Out-dated technology to be replaced by new one to minimize losses. There are numerous examples of such improvement plans. Use of computerized milk reception in place of manual gives more accurate testing and weighing along with prompt accounting of reception. Other example would be replacing manual filling and packing by good quality automatic fillers and packing machine.

iii) **Fixing Frequency of Equipment Cleaning**: On the basis of experience and exercises, frequency of pasteurizer and chiller CIP cleaning should be finalized to minimize losses on account of frequent drainage and flushing.

iv) **Regular Monitoring Plan** must have comparative bench-mark of best of class in the similar type of plants. Balancing stocks and testing the effluents quality can monitor the milk solids losses. This will guide to excel for identifying and correction for losses.

v) **Continual Improvement Techniques**: A small group of plant personnel to work as quality circle for identifying causes for losses and their expected solution have been found very effective.

vi) **Utilization of By-product** to a great extent by re-using them or marketing. This also requires efforts for product development to accommodate effective utilization of the by-products.

vii) **Implementing Clean production or Environment Management System (EMS) Techniques**: Such as ISO: 14000 series advocates pollution

management through a systematically designed loss prevention programmes with effective multi-stage/layer monitoring / audits. Thus successful implementation will improve the situation with sustenance.

1.4 MONITORING THE MILK LOSSES

Monitoring of milk losses would be accomplished in two ways. It would be either done by the production people as part of their routine task or by other personnel independent of the concerned production work. The second type of monitoring is more independent than the former one and would be used as a source of effective feedback for the senior management to exercise suitable improvement actions. In both the case an effective checklist will serve as a guiding tool.

Table 1.5 : Check List for independent monitoring (audit for milk losses) and self appraisal for taking corrective measures

SL	Parameter	Observation
1	Process /section monitored	Whole plant or particular section or product
2	Date / Shift/time	Mention the time/shift/date
3	Officer responsible	Who is suppose to look after the improvement?
4	Milk loss is being accounted? What is the loss status?	Being done or not? Compare with set target or best in class.
5	Commitment level for loss control? - Trend of handling loss and - Action status in Past? - Future planning status?	What are the actions initiated so far. What sorts of provisions are planned /implemented? Assess the extent.
6	Floor is wet or dry?	Look at why wet. Leakage is washed? See problem area.
7	Visibility of milk leakage?	Identify objectively.
8	Milk spillage /overflow status?	Observed or not?
9	Does target for milk solids loss /utilization given?	The status will show commitment level.
10	Does quality of effluents monitored? What is the status?	Will indicate severity of milk losses.
11	Status of product defect or milk souring?	Indicate processing conditions responsible for losses.
12	Status of cleaning frequency of tanks and equipments?	Fixed or not. How frequently and why? Can it be reduced? It will reduce flushing losses.

13	Status of loss due to cutting and shaping of milk products	What is status? Can there be way-out? Or can these be utilized?
14	Status of recovery system? Extent of recovery of milk solids? Ghee section- Powder section-	What is the status? Can there be further improvement?
15	Status of by-product utilization	How these are utilized? Can there be a better utilization?
16	Status of market return / product recall?	Why market return? How to control them? What is the extent of market return? How it is utilized?
17	Status of weighing and monitoring of filling/packing quantity?	What is the status? Facilities are present? What has been done to continually improve the status?
18	Status of Product standardization?	Status?
19	Status of calibration of Fat & Snf testing apparatus?	What is the policy being followed? Standard facilities are available for calibration?

Check Your Progress-3

1. Can you list five prominent loss prevention measures in a dairy plant?

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2. What do you understand by EMS?

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3. How preventing the milk loses will have favorable influence on pollution control?

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1.5 LET US SUM UP

Dairy plant has milk solids losses due to incorrect measurement or testing, faulty handling, leakages, poor maintenance of equipments and pipes lines, improper drainage of milk solids on account of frequent cleaning or carelessness, spoilage of milk and milk products, inadequate recovery of milk solids, over filling or less over run in products like ice-creams or butter. Milk solids cost is the major component of product cost and therefore, requires prompt attempt to identify and arrest these losses. Proper monitoring through weighing and testing of milk and milk products in the form of milk solids accounting gives timely information on losses to exercise judicious control measures. Milk losses has direct impact over cost of pollution control measures. Therefore, timely action to control these losses will reduce production cost and pollution.

