# THE FEASIBILITY OF MILKING IN A FEEDING BOX

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Summary

With the aim of introducing completely automated milking, preliminary research has been carried out on the possibility of using the concentrate feeding box for milking. For a period of 11 weeks a test group of 20 cows was milked in a modified concentrate feeding box at irregular times and several times during 24 hours. The milking clusters were attached by hand.
The cows visited the box on average 5.4 times and were milked on average 4 times in 24 hours. An average daily milk yield of 27.4 kg was obtained, containing 4.13% fat and 3.34% protein. The increase in production as a result of more frequent milking was approximately 5 kg per cow per day in this test. The daily feed intake of each animal was approximately 21 kg DM of roughage and concentrates. If concentrates were not supplied during milking, this had a negative effect on milk yield.

An analysis of the milkings showed that milk production was slightly less with smaller milk yields than predicted. The fat gramme production did, however, increase as a result of the higher fat percentage. With predicted milk yields of more than 10 kg, fat gramme production was clearly less than predicted as a result of lower milk production and lower fat percentage.
Health problems were not monitored. Some animals were treated for foot problems.
The quality of the milk was consistently high. As there were about 80 cleaning cycles per day, there was the possible problem of water remaining in the milking system.
The milking equipment was in operation for on average 21 hours a day; this posed no problems.
In conclusion it can be said that the concentrate feeding box is a suitable place for milking and it is the only place where the cow already presents herself several times a day. Milking several times a day clearly had a positive influence on milk production.

Contents

## Introduction

Considerable research has already been carried out on the possibility of automation on dairy farms, for example, by the application of electronics and microelectronics.

A cow identification system enables identification of the animal when it is necessary to take some action. Both roughage and concentrate rations can be dispensed to the individual animals. Individual production can be registered per cow. It is possible to identify sick cows and cows in heat by the use of sensors (transducers). Milk, which deviates from the norm, can be identified and separated.

In spite of the level of automation, the dairy farmer still experiences a very high degree of mental and physical stress and milking is a major cause of this. The present level of technology and the existing methods of signalling deviations open the way for complete automation of the milking process. IMAG has now begun work on techniques for the automatic attachment of the milking cluster.

It is possible to milk a cow several times a day with an automatic milking system; this means, however, that it is necessary for the animals to come to the milking machine several times a day.

Programmed concentrate dispensing systems are already in use on approximately 3000 Dutch dairy farms for concentrate rationing. With these systems the animals can eat concentrate rations throughout the day in the feeding boxes which are located in the stall. These feeding boxes may also be used in principle to automatically milk the cows several times a day; the existing walk-through milking parlour then becomes obsolete.

In order to investigate the possibility of this, a group of 20 cows was milked in the concentrate feeding box on the experimental farm "De Vijf Roeden" at Duiven from 1st February '84 to 17th April '84. Here the milking clusters were attached by hand. The first trial was set up to investigate the feasibility of this milking method.

## 1. Research

### 1.1 Research aim

The aim of the research is to determine whether it is feasible to use the concentrate feeding box as a milking place. The following are the main questions to be taken into consideration:

- do the cows come to the feeding box to be milked;
- how often do the cows come to be milked;
- how do the cows react when milked in this way;
- how does the system affect milk production and milk quality?

The influence of a number of factors on production (milk, fat and protein) was then studied, such as the milking time interval and the time of milking.
The trial was carried out over a period of 11 weeks, from 1st February '84 to 17 April '84.

### 1.2 Experimental farm

About 70 Friesian FH/HF cows are kept on IMAG's experimental farm, "De Vijf Roeden", at Duiven. Milk production level is 6500-6600 kg per cow and the average age of the cows is 4.01 years. The cows are normally milked twice a day in an 8 stall herringbone parlour.
Concentrates are normally dispensed in feeding boxes in the stall and a small amount is given in the milking parlour. Production, animal health, reproduction, feeding and the milking machine are monitored by an on-farm computer management system.

### 1.3 Test group

A test group of 20 animals was selected from the dairy herd; the group was selected so that an even distribution of age and lactation stage was obtained.

Data on the animals in the test group are given in Table 1. These data were valid at the beginning of the test.

Table 1. Test group (data at beginning of test)

| cow nr. | age at calving (years and months) | days in lactation | milkyield (kg/day) | status | days in status |
|---|---|---|---|---|---|
| 13 | 5.10 | 158 | 24.3 | pregnant | 65 |
| 15 | 6.11 | 214 | 23.2 | pregnant | 149 |
| 18 | 6.01 | 160 | 18.5 | pregnant | 93 |
| 36 | 6.07 | 160 | 22.0 | pregnant | 109 |
| 64 | 4.09 | 204 | 22.6 | pregnant | 132 |
| 70 | 4.09 | 145 | 22.7 | served | 23 |
| 76 | 4.04 | 301 | 26.2 | pregnant | 126 |
| 86 | 4.11 | 37 | 36.0 | calved | 37 |
| 89 | 6.05 | 170 | 26.8 | pregnant | 103 |
| 91 | 6.01 | 201 | 21.9 | pregnant | 114 |
| 106* | 4.09 | | | dry | 68 |
| 118 | 3.09 | 158 | 20.1 | pregnant | 61 |
| 127 | 4.01 | 15 | 33.2 | calved | 15 |
| 144 | 2.01 | 128 | 23.7 | pregnant | 66 |
| 205 | 3.09 | 27 | 31.4 | calved | 27 |
| 208 | 3.02 | 212 | 21.6 | pregnant | 121 |
| 210 | 2.11 | 138 | 21.0 | pregnant | 75 |
| 211 | 3.03 | 55 | 28.7 | in oestrus | 8 |
| 214 | 3.00 | 41 | 32.6 | in oestrus | 2 |
| 218 | 3.01 | 62 | 24.8 | in oestrus | 11 |

* cow 106 calved 7th February '84

## 1.4 Milking place and equipment

The feeding box in the cubicle was modified for this trial into a milking/feeding box. Two cubicles were used for this (Fig. 1).

