FACTORS AFFECTING YIELD AND COMPOSITION OF MILK.

The variation in composition and daily yield of milk is a regular phenomenon in all milking animals. Broadly, the factors which are responsible for such variations can be divided into (1) Physiological, which will be governed by the genetical make up and (2) Environmental, such as age, number of previous lactations, pregnancy, nutrition status, etc. The dairyman has hardly got any control over the physiological factors but he has some control over the environmental factors. A thorough understanding of the factors that change the environment of the dairy cattle can be used to take advantage of some of the changes in milk composition and yield that occur during a normal lactation.

1. Change Occurring during a Normal Lactation.

A normal lactation curve. The cow reaches her peak yield in about 3 - 6 weeks after parturition, and then gradually the production declines. For Cross-bred and other high yielders it is advisable to have a lactation period of 305 days so that a clear 60 day dry period and a yearly calving programme is achieved. The peak yield of the cow is dependent on her body condition at calving, her genetical potential, her freedom from metabolic and infectious diseases and the feeding regime after calving. Peak milk production plays an important role in determining lactation milk production, since there is a high correlation between these two factors.

The rate of decline in milk yield after calving is known as persistency. For high lactation yield cows must have high persistency as well as high peak milk production. Rate of decline is enhanced by pregnancy particularly with effect from twenty-second week of pregnancy. This decline attitude at its five and a half month of pregnancy may be avoided if the cows are bred 60 days after previous calving.
There is general inverse relationship between milk yield with its protein and fat percentages. As yield increases, the percentage composition of these two elements decreases. Lactose content shows very slight decline towards the end of lactation and ash content shows a very slight increase with advancing lactation.

**Colostrum.** The first milk from the mother after birth of the young mammal, which has a markedly different composition from that of normal milk. The most significant difference is the high percentage of protein in colostrum. The composition of colostrum changes significantly into normal milk within 3 - 4 days following parturition, but it takes about 15 days for complete normalisation.

2. **Day-to-day Variations.** Percentage of composition of milk as well as milk yield vary considerably from day-to-day. In general excitement, oestrus, incomplete milking, and other irregularities previous to milking, disease, under feeding and related factors, cause daily variation of milk yield. Depression in milk yield that lasts for several days are usually accompanied by higher fat tests as because there is a general inverse relationship between milk yield and fat test. An incomplete milking fails to obtain the last drawn milk, which is extremely high in milk fat. First drawn milk, or foremilk may be as low as 1% milk fat, whereas the last drawn milk may be as high as 8 - 15%. The milk yield at the next milking is higher in milk fat content.
Lactational changes in milk yield and composition in dairy cows

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since it contains the leftover milk from the last milking with high fat content from the present milking.

Fat test may again vary up to 1% between the night and morning milking when the cows are milked at 14 and 10 hours intervals. The explanation for this variation will involve probably two factors: (1) due to relationship of pressure to milk and fat secretion, in which milk produced during a long interval and against a higher udder pressure which has a lower fat test, (2) due to exercise, which has a tendency to increase the level of milk fat. Consequently the evening milk of cows at equal intervals produces milk that has a slightly higher fat test than does that obtained from morning milking.

3. Dry Period and Body Condition.
The length of the dry period and the body condition at calving are related. Cows must be in good body condition at calving and must have had a dry period to attain maximum production. The dry period is important for replenishing body supplies if the cow is in poor body condition at calving and also to regenerate milk secretory tissue. An increase of highest milk yield results with dry period between 50 to 59 days. Although longer dry periods result in higher daily production in the following lactation, the total milk produced over a series of lactations is not increased.

4. Age of Cow at Calving.
It is well known that cows produce more milk as they attain certain ages after which a progressive reduction in the level of milk production occurs and continues until they die. During first lactation at an average age of 2.5 years cow produces approximately 76% of the milk produced by a mature cow. Average figures for 3 year old cows indicate that they produce approximately 85% of the milk produced by a mature cow; the figures for 4 and 5 year old cows are 92% respectively. Cows of most breeds are considered mature between 6 and 7 years old. There is some variation among breeds. When cows are 8 to 9 years of age, a reduction in the level of milk production commences. In addition to the increase of milk production with age, there is a slight decrease in the SNF and fat per cent through the fifth lactation, beyond which there is little change.

5. Body Weight.
A general relationship exists between the body weight of cows and level of milk production. Larger cows have more udder secretory tissue and larger digestive systems.

A significant reduction of milk yield occurs towards the end of pregnancy. Although the exact reason is not yet known but according to one hypothesis it has been suggested that level of nutrient required for foetal development is highest; however, this appears to be only 1 to 2 per cent of the daily requirement of the cow. Another convincing explanation is that of a change in hormone production, in which large amounts of oestrogen and progesterone are released into blood stream, which are detrimental to high
milk yield. During fourth to fifth months of gestation there is an increase of SNF.

7. Temperature and Humidity.
Severe weather conditions drastically affect milk production. Temperatures between 40 - 75°F have no effect on the milk production. In this range (Comfort Zone), no body processes are directly involved in maintaining body temperature. At a very high temperature feed consumption is greatly reduced, there is an increase in water intake, an increase in body temperature and respiration resulting decrease in milk yield with lowered milk fat, SNF and total solids.

