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PROVINCE OF KWAZULU-NATAL

DAIRYING IN KWAZULU-NATAL

Dairy Herd Structure / Dairy Herd Dynamics

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INTRODUCTION

Lactation can be initiated with drugs but, in general, if a cow does not produce a calf, she will not produce milk. Calves are also necessary to provide replacements for the dairy herd, and surplus heifers can form a very important part of the dairy farmer's income. Therefore, reproduction management is vital to successful dairying.

The cow's early life, from birth until she is mated for the first time, is dealt with in detail in Natal Dairy Leaflets 3.1 and 3.2. It is important to understand that a heifer must not be mated at too light a mass. From 65 to 70 % of her expected mature mass is normally considered to be a desirable mating mass. After mating, the heifer must continue to grow so that she is as close to her mature mass as possible at first calving (See Table 4 in Dairy Leaflet 3.2 for growth standards for the main dairy breeds). The age at which the heifer becomes a cow, that is her age at first calving, depends on the rearing system (she must meet the target weights mentioned above) and the desired generation interval. The sooner a heifer calves down, the sooner she contributes to the economy of the farm in the form of milk and calves. Therefore, the farmer must weigh up the possible extra rearing costs of, say, calving heifers at close to two years of age, which is the earliest practicable age, against the loss of income from milk and calves by delaying calving to a later age. If a farmer is wanting to expand his herd, then the lower the age at first calving, the faster is the rate of increase in the herd. Interestingly, in a stable herd, the age at first calving has no effect on the number of surplus animals available for sale each year. A greater age at first calving merely means that there are more heifers on the farm. A final consideration is that the older the heifer, the lower her fertility. In other words, the later a heifer is mated the more difficult it is to get her into calf. For this reason, heifers should not calve down later than three years of age.

Once a heifer has calved for the first time, she becomes a cow, and takes her place in the milking herd. It can be shown that the farmer should aim for a calf per cow per year. Therefore, the cow must be got back into calf so that she re-calves as close to one year after her previous calf as possible. In practice, cows not pregnant after a reasonable period are culled for infertility. Although a cow may not be truly infertile at culling, the farmer may decide that the extra cost of keeping her and continuing to try to get her into calf is not justified. As a generalisation, it can be said that the average South African dairy cow produces three calves in her life time. This average is calculated from a large population of cows, some of which have fewer than three lactations

and others which may go on for as many as ten lactations. Expected age structures in expanding and stable herds are shown in Table 1. The number of heifers is dependant on the age at first calving (AFC) and the age when surplus heifers are sold.

Table 1. Typical age structure of expanding and stable dairy herds

Lactation number	Per cent of cows in herd in each lactation	
	Expanding herd	Stable herd
1	33	25
2	22	20
3	16	15
4	11	12
5	8	9
6	5	6
7	4	5
8	0	4
9	1	3
10	0	1
Average lactations	2,8	3,4

As mentioned above, some cows are culled for fertility, and some may be culled for other reasons, *e.g.* mastitis. Also, some cows die through accident or disease. The annual culling rate (including mortality) is typically from 20 to 30%. This means that to maintain a herd of 100 cows, 20 to 30 replacement heifers must calve into the herd each year. In the remainder of this leaflet the interactions between these factors in the life of the dairy cow and dairy herd will be examined in some detail.

DEFINITIONS OF TERMS

Culling Rate (S)

The percentage of cows culled per year. This is usually 25 to 30% of the herd. In other words, in a herd of 100 cows only 70 to 75 of the cows will remain in the herd after one year. This implies that at least

25 to 30% heifers have to be brought into a herd every year to maintain herd size.

Replacement Rate (R)

The percentage of cows brought into the herd per year expressed as a percentage of the number of cows in the herd at the start of the year.

Rate of Increase (E)

Replacement Rate less Culling Rate equals Rate of Increase. For example, if there were 100 cows at the start of year, 25 cows were culled and 33 heifers brought in, then:-

Culling Rate	=	25%
Replacement Rate	=	33%
Rate of Increase	=	33-25 = 8%

Age at First Calving (AFC)

The time from birth to calving, *i.e.* when a heifer becomes a cow, is called the age at first calving. The mean age at first calving is the generation interval in the herd. The younger the AFC, the greater the potential rate of increase and the fewer the heifers which have to be fed and cared for. It should not normally be less than two years of age or greater than three and heifers should have achieved about 90% of their average mature mass when weighed just before calving.

Note the following three points very well. First, if a farmer wishes to expand his herd then the younger the AFC, the greater the potential rate of expansion. Second, the younger the AFC, the sooner the heifer becomes a