1.6 KEY WORDS

Accounting : The principle and practice of setting up and auditing financial accounts.

Composition : The makeup of a thing or person, constitution

Loss : A losing or being lost, the damage or disadvantage

Measure : A determining of extent, dimensions, etc

Milk : A white liquid secreted by mammary glands of females for suckling their young.

Milk Solids : Completed dehydrated milk containing Fat and SNF

Recovery : Regaining the lost milk or milk solids

SNF : Total solids minus fat in milk

Over run : To spread out over so as to cover

1.7 SOME USEFUL BOOKS

De, Sukumar,1980, Outlines of Dairy Technology, Oxford University press, New Delhi-1100002

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1.8 ANSWER TO CHECK YOUR PROGRESS

Your answers should included the following points:

Check Your Progress - 1

1. Various points in milk reception having potentiality of milk loss are spillage during tilting, leakage from dump vat, filter, pump and fitting, pipe line, chiller and raw milk storage tank including flushing of the tank.

2. 0.5 – 1.0 %

3. Leakage at cream outlet and leakage at skim milk outlet and losses in skim.

Check Your Progress - 2

1. Number of 200ml DTM pouches = 1000×5 = 5000, Milk TS = 108.15 Kg

   a) Excess DTM milk= 5000×5 = 25000ml, or 25000×1.03/1000= 25.75 Kg × (1.5+9)/100= 2.7 Kg TS loss or % TS loss =2.7×100/108.15 = 2.49% TS loss

      Number of 500ml TM pouch = 1000×2 =2000, Milk TS= 118.45 Kg TS

   b) Excess TM= 2000×5= 10000ml = 10 Lit = 10.3 Kg milk, or 10.3×(3+8.5)/100=1.18Kg Milk TS loss, % TS loss = 1.18×100/118.45= 0.99% TS loss

      Number of 1000ml Std. M pouch= 1000, Milk TS= 139.05 KG

   c) Excess Std Milk= 1000×5 = 5000ml = 5 lit milk = 5.15 Kg milk or 5.15×(4.5+9)/100 = 0.695 Kg Milk TS loss, % TS loss= 0.695×100/139.05 = 0.5% TS

      Total milk (DTM+TM+Std.Milk) = 108.15+118.45+139.05= 365.65 KG

   d) Total Milk TS loss = 2.7+1.18+0.695= 4.575 KG

      Therefore % milk TS losses = 4.575×100/365.65 = 1.25%

      In this way see that milk TS loss of smaller size pack is highest and biggest size 1Lit is lowest for the same quantity of milk packed.

2. In both the case 1% difference is between sending and receiving dairy, hence for sending dairy:

   Fat loss = (6.0-5.9)×50000/100= 50Kgs fat, % fat loss = 50×100/(50000×0.06)=1.67%

SNF Loss= (9.0-8.9)×50000/100=50Kgs, Snf, % Snf loss= 50×100/(50000×0.09) = 1.11%

3. Total Fat in cream = 34000×40/100 = 13600 Kg,

   Total SNF in cream= 34000×0.05 = 1700 Kg

   Fat recovered in ghee= 13500 Kgs

   Loss of TS = 13600+1700 – 13000 = 2300 Kg TS, % loss = 1800×100/15300

   = 11.76 % Total solids losses

Check Your Progress - 3

1. Operations and design related factors such as leakage, pilferages, flushing, excess filing in packing, failure of packs during and after packing, market return, testing errors of milk during sourcing and standardization are the major factor for milk losses in dairy plants.

2. Five measure milk loss prevention measures are:

   1. Ensure accuracy in milk testing.

   2. Ensure accuracy in milk standardization.

   3. Identify and stop leaky points in line. Monitor losses through solids accounting system

   4. Prevent milk /cream souring.

   5. Use flushing to recover milk solids

3. EMS is Environment Management System such as ISO: 14000

   Prepare an effective milk solids losses management system comprising of a comprehensive checklist for identifying sources and points of milk solids losses in a liquid milk plant and programme for loss prevention?