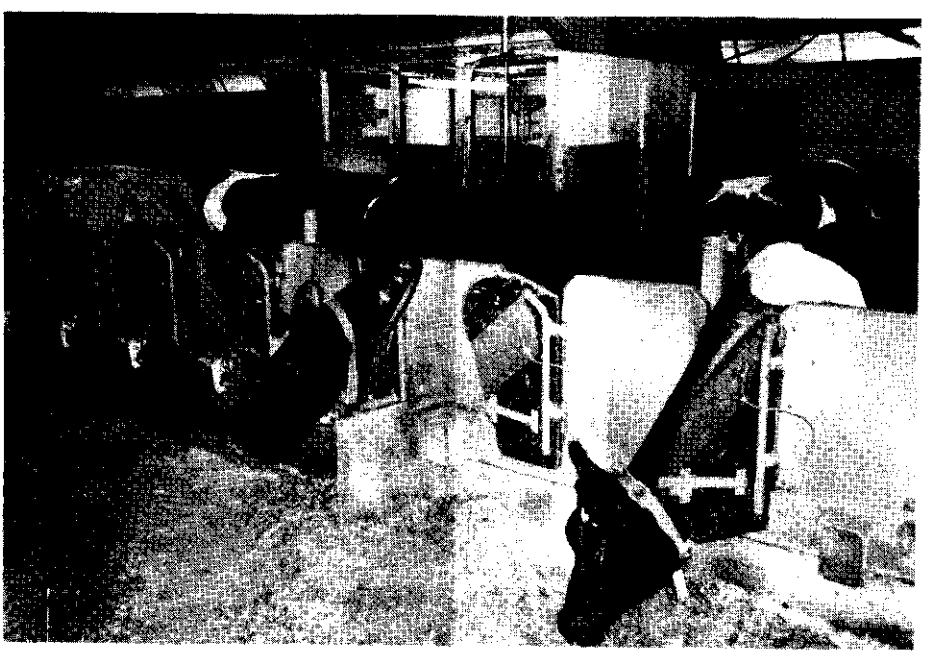

Figure 1. Cows at the feeding trough with milking/feeding box in background

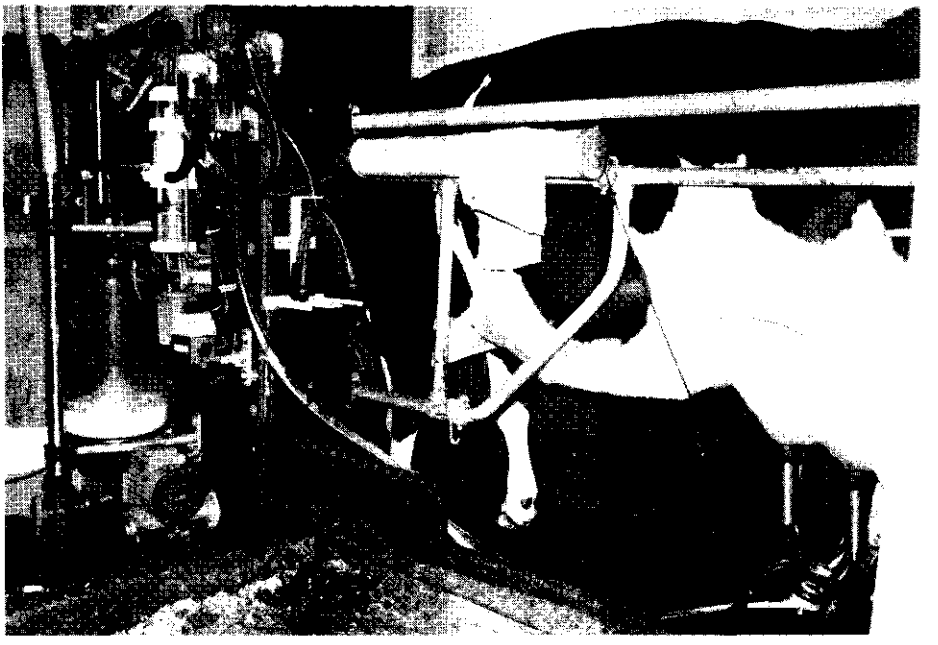

Figure 2. Milking equipment in the milking/feeding box

All the milking, measuring and cleaning equipment was installed in the milking area (Figure 2).

A short milking line was positioned at medium height with one cluster which was removed automatically. The vacuum level was 50 kPa. An Enfarm milk meter was used to determine milk yield level; it was also used for taking samples. The installation was automatically cleaned twice a day. There was a short washing cycle of 1 minute after each milking.

## 1.5 Milking

Milking and accompanying tasks, such as administration, milk sampling, silage distribution, cubicle cleaning, etc. were carried out by 5 milkers; each milker was present for 6 hours in turn.
A video terminal, connected to the farm computer, was placed in the feeding/milking station and data on the animals could be input or accessed. When a cow appeared in the feeding area, then data on the animal appeared on the screen and the decision whether to milk the cow was based on this information.
In the first week of the trial, the cluster was only attached if the cow had not been milked in the last 4 hours. In the later stages of the trial, the cluster was attached if the animal had not been milked in the last 3 hours and if the predicted production was at least 3.5 l. These criteria were selected to prevent obtaining too low a milk yield per milking. Any cow, which did not appear in the feeding box 12 hours after the last milking, had to be brought to the box.

## 1.6 Observations

During the trial the following data were monitored:
- number of the cow in the box
- time of entry into the box
- whether the cow was milked or not
- measured milk yield
- whether or not concentrates were dispensed.

A diary on cow behaviour was also kept. Note was made of, for example, cows in heat, lameness and cows which had to be brought to the box because more than 12 hours had passed since they were last milked.
Every 3 weeks a milk sample was taken from every milking during 72 hours in order to obtain information on short and long term variations in milk, fat and protein production. A period of 24 hours was always taken as valid for the official production control. All milkings were sampled over periods of

28 hours in the intervening weeks.
A milk sample was taken 3 times a week from the milk tank to test fat, protein and lactose. A sample was also taken from the tank containing the milk from the other cows on the farm for comparison. The milk from both tanks was sampled once a week to determine freezing point, acidity of milkfat and the cell count of the milk.

## 1.7 Feeding

Roughage was fed ad lib. to the test group. The roughage intake of the group was monitored by comparing the amount supplied with the remainder left.
The amount of concentrates required per cow was determined twice a day on the basis of the estimated roughage intake, actual milk production, body weight and age. The maximum amount of concentrates supplied was determined by the estimated roughage intake and the structure value of the roughage ration.
On the basis of these data, the maximum amount of concentrates dispensed was 14.2 kg per day. This was obtained with a milk production of approximately 32 kg per day. Later, for some animals with a very high production, the maximum amount dispensed rose to 16 kg.

## 2. Results

### 2.1 Some general aspects

Table 2 shows a number of important test results.

Table 2. Milk production, frequency of box visits and milking, and daily concentrate intake per cow (figures averaged out over the whole test period)

| cow no. | milk kg/day | fat % | protein % | frequency of box visits (/day) | milking frequency (/day) | concentrate intake (kg DM/day) |
|---|---|---|---|---|---|---|
| 13 | 27.8 | 3.71 | 3.30 | 5.1 | 4.2 | 11.3 |
| 15 | 15.6 | 4.53 | 3.85 | 5.3 | 3.2 | 5.8 |
| 18 | 19.6 | 4.65 | 3.52 | 3.6 | 3.1 | 7.8 |
| 36 | 21.4 | 4.31 | 3.64 | 3.1 | 3.0 | 8.0 |
| 64 | 21.5 | 4.47 | 3.25 | 4.7 | 3.8 | 9.4 |
| 70 | 25.2 | 4.45 | 3.15 | 4.7 | 3.7 | 10.1 |
| 76 | 25.2 | 3.67 | 3.34 | 4.8 | 3.8 | 9.4 |
| 86 | 40.9 | 3.52 | 3.01 | 8.3 | 5.4 | 13.3 |
| 89 | 29.0 | 4.33 | 3.29 | 3.4 | 3.2 | 11.6 |
| 91 | 22.7 | 4.83 | 3.64 | 5.7 | 4.1 | 9.7 |
| 106 | 41.1 | 3.65 | 3.04 | 4.1 | 3.7 | 10.8 |
| 118 | 21.8 | 4.69 | 3.82 | 9.1 | 4.6 | 9.9 |
| 127 | 38.4 | 3.49 | 3.04 | 5.4 | 4.4 | 13.4 |
| 144 | 26.7 | 4.66 | 3.53 | 4.9 | 3.7 | 11.5 |
| 205 | 36.0 | 3.63 | 3.17 | 7.0 | 5.1 | 13.6 |
| 208 | 23.3 | 4.47 | 3.32 | 3.8 | 3.2 | 8.4 |
| 210 | 23.8 | 4.41 | 3.61 | 5.8 | 4.2 | 9.2 |
| 211 | 29.8 | 4.47 | 3.58 | 6.5 | 4.7 | 13.2 |
| 214 | 31.5 | 4.08 | 3.33 | 6.3 | 4.8 | 12.9 |
| 218 | 26.8 | 4.26 | 3.43 | 6.1 | 4.2 | 10.9 |
| average | 27.4 | 4.13 | 3.34 | 5.4 | 4.0 | 10.5 |

If an average lactation stage was taken into account, a high average daily production of 27.4 kg milk was obtained. At the end of the trial the cows were an average of 200 days in lactation. The fat and protein levels in the milk remained at the normal level, 4.13% and 3.34%, respectively. There was, however, a very large variation mainly in the fat content; this varied around 3.5% with a daily milk yield of more than 35 kg. The fat content was in many cases higher than 4.4% when the daily milk yield was less than 25 kg. Because of the high milk production the concentrate intake of 10.5 kg DM per day was also high. When calculating concentrate rations, milk production should also be taken into account. The average number of times a cow visited the box was 5.4 per day. There was no clear relationship between the frequency of visits to the box and the amount of concentrates supplied and milk production. On average each animal was milked 4.0 times a day with a variation of 3.0 to 5.4. There was also a relationship between milking frequency and milk production. This was, however, mainly due to the criteria set for cluster attachment when a cow visited the box. A cow with a high production level will fulfill these criteria more quickly. Differences in milking frequency also occurred with identical production levels. However, cows, which visited the box less frequently, also showed a somewhat lower milking frequency. More detailled data on milk production, frequency of box visits and feed intake are given in appendices 1, 2 and 3.
A number of these aspects are discussed in more detail in the following.

## 2.2 Transition from milking twice a day to milking several times a day

The trial began on 1st February 1984. The test group is normally milked in the morning in the herringbone milking parlour.
At 12.00 midday the first milking took place in the feeding box. Most animals came to the box voluntarily. A number of cows did not appear within 12 hours since the previous milking and these animals had to be brought to the box. The number of cows, which had to be brought to the box, was limited; in the first week it was less than 5% of the number of milkings and later less than 1%. It was a problem mainly with cows which were drying off, but also with some cows with foot problems (see also Appendix 4).
On the whole the transition to milking several times a day was successful.

The most striking feature was the peacefulness of the cows in the test group.

## 2.3 Frequency of visits to the box and milkings

The feeding box was visited a total of 8116 times and the cows were milked 6049 times or on 75% of the visits. Figure 3 shows the average frequency of box visits and of milkings per day during the 11 test weeks.

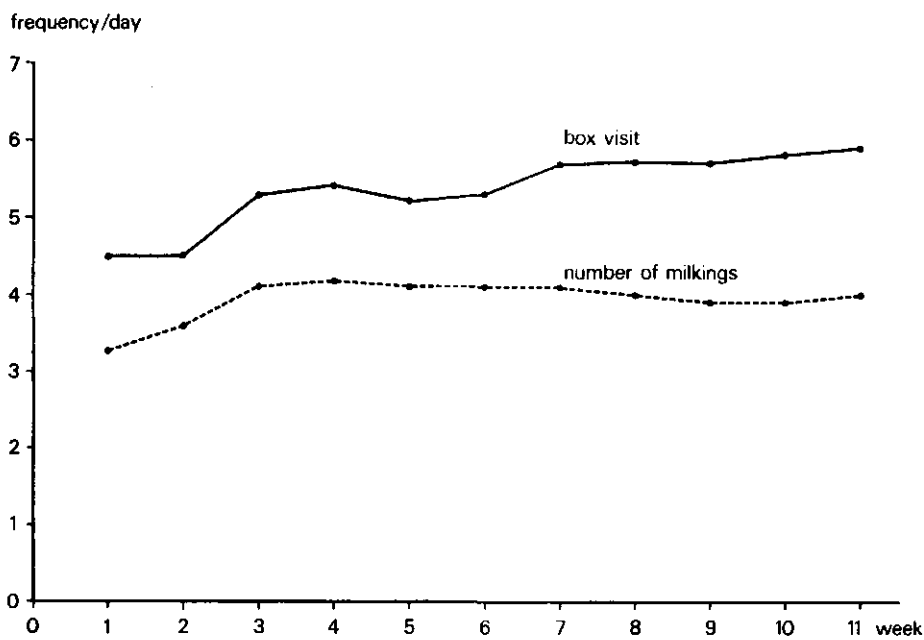


Figure 3. Average frequency of box visits and of milkings

The feeding box was visited on average 100 times a day, with a maximum frequency of 135 and a minimum frequency of 77. The average was 5.4 per cow with a maximum of 16 and a minimum of 1 visit. Milking frequency was on average 80 per day, with a maximum of 90 and a minimum of 60. The highest milking frequency registered per day for any cow was 7. Figure 4 gives the average number of box visits and milkings during the day.

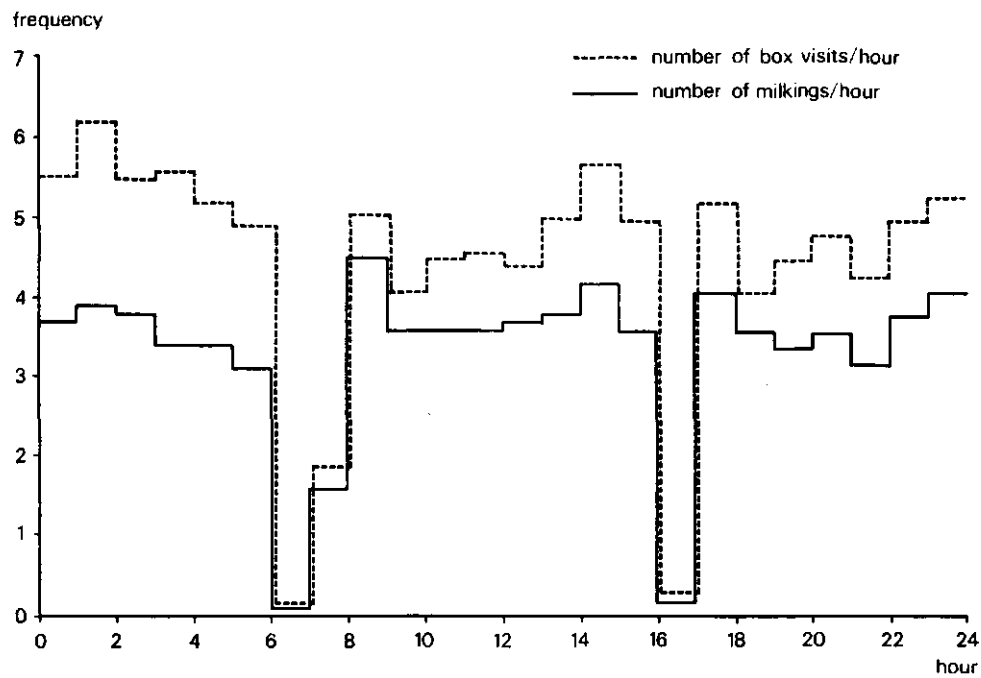


Figure 4. Number of box visits and milkings by hour of the day

The cows in the test group were not milked when the other cows on the farm were milked. At these times (6.00 - 7.30 and 16.00 - 17.30) the milking equipment was thoroughly cleaned and the milk tank emptied and cleaned. After these forced interruptions in the milking, milking frequency was high; it was also slightly higher in the afternoon from 13.00 to 15.00 and in the evening from 22.00 tot 24.00.

## 2.4 Milk production

Figure 5 gives the variation in the average standard cow production in kg per day for the test group. The curve for the other group of cows on the farm is also given for comparison. This group was milked twice a day in the milking parlour. Roughage rations were identical for both groups.

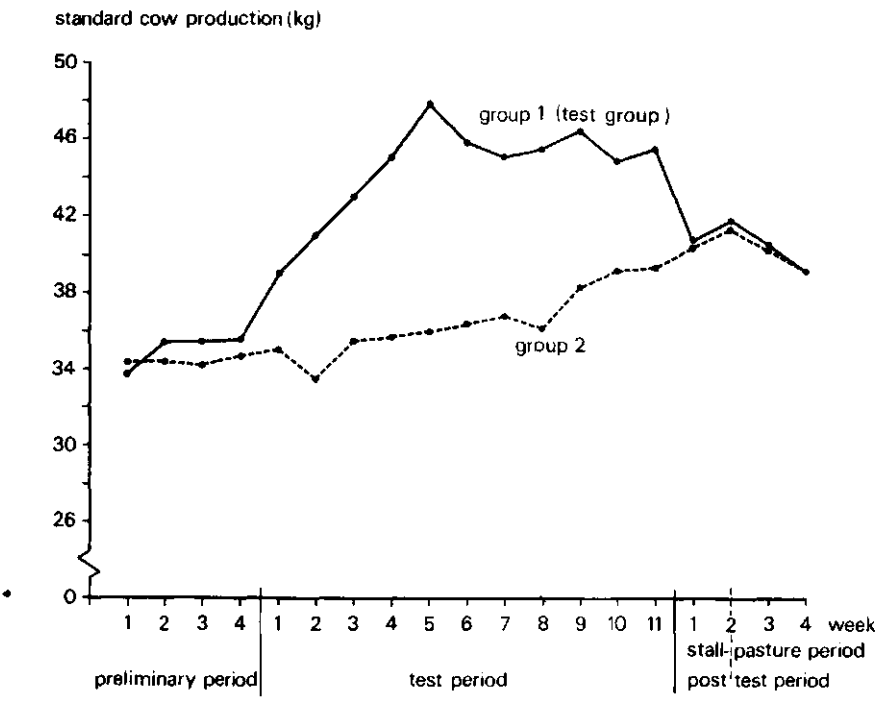


Figure 5. Standard cow production

In the first 5 weeks of the trial, there was an increase in the standard cow production of about 35.5 kg in the preliminary period, up to about 47 kg in the fifth test week. Over the last 8 weeks standard cow production was above 44 kg per day. The transition back to milking twice a day was accompanied by a marked decrease.

The other group of cows on the farm showed a gradual increase in the standard cow production during the test period. The level of this group did, however, remain clearly below that of the test group. After the trial was finished, both groups achieved approximately the same level once more.

During the trial the standard cow production of the test group was on average 8 kg higher than that of the other group on the farm. With an average of 156 days in lactation and an average age of 4 years and 6 months, a higher milk production of about 5 kg per day was obtained when compared to predictions based on the production level of the other group.

A number of cows from the test group gave milk 4 weeks prior to and a minimum of 4 weeks after the period of the trial. The average production results for these animals are given in Table 3 for the period prior to the test and the test period. The results obtained during the period after the test are not given, because they were influenced by the transition to pasture.

Table 3. Comparison of production data for a number of cows in the period prior to the test and the test period

| cow no. | preliminary period milk | fat | protein | days in lactation at start of test | test period milk | fat | protein | difference between test and preliminary period milk | fat + protein |
|---|---|---|---|---|---|---|---|---|---|
| | kg/day | % | % | | kg/day | % | % | kg/day | gr/day |
| 205 | 27.5 | 3.80 | 3.47 | 27 | 36.0 | 3.63 | 3.17 | +8.5 | +449 |
| 86 | 36.7 | 4.04 | 3.46 | 37 | 40.9 | 3.52 | 3.01 | +4.1 | - 82 |
| 214 | 31.9 | 4.09 | 3.33 | 41 | 31.5 | 4.08 | 3.33 | -0.4 | - 33 |
| 211 | 28.1 | 4.51 | 3.33 | 55 | 29.8 | 4.47 | 3.58 | +1.7 | +196 |
| 218 | 25.8 | 4.18 | 3.33 | 62 | 26.8 | 4.26 | 3.43 | +1.0 | +123 |
| 144 | 24.7 | 4.41 | 3.45 | 128 | 26.7 | 4.66 | 3.53 | +2.0 | +245 |
| 210 | 21.6 | 4.17 | 3.54 | 138 | 23.8 | 4.41 | 3.61 | +2.1 | +243 |
| 70 | 23.2 | 4.11 | 3.17 | 145 | 25.2 | 4.45 | 3.15 | +2.0 | +226 |
| 13 | 23.9 | 3.75 | 3.42 | 158 | 27.8 | 3.71 | 3.30 | +3.9 | +235 |
| 118 | 20.4 | 4.39 | 3.56 | 158 | 21.8 | 4.69 | 3.82 | +1.4 | +233 |
| 18 | 19.3 | 4.49 | 3.45 | 160 | 19.6 | 4.65 | 3.52 | +0.3 | + 69 |
| 36 | 20.7 | 4.24 | 3.70 | 160 | 21.4 | 4.31 | 3.64 | +0.7 | + 58 |
| 89 | 28.2 | 4.35 | 3.44 | 170 | 29.0 | 4.33 | 3.29 | +0.8 | + 13 |
| 91 | 22.3 | 4.64 | 3.54 | 201 | 22.7 | 4.83 | 3.64 | +0.4 | + 99 |
| average | 25.3 | 4.21 | 3.43 | 117 | 27.4 | 4.21 | 3.39 | +2.1 | +148 |

Despite continuation of the lactation stage, the average daily milk yield in the test period increased by 2.1 kg/day and fat and protein production by 148 gramme/day. Milk, fat and protein production averaged over all the cows is given in Table 4 for the four periods of the test.

Table 4. Average group production in the 4 periods

| week numbers | milk kg/day | fat % | fat gramme/day | protein % | protein gramme/day |
|---|---|---|---|---|---|
| 1 - 3 | 28.0 | 4.19 | 1173 | 3.37 | 943 |
| 4 - 6 | 29.3 | 4.10 | 1201 | 3.32 | 972 |
| 6 - 9 | 26.6 | 4.17 | 1109 | 3.30 | 877 |
| 9 - 11 | 24.1 | 4.05 | 965 | 3.39 | 816 |
| Total | 27.1 | 4.13 | 1131 | 3.34 | 925 |

It can be seen from the above table that the changeover to milking several times a day resulted initially in a gradual increase in average production. Peak production was reached in the second period (weeks 4-6). Subsequently, there was a decrease as a result of the continuation of lactation.

## 3. Short term influences on milk production

### 3.1 Calculation method

The cows were milked several times a day and at different times during the day in the test period. The milking system used here meant that the interval between consecutive milkings could be varied for a particular cow. The length of this interval naturally influences milk yield at a given moment. The extent to which factors, such as time of milking and whether concentrates are supplied during milking, influence the measured milk yield should also be taken into account. In order to investigate this, each milk yield measured was compared with the milk yield predicted based on the average production in the appropriate week. Each milk yield measured was expressed in this way as a percentage of the predicted milk yield. These percentages were further used to assess a number of influencing factors.

### 3.2 Stimulation effect of milk ejection by concentrate feeding

During the research and within the framework of the criteria set for milking, concentrates were normally supplied during milking. Cows were, however, milked when no concentrates were supplied, because the animal had already eaten the amount of concentrates allotted for this period.
The effect of not supplying concentrates during milking on milk yield was studied (Table 5).

Table 5. Effect of not supplying concentrates during milking

| cow no. | no. of milkings without concentrates | av. measured milk yield (kg) | av. predicted milk yield (kg) | milk yield measured as % of prediction |
|---|---|---|---|---|
| 13 | 18 | 4.5 | 5.5 | 81 |
| 15 | 45 | 3.4 | 3.8 | 88 |
| 18 | 28 | 4.8 | 5.6 | 87 |
| 36 | 10 | 6.1 | 6.3 | 98 |
| 64 | 33 | 3.9 | 4.4 | 90 |
| 70 | 25 | 4.6 | 5.1 | 90 |
| 76 | 30 | 4.5 | 5.1 | 90 |
| 86 | 50 | 6.6 | 7.0 | 94 |
| 89 | 4 | 2.8 | 4.8 | 59 |
| 91 | 30 | 4.1 | 5.2 | 78 |
| 106 | 4 | 6.6 | 6.9 | 94 |
| 118 | 76 | 4.1 | 4.4 | 92 |
| 127 | 11 | 5.2 | 6.7 | 78 |
| 144 | 28 | 2.8 | 4.5 | 62 |
| 205 | 32 | 4.3 | 5.6 | 77 |
| 208 | 23 | 5.0 | 5.1 | 97 |
| 210 | 49 | 4.1 | 4.8 | 85 |
| 211 | 39 | 4.3 | 5.1 | 85 |
| 214 | 14 | 3.9 | 4.8 | 80 |
| 218 | 34 | 3.7 | 4.5 | 81 |
| Total | 583 | 4.4 | 5.1 | 86 |

The number of milkings when concentrates were not supplied varied from 4 to 76 for various cows.

On average the milk yields measured for milkings when no concentrates were supplied were 14% less than predicted. The reason for this is that milk ejection is less good if concentrates are not supplied (stimulation effect). For those milkings which followed on milkings when concentrates were not supplied, the production measured was about 13% higher than predicted. It can be concluded from this that the milk, which was not given during milking without concentrates, was given in addition to the predicted amount during the next milking when concentrates were supplied.
It is interesting to note that individual animals reacted very differently if concentrates were not supplied.

### 3.3 Influence of time of milking

A study was carried out to determine whether the time of milking within a 24 hour period influenced milk yield. For this purpose a 24 hour period was divided into 8 periods of 3 hours. The milk yield measured was again expressed as a percentage of the predicted yield from all the milkings over a period (Table 6). Milkings when no concentrates were supplied and milkings subsequent to these are not included here.

Table 6. Effect of time of milking on milk yield

| period (hours) | no. of milkings | av. measured milk yield (kg) | av. predicted milk yield (kg) | milk yield measured as % of prediction |
|---|---|---|---|---|
| 0.00 - 3.00 | 689 | 6.22 | 6.37 | 98 |
| 3.00 - 6.00 | 477 | 6.22 | 6.59 | 95 |
| 6.00 - 9.00 | 348 | 7.71 | 7.30 | 106 |
| 9.00 - 12.00 | 640 | 8.91 | 8.70 | 103 |
| 12.00 - 15.00 | 757 | 6.91 | 6.86 | 101 |
| 15.00 - 18.00 | 506 | 6.43 | 6.43 | 100 |
| 18.00 - 21.00 | 721 | 7.00 | 6.98 | 100 |
| 21.00 - 24.00 | 767 | 7.14 | 7.25 | 99 |
| 0.00 - 24.00 | 4905 | 7.06 | 7.07 | 100 |

The table shows that in the period from 0.00 - 3.00 and from 3.00 - 6.00 the milk yield was less than that predicted. This reduction was compensated for in the following periods. The reason for the difference, which mainly occurred from 3.00 - 6.00 and from 6.00 - 9.00, was not completely clear. There was little difference between the predicted and measured values for the other periods.
It should be noted that the differences between the periods for the individual animals may deviate from the values given in the table.

## 3.4 Influence of milking interval and predicted milk yield

With more frequent milking it is important to determine the optimum milking frequency for various production levels. Milking interval determines milking frequency. Thus, the influence of milking interval on milk yield was studied first (Table 7).

Table 7. Effect of milking interval on milk yield

| interval (hours) | no. of milkings | av. measured milk yield (kg) | av. predicted milk yield (kg) | milk yield measured as % of prediction |
|---|---|---|---|---|
| less than 4 | 909 | 4.53 | 4.61 | 98 |
| 4 - 5 | 1106 | 5.57 | 5.58 | 100 |
| 5 - 6 | 911 | 6.54 | 6.54 | 100 |
| 6 - 7 | 594 | 7.69 | 7.62 | 101 |
| 7 - 8 | 427 | 8.70 | 8.55 | 102 |
| 8 - 9 | 339 | 9.54 | 9.42 | 101 |
| 9 - 10 | 234 | 10.12 | 10.15 | 100 |
| more than 10 | 385 | 11.72 | 11.99 | 98 |
| total | 4905 | 7.06 | 7.07 | 100 |

The difference between predicted and measured milk yields was not very large for the different interval classes. The optimum interval was somewhere between 5 and 9 hours.

The test group, however, contained cows with different production levels. Table 8 shows to what extent the predicted milk yield was obtained for the various prediction levels.

Table 8. Relationship between predicted and measured milk yield

| predicted milk yield (kg) | no. of milkings | av. measured milk yield (kg) | av. predicted milk yield (kg) | milk yield measured as % of prediction |
|---|---|---|---|---|
| less than 4 | 444 | 3.57 | 3.63 | 99 |
| 4 - 6 | 1682 | 4.92 | 5.00 | 98 |
| 6 - 8 | 1295 | 7.03 | 6.92 | 102 |
| 8 - 10 | 747 | 8.99 | 8.87 | 101 |
| 10 - 12 | 421 | 10.95 | 10.94 | 100 |
| 12 - 14 | 189 | 12.82 | 12.91 | 99 |
| 14 - 16 | 85 | 14.26 | 14.79 | 96 |
| more than 16 | 42 | 17.14 | 18.34 | 94 |
| total | 4905 | 7.06 | 7.07 | 100 |

These data show that optimum milking was carried out with predicted milk yields of between 6 and 12 kg. The differences here were, however, small, particularly in the case of the lower milk yields.
Possible influences on the fat and protein content are discussed in the following chapter.

## 4. Milk control

### 4.1 Test milkings

Over a set period fat and protein levels for each milking were sampled in each test week, with the exception of the first week. The length of these observation periods varied from 28 hours (6x) to 72 hours (4x).
Fat and protein levels were determined for a total of 1494 milkings, i.e. approximately 25% of all milkings during the total test period. The average milk yield per cow and the average fat and protein percentages with their standard deviations are given in Table 9.

Table 9. Average milk yield, fat and protein content per cow for all test milkings

| cow no | no. of observations | milk (kg) | | fat (%) | | protein (%) | |
|---|---|---|---|---|---|---|---|
| | | av. | st. dev. | av. | st. dev. | av. | st. dev. |
| 13 | 75 | 6.37 | 2.77 | 3.72 | 0.37 | 3.30 | 0.08 |
| 15 | 49 | 4.55 | 1.71 | 4.49 | 0.68 | 3.86 | 0.16 |
| 18 | 57 | 6.44 | 2.50 | 4.69 | 0.51 | 3.51 | 0.16 |
| 36 | 57 | 7.19 | 2.08 | 4.39 | 0.56 | 3.63 | 0.09 |
| 64 | 75 | 5.47 | 2.12 | 4.53 | 0.52 | 3.25 | 0.18 |
| 70 | 75 | 6.34 | 3.02 | 4.43 | 0.41 | 3.15 | 0.08 |
| 76 | 68 | 6.95 | 2.74 | 3.72 | 0.59 | 3.35 | 0.09 |
| 86 | 100 | 7.58 | 2.45 | 3.48 | 0.61 | 3.01 | 0.09 |
| 89 | 64 | 9.08 | 3.62 | 4.44 | 0.66 | 3.29 | 0.10 |
| 91 | 77 | 5.38 | 2.59 | 4.92 | 0.71 | 3.66 | 0.17 |
| 106 | 67 | 11.57 | 4.12 | 3.78 | 0.72 | 3.06 | 0.42 |
| 118 | 84 | 4.78 | 1.34 | 4.68 | 0.43 | 3.82 | 0.15 |
| 127 | 86 | 8.76 | 3.04 | 3.61 | 0.63 | 3.04 | 0.09 |
| 144 | 70 | 7.44 | 3.25 | 4.68 | 0.32 | 3.52 | 0.13 |
| 205 | 93 | 7.13 | 2.19 | 3.68 | 0.49 | 3.17 | 0.10 |
| 208 | 58 | 7.68 | 3.07 | 4.57 | 0.74 | 3.32 | 0.10 |
| 210 | 83 | 5.56 | 1.94 | 4.43 | 0.56 | 3.61 | 0.11 |
| 211 | 87 | 6.21 | 1.97 | 4.46 | 0.56 | 3.59 | 0.13 |
| 214 | 90 | 6.62 | 2.82 | 4.01 | 0.83 | 3.34 | 0.13 |
| 218 | 79 | 6.24 | 2.64 | 4.31 | 0.61 | 3.45 | 0.17 |

The large standard deviation in milk yield was mainly caused by the interval differences between the milkings and a decline in production as lactation continued.

The large standard deviation in fat percentages was striking. The difference between milkings was 1.5 to 2 % (Appendix 5). There was considerably less variation in protein content.

## 4.2 Short term effects on milk, fat and protein production

As was done for all the milk yields in Chapter 3, factors influencing the relationship between measured and predicted production were studied for all the test milkings. Both milk production and fat and protein production were studied.

If concentrates were not supplied, this had a clear influence on milk yield (Table 5). These effects were to a large extent balanced out by those milkings which followed on milkings when concentrates were not supplied.

The fat percentage for milkings without concentrates was also slightly lower than predicted. This was not totally compensated for in the following milkings.

Further analyses of milkings when no concentrates were supplied and the first milkings after these were not included, as these would have made it more difficult to distinguish the results of the different influences.

Table 10 shows the influence of milking time (period of the day).

Table 10. Effect of milking time on milk, fat and protein production

| period (hours) | no. of milkings | production measured as % of prediction | | | | |
|---|---|---|---|---|---|---|
| | | milk | fat | | protein | |
| | | | grammes | % | grammes | % |
| 0 - 3 | 171 | 98 | 100 | 102 | 98 | 100 |
| 3 - 6 | 115 | 93 | 94 | 100 | 93 | 100 |
| 6 - 9 | 70 | 107 | 100 | 94 | 105 | 99 |
| 9 -12 | 154 | 104 | 97 | 94 | 102 | 99 |
| 12 -15 | 233 | 102 | 103 | 102 | 102 | 100 |
| 15 -18 | 128 | 99 | 105 | 106 | 100 | 100 |
| 18 -21 | 177 | 99 | 102 | 102 | 100 | 101 |
| 21 -24 | 174 | 98 | 100 | 102 | 99 | 101 |

From the analysis of all the milkings, it has already been shown that milk production in the period 3.00 - 6.00 is lower and in the period 6.00 - 12.00 higher than predicted. The fat percentage of the milk was, however, clearly less than that predicted for this period. As a result of this, the final fat gramme production approximately reached the predicted level or even remained slightly below it (9.00 - 12.00). The fat gramme production and the fat percentages were considerably higher than predicted in the period from 15.00 - 18.00. A possible explanation for these effects is the natural daily rhythm of the cow.

The protein percentage remained almost unaffected by the time of day when milking took place. The differences in the protein gramme production then also corresponded to the differences in milk production.

The effects of predicted milk yield level are shown in Table 11.

Table 11. Effect of predicted milk yield level on milk, fat and protein production

| predicted milk yield (kg) | no. of milkings | production measured as % of prediction | | | | |
|---|---|---|---|---|---|---|
| | | milk | fat | | protein | |
| | | | grammes | % | grammes | % |
| < 4 | 117 | 99 | 105 | 106 | 98 | 100 |
| 4 - 6 | 430 | 98 | 102 | 104 | 98 | 100 |
| 6 - 8 | 325 | 101 | 104 | 103 | 101 | 100 |
| 8 -10 | 174 | 102 | 101 | 99 | 103 | 101 |
| 10 -12 | 86 | 102 | 96 | 94 | 100 | 98 |
| 12 -14 | 50 | 100 | 94 | 95 | 101 | 101 |
| 14 -16 | 25 | 99 | 91 | 92 | 99 | 100 |
| > 16 | 15 | 96 | 85 | 88 | 96 | 100 |

The influence of milk yield level on the difference between measured milk production and predicted milk production was not very great. Tables 8 and 11 both show that with smaller predicted milk yields the measured milk yield was slightly lower than that predicted.

Milk yield level did, however, have a clear influence on fat percentage. With smaller milk yields the fat percentage measured was clearly higher and with larger milk yields clearly lower than that predicted. Consequently, the relative maximum fat gramme production was obtained with smaller milk yields. With predicted milk yields of more than 10 kg, the fat gramme production was clearly less than that predicted as a result of lower milk production and a lower fat percentage. To summarize, these results indicate that if the predicted milk yield is smaller, milk production is slightly lower, but fat gramme production increases as a result of the higher fat percentage.

The level of the milk yield only slightly affected protein percentage. The relative protein gramme production was, therefore, mainly determined by relative milk production.

## 5. Composition and quality of milk obtained

### 5.1 Composition

The milk was tested 3 times a week for fat, protein and lactose content. The results are summarized in Appendix 6.
This shows that the fat content in the milk varied from 3.94 to 4.29 (average 4.13), the protein content from 3.25 to 3.42 (average 3.31) and the lactose content from 4.38 tot 4.71 (average 4.56). The fat and protein content showed a good correlation with the levels determined for the individual animals in the milk control.

### 5.2. Milk quality

Table 12 contains a summary of the cell count, acidity of milkfat, freezing point of milk and the total colony count.

Table 12. Milk quality

| week | cell count (x 1000) | acidity of milkfat | freezing point °C | total colony count (x 1000) |
|---|---|---|---|---|
| 1 | | | | 8 (26) |
| 2 | 105 (178) | 0.42 (0.61) | -0.529 (-0.518) | |
| 3 | 158 (234) | 0.36 (0.74) | -0.520 (-0.531) | 16 (10) |
| 4 | 203 (160) | 0.35 (0.54) | -0.526 (-0.534) | 13 (31) |
| 5 | 150 (126) | 0.34 (0.62) | -0.525 (-0.533) | |
| 6 | 91 (150) | 0.42 (0.67) | -0.528 (-0.533) | |
| 7 | 104 (223) | 0.41 (0.56) | -0.532 (-0.537) | 59 (13) |
| 8 | 87 (178) | 0.39 (0.58) | -0.531 (-0.526) | |
| 9 | 117 (119) | 0.36 (0.49) | -0.532 (-0.532) | 45 (12) |
| 10 | 102 ( 94) | 0.36 (0.46) | -0.531 (-0.531) | 34 (15) |
| average | 124 (162) | 0.38 (0.58) | -0.528 (-0.531) | 29 (18) |

Comparative results from the other tank on the farm are given in brackets. The cell count was low with an average of 124 000 cells (87 - 204). If the cell count is taken as an indicator of udder health, milking several times a day did not have an unfavourable effect on the condition of the udder.
The freezing point of milk provides information on the possible addition of water during milking and storage. The freezing point was on average -0.526 °C up to and including test week 6. Some water addition may occur with a total of 80 cleaning cycles. In the second half of the research, the cleaning frequency was slightly reduced; the average freezing point was then acceptable at -0.531°C.
To facilitate payment for the milk according to quality, the total colony count was determined six times during the test period. The total colony count is influenced both by hygiene during milking and the cleanliness of the equipment. The total colony count was low with an average of 29 000 (13 - 59). It may, therefore, be concluded that the selected milking place, i.e. the feeding box, did not have an unfavourable effect on milk quality. The reduced cleaning frequency was a possible cause of the slightly higher total colony counts during the second half of the test.

## 6. Additional aspects

### 6.1 Feed intake

Details of the feeding method have been given in Chapter 1. Roughage was fed ad lib. and the amount of concentrates was recalculated every day.
Concentrates were dispensed by an automatic feeder and the amount each animal received recorded.
The daily average feed intake per cow in kg DM is given in Table 13 and is divided into 4 periods.

Table 13. Average feed intake of group

| Period | daily intake in kg DM per cow | | |
|---|---|---|---|
| | roughage | concentrates | total |
| 1/2 - 21/2 | 10.5 | 10.4 | 20.9 |
| 22/2 - 13/3 | 10.5 | 11.5 | 22.0 |
| 14/3 - 3/4 | 11.2 | 10.3 | 21.5 |
| 4/4 - 17/4 | 12.2 | 9.6 | 21.7 |
| total period | 10.9 | 10.5 | 21.4 |

This shows an average daily DM intake of 21.4 kg per cow, somewhat less in the initial period and slightly higher in the second period of the test, which was the period with the highest milk production.
Feed intake was 10.5 and 10.9 kg DM for concentrates and roughage, respectively. With a reduction in concentrate DM intake during the third and fourth period, there was an increase in roughage intake.
In an approximately comparable period, feed of identical quality and composition was supplied to the other group of 20 cows with an average age of of 4.07.

This group had a feed intake of 9.5 kg DM of concentrates and 10.1 kg DM of roughage with a milk yield of 25.0 kg per cow per day.
Daily concentrate intake per cow as an average over the total test period has already been given in Table 4. The results are given in more detail in Appendix 3 and are divided into 4 periods. The size of concentrate intake was, of course, chiefly dependent on the size of the milk yield.

Appendix 1. Number of visits to box and milkings in the various periods

| cow no. | periods | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | box visits | mil-kings | box visits | mil-kings | box visits | mil-kings | box visits | mil-kings | box visits | mil-kings |
| 13 | 3.8 | 3.4 | 5.4 | 4.5 | 5.3 | 4.4 | 6.1 | 4.8 | 5.1 | 4.2 |
| 15 | 4.3 | 3.4 | 5.5 | 3.9 | 6.1 | 2.7 | 5.8 | 1.5 | 5.3 | 3.2 |
| 18 | 3.8 | 3.4 | 3.9 | 3.5 | 3.5 | 2.9 | 2.8 | 2.4 | 3.6 | 3.1 |
| 36 | 3.0 | 2.9 | 3.0 | 3.0 | 3.4 | 3.2 | 3.2 | 2.8 | 3.1 | 3.0 |
| 64 | 4.3 | 3.7 | 4.7 | 4.3 | 5.2 | 3.7 | 4.7 | 3.5 | 4.7 | 3.8 |
| 70 | 2.5 | 2.3 | 3.7 | 3.6 | 6.5 | 4.5 | 6.8 | 4.8 | 4.7 | 3.7 |
| 76 | 3.9 | 3.4 | 4.8 | 4.1 | 5.0 | 4.0 | 5.9 | 3.5 | 4.8 | 3.8 |
| 86 | 7.6 | 5.0 | 8.3 | 5.5 | 8.7 | 5.6 | 9.1 | 5.8 | 8.3 | 5.4 |
| 89 | 3.5 | 3.1 | 3.1 | 2.9 | 3.7 | 3.5 | 3.5 | 3.2 | 3.4 | 3.2 |
| 91 | 5.5 | 3.9 | 5.6 | 4.7 | 5.8 | 3.9 | 6.1 | 3.8 | 5.7 | 4.1 |
| 106 | 4.4 | 3.5 | 4.2 | 3.8 | 4.3 | 4.0 | 3.4 | 3.1 | 4.1 | 3.7 |
| 118 | 8.2 | 4.6 | 8.3 | 4.8 | 10.1 | 4.6 | 10.2 | 4.4 | 9.1 | 4.6 |
| 127 | 4.9 | 4.1 | 5.7 | 4.6 | 5.3 | 4.3 | 5.6 | 4.7 | 5.4 | 4.4 |
| 144 | 4.5 | 3.5 | 4.7 | 3.9 | 5.5 | 3.8 | 4.8 | 3.6 | 4.9 | 3.7 |
| 205 | 5.8 | 4.3 | 7.2 | 5.3 | 7.7 | 5.5 | 7.3 | 5.2 | 7.0 | 5.1 |
| 208 | 2.9 | 2.8 | 4.0 | 3.3 | 4.2 | 3.4 | 4.5 | 3.4 | 3.8 | 3.2 |
| 210 | 6.1 | 4.2 | 5.8 | 4.5 | 5.7 | 4.1 | 5.8 | 4.0 | 5.8 | 4.2 |
| 211 | 6.7 | 4.8 | 6.0 | 4.8 | 6.5 | 4.7 | 7.1 | 4.4 | 6.5 | 4.7 |
| 214 | 5.7 | 4.5 | 6.6 | 5.0 | 6.0 | 4.8 | 7.4 | 5.1 | 6.3 | 4.8 |
| 218 | 5.1 | 3.9 | 5.8 | 4.3 | 6.1 | 4.1 | 8.2 | 4.8 | 6.1 | 4.2 |
| average | 4.8 | 3.7 | 5.3 | 4.2 | 5.7 | 4.1 | 5.9 | 3.9 | 5.4 | 4.0 |

Appendix 2. Milk production per cow in the various periods

| cow no. | periods | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1/2-21/2 | | | 22/2-13/3 | | | 14/3-3/4 | | | 4/4-17/4 | | | 1/2-17/4 | | |
| | milk kg/d | fat % | protein % | milk kg/d | fat % | protein % | milk kg/d | fat % | protein % | milk kg/d | fat % | protein % | milk kg/d | fat % | protein % |
| 13 | 27.7 | 3.70 | 3.34 | 29.4 | 3.74 | 3.29 | 27.2 | 3.77 | 3.24 | 26.5 | 3.61 | 3.33 | 27.8 | 3.71 | 3.30 |
| 15 | 21.2 | 4.41 | 3.74 | 18.0 | 4.62 | 3.81 | 9.6 | 4.56 | 4.03 | 4.1 | 4.31 | 4.16 | 15.6 | 4.53 | 3.85 |
| 18 | 19.9 | 4.54 | 3.47 | 21.9 | 4.53 | 3.43 | 19.7 | 4.64 | 3.48 | 15.5 | 4.89 | 3.70 | 19.6 | 4.65 | 3.52 |
| 36 | 21.7 | 4.52 | 3.61 | 22.4 | 4.21 | 3.67 | 21.5 | 4.35 | 3.60 | 19.1 | 4.21 | 3.68 | 21.4 | 4.31 | 3.64 |
| 64 | 23.0 | 4.36 | 3.18 | 24.1 | 4.33 | 3.13 | 20.2 | 4.54 | 3.25 | 17.1 | 4.67 | 3.46 | 21.5 | 4.47 | 3.25 |
| 70 | 24.1 | 4.65 | 3.17 | 26.4 | 4.46 | 3.13 | 25.6 | 4.49 | 3.12 | 24.5 | 4.25 | 3.20 | 25.2 | 4.45 | 3.15 |
| 76 | 26.7 | 3.69 | 3.34 | 27.5 | 3.67 | 3.31 | 24.6 | 3.75 | 3.32 | 19.8 | 3.49 | 3.45 | 25.2 | 3.67 | 3.34 |
| 86 | 42.2 | 3.39 | 2.99 | 43.4 | 3.62 | 2.98 | 40.2 | 3.58 | 2.99 | 35.8 | 3.46 | 3.08 | 40.9 | 3.52 | 3.01 |
| 89 | 29.5 | 4.26 | 3.32 | 29.8 | 4.56 | 3.20 | 29.2 | 4.23 | 3.28 | 26.6 | 4.26 | 3.38 | 29.0 | 4.33 | 3.29 |
| 91 | 23.8 | 4.65 | 3.48 | 25.3 | 4.74 | 3.56 | 21.0 | 5.03 | 3.66 | 19.4 | 4.86 | 3.86 | 22.7 | 4.83 | 3.64 |
| 106 | 34.0 | 4.35 | 3.83 | 43.8 | 3.76 | 3.14 | 44.0 | 3.47 | 2.80 | 39.4 | 3.31 | 2.73 | 41.1 | 3.65 | 3.04 |
| 118 | 22.0 | 4.75 | 3.81 | 23.3 | 4.52 | 3.78 | 21.4 | 4.79 | 3.80 | 19.7 | 4.74 | 3.93 | 21.8 | 4.69 | 3.82 |
| 127 | 38.9 | 3.39 | 3.08 | 40.8 | 3.35 | 3.04 | 37.8 | 3.61 | 3.00 | 34.7 | 3.57 | 3.08 | 38.4 | 3.49 | 3.04 |
| 144 | 26.7 | 4.61 | 3.47 | 28.1 | 4.58 | 3.46 | 26.2 | 4.66 | 3.52 | 25.2 | 4.78 | 3.67 | 26.7 | 4.66 | 3.53 |
| 205 | 35.2 | 3.78 | 3.25 | 37.5 | 3.64 | 3.16 | 36.3 | 3.69 | 3.08 | 34.6 | 3.44 | 3.23 | 36.0 | 3.63 | 3.17 |
| 208 | 22.8 | 4.92 | 3.33 | 24.3 | 4.32 | 3.28 | 23.5 | 4.38 | 3.31 | 21.9 | 4.42 | 3.39 | 23.3 | 4.47 | 3.32 |
| 210 | 24.6 | 4.51 | 3.57 | 25.6 | 4.23 | 3.59 | 22.9 | 4.54 | 3.57 | 20.8 | 4.37 | 3.72 | 23.8 | 4.41 | 3.61 |
| 211 | 32.6 | 4.36 | 3.46 | 32.1 | 4.31 | 3.55 | 27.7 | 4.56 | 3.58 | 24.8 | 4.62 | 3.75 | 29.8 | 4.47 | 3.58 |
| 214 | 35.3 | 4.08 | 3.23 | 33.6 | 4.01 | 3.28 | 28.5 | 4.15 | 3.34 | 26.9 | 4.07 | 3.47 | 31.5 | 4.08 | 3.33 |
| 218 | 28.1 | 4.16 | 3.25 | 28.7 | 4.31 | 3.37 | 24.8 | 4.48 | 3.44 | 24.7 | 4.00 | 3.63 | 26.8 | 4.26 | 3.43 |
| average | 28.0 | 4.19 | 3.37 | 29.3 | 4.10 | 3.32 | 26.6 | 4.17 | 3.30 | 24.1 | 4.05 | 3.39 | 27.4 | 4.13 | 3.34 |

Appendix 3. Concentrate intake (kg DM/day) in the various periods

| cow no. | periods | | | | |
|---|---|---|---|---|---|
| | 1/2-21/2 | 22/2-13/3 | 14/3-3/4 | 4/4-17/4 | 1/2-17/4 |
| 13 | 11.0 | 12.3 | 10.7 | 11.1 | 11.3 |
| 15 | 10.0 | 8.2 | 2.7 | 0.4 | 5.8 |
| 18 | 7.0 | 9.3 | 8.0 | 6.4 | 7.8 |
| 36 | 7.8 | 8.7 | 7.9 | 7.5 | 8.0 |
| 64 | 10.0 | 11.3 | 8.2 | 7.3 | 9.4 |
| 70 | 9.3 | 10.7 | 10.3 | 10.5 | 10.1 |
| 76 | 10.1 | 11.0 | 8.7 | 7.2 | 9.4 |
| 86 | 14.0 | 13.9 | 13.8 | 10.6 | 13.3 |
| 89 | 11.3 | 11.4 | 11.7 | 12.1 | 11.6 |
| 91 | 10.1 | 11.5 | 8.8 | 7.6 | 9.7 |
| 106 | 7.0 | 11.9 | 12.9 | 12.0 | 10.8 |
| 118 | 9.1 | 11.6 | 9.8 | 8.6 | 9.9 |
| 127 | 13.1 | 13.4 | 13.3 | 13.8 | 13.4 |
| 144 | 10.7 | 11.6 | 11.8 | 12.0 | 11.5 |
| 205 | 12.8 | 14.0 | 14.0 | 13.6 | 13.6 |
| 208 | 7.3 | 9.5 | 8.4 | 8.3 | 8.4 |
| 210 | 9.2 | 10.8 | 8.6 | 7.9 | 9.2 |
| 211 | 13.9 | 13.5 | 13.0 | 12.2 | 13.2 |
| 214 | 13.1 | 13.6 | 12.8 | 11.7 | 12.9 |
| 218 | 10.6 | 12.6 | 9.9 | 10.3 | 10.9 |
| average | 10.4 | 11.5 | 10.3 | 9.6 | 10.5 |

Appendix 4. Cows which had to be brought to the box after a milking interval of more than 12 hours

| cow no. | frequency of bringing cows to the box in week no. | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | total | remarks |
| 13 | 1 | | | | | | | | | | | 1 | late lactation |
| 15 | 3 | | 1 | | | 1 | 1 | 2 | 2 | | | 10 | dried out |
| 18 | 2 | | | 1 | | 2 | | | 1 | 1 | 3 | 10 | dried out |
| 36 | 2 | 1 | | 2 | | | | | 1 | 2 | | 8 | dried out |
| 64 | | 1 | | | | | 1 | 1 | | | | 3 | |
| 70 | 3 | 6 | 6 | 1 | 1 | | | | | | | 17 | foot inflammation |
| 76 | 2 | 2 | | | | | | | | | | 4 | |
| 86 | | | | | | | | | | | | | |
| 89 | 3 | | | 3 | 3 | 1 | | | | | 1 | 11 | trichina |
| 91 | | | | | | 2 | 1 | 1 | | | | 4 | dried out |
| 106 | | | 2 | | | | | | | | | 2 | just calved |
| 118 | | | | | | | | | | | | | |
| 127 | 1 | | | | | | | | | | | 1 | |
| 144 | 2 | 1 | | | | | | | | | | 3 | |
| 205 | | | | | | | | | | | | | |
| 208 | 3 | 2 | 2 | | | | | 1 | | 2 | | 10 | dried out |
| 210 | | | | | | | | | | | | | |
| 211 | | | | | | | | | | | | | |
| 214 | | | | | | | | | | | | | |
| 218 | 3 | 2 | | | | 1 | | | | | | 6 | |
| total | 25 | 15 | 11 | 7 | 4 | 7 | 3 | 5 | 4 | 5 | 4 | 90 | |

Appendix 5. Test milk data from cow number 211 for observation period of 72 hours

| date | time (hr min) | milk (kg) | fat (%) | protein (%) |
|---|---|---|---|---|
| 27-3 | 14.34 | 6.0 | 4.92 | 3.49 |
| 27-3 | 19.03 | 5.2 | 4.66 | 3.64 |
| 28-3 | 2.04 | 7.4 | 4.28 | 3.69 |
| 28-3 | 5.48 | 3.1 | 3.23 | 3.63 |
| 28-3 | 13.07 | 9.7 | 5.06 | 3.48 |
| 28-3 | 19.43 | 6.7 | 4.65 | 3.66 |
| 28-3 | 22.59 | 3.6 | 5.22 | 3.74 |
| 29-3 | 4.18 | 5.5 | 4.06 | 3.70 |
| 29-3 | 10.52 | 7.6 | 4.30 | 3.50 |
| 29-3 | 15.22 | 5.2 | 5.00 | 3.66 |
| 29-3 | 20.25 | 5.7 | 4.56 | 3.69 |
| 30-3 | 0.14 | 4.0 | 4.40 | 3.63 |
| 30-3 | 5.33 | 5.0 | 3.46 | 3.54 |
| 30-3 | 11.09 | 7.4 | 4.44 | 3.54 |

Appendix 6. Fat, protein and lactose content in the tank milk

| date | fat % | protein % | lactose % | date | fat % | protein % | lactose % |
|---|---|---|---|---|---|---|---|
| 3/2 | 4.16 | 3.32 | 4.64 | 14/3 | 4.19 | 3.25 | 4.51 |
| 6/2 | 3.94 | 3.26 | 4.52 | 16/3 | 4.23 | 3.28 | 4.60 |
| 8/2 | 4.06 | 3.28 | 4.52 | 19/3 | 4.27 | 3.25 | 4.53 |
| 10/2 | 4.03 | 3.34 | 4.55 | 21/3 | 4.25 | 3.26 | 4.58 |
| 13/2 | 4.19 | 3.35 | 4.52 | 23/3 | 4.16 | 3.30 | 4.56 |
| 15/2 | 4.10 | 3.31 | 4.49 | 26/3 | 4.21 | 3.30 | 4.54 |
| 17/2 | 4.17 | 3.35 | 4.53 | 28/3 | 4.07 | 3.21 | 4.38 |
| 20/2 | 4.08 | 3.36 | 4.56 | 30/3 | 4.22 | 3.29 | 4.53 |
| 20/2 | 4.04 | 3.34 | 4.55 | 2/4 | 4.29 | 3.30 | 4.54 |
| 24/2 | 4.06 | 3.32 | 4.52 | 4/4 | 4.18 | 3.32 | 4.56 |
| 27/2 | 4.05 | 3.35 | 4.58 | 6/4 | 4.11 | 3.35 | 4.60 |
| 29/2 | 4.01 | 3.31 | 4.56 | 9/4 | 4.08 | 3.35 | 4.59 |
| 2/3 | 4.28 | 3.39 | 4.71 | 11/4 | 4.23 | 3.35 | 4.64 |
| 5/3 | 3.97 | 3.28 | 4.55 | 13/4 | 4.16 | 3.42 | 4.68 |
| 7/3 | 4.11 | 3.31 | 4.62 | 16/4 | 4.20 | 3.39 | 4.59 |
| 9/3 | 4.16 | 3.30 | 4.58 | 18/4 | 4.15 | 3.35 | 4.54 |
| 12/3 | 4.17 | 3.29 | 4.56 | | | | |