High relative humidity accentuates the problem of high temperatures.

8. Season of the Year.
Milk production is usually less during the summer because of the higher environmental temperatures and the prevalence of green-forage scarcity. Thus the season of calving has got a marked effect on the total production. Cows freshening shortly before winter months produce more total yield than those calving at other times of the year. The increase is probably due to more favourable temperature and more digestible feeds available during the winter.

9. Calving Interval
The interval between calving is another important management problem the farmer must deal with. The decision should be made on the basis of individual factors such as feed consumption, labour cost and reproductive efficiency, etc. It has been shown that it is most profitable for cows to calve at twelve-month intervals. This requires to breed the cows within 2 to 3 months after freshening. More milk can be obtained in a single lactation with longer calving intervals but total production over two or more years is greatest with the yearly calving interval.

10. Interval between the Milking.
As milk pressure increases in the gland, the rate of milk secretion decreases until the pressure in the lumen of the alveolus becomes equal to the secretory pressure in the cells lining the alveolus. At this point secretion of milk stops. Therefore, frequent evacuation of the udder is essential for maximum milk production. It has been shown that milking cows three times a day increases milk production 10 to 25% over two times daily milking. Milking four times a day instead of three results in another 5 to 15% increase in production.

11. Feeds and Feeding.
(a) Changes in Milk fat content.
Changing feeding regime can alter fat content of milk. The various types of ration, which can cause a decrease in milk fat percentage, are as follows:

1. High concentrate rations
2. Low roughage rations
3. Grass from lush spring pastures
4. Finely ground hay
5. Heat treated feeds
6. Feeds in pelleted form
It has been noted that the above rations decreases milk fat by depressing acetic acid production in one hand and on the other hand by increasing propionic acid production. Generally the molar percentages of VFA in the rumen are:

<table>
<thead>
<tr>
<th>VFA</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>Acetic acid</td>
<td>65%</td>
</tr>
<tr>
<td>Propionic acid</td>
<td>20%</td>
</tr>
<tr>
<td>Butyric acid</td>
<td>12%</td>
</tr>
<tr>
<td>Others</td>
<td>3%</td>
</tr>
</tbody>
</table>

Fat depressing rations cause the acetic acid to drop by 10% or more and the propionic acid to increase by similar amount.

Another theory behind the milk fat depression states that there is a reduction in the amount of hydroxybutyric acid in the blood and consequently a deficiency in the amount of this 4-carbon unit that is available for milk fat synthesis.

A third theory states that the high propionate production causes a glycogenic response in the body that suppresses the mobilisation of fat from the tissues and thereby causes a decline in blood lipids that are available for milk fat synthesis.

A fourth theory states that fatty acid esterification in adipose tissue is elevated, which also reduces the availability of triglycerides to the mammary gland.

Research findings suggest that feeding the following materials can partially rectify the fat depression in milk:

1. Sodium or potassium bicarbonate
2. Magnesium carbonate
3. Magnesium carbonate
4. Partially delactosed whey
5. Sodium bentonite
6. Calcium hydroxide.

Some of these compounds increase the rumen pH and others decrease propionate production and increase rumen acetate production. The drawback in using these substances is that most of them are unpalatable and decrease appetite.

The following types of rations will help to increase milk fat percentage:

1. Feed rations having at least 17% fibre.
2. Use a screen that is more than 1/8 inch in diameter if ground forage is used.
3. Feed ungrounded forage at a minimum rate of 1.5 hay equivalent to 100 pounds of body weight per day.

The fat content of rations normally fed on dairy cows has no influence on either milk yield or milk composition. High fat feeds results on slightly higher milk production than low fat feeds due to high energy value of the feeds.

(b) Change in protein and SNF content. Changes in protein and SNF contents of milk are less pronounced by environmental factors, which the mineral and lactose contents are not at all variable under normal farm conditions.
Underfeeding of dairy cows results in a 0.2% reduction in protein and SNF percentages and a depression in milk yield. Increasing the plane of nutrition to 25% above normal standards results in an increase in SNF and protein percentages to the same extent. High level of nutrition results in an elevated propionic acid production in the rumen.

(c) Change in mineral and vitamin content. Among minerals, the major elements (calcium, phosphorus, potassium, chlorine and sodium) cannot be changed by altering the levels of these elements in the ration of a cow. Trace minerals with the exception of iron and copper can be increased by increasing the levels of those minerals in the ration up to a certain extent. For iodine, which is transferred in maximum amount, it is only 3 to 5% of the amount present in the ration appears in milk. Among vitamins, some of the fat-soluble vitamins, A, D and E can be increased in milk through dietary process. Marked seasonal variation occurs if the vitamin content is increased when the cow is exposed to enough of green forages especially during rainy season. The carotene present in all green forages are converted into vitamin A. Vitamin D content of milk can similarly be increased by providing sun-cured roughages or by exposing the cows to direct sunlight.

(d) Changes in specific gravity of milk. When the dairy cow goes off feed there is a decrease in the volume of milk produced, accompanied by increase in the fat, mineral, protein and total solids with a simultaneous reduction in lactose and specific gravity of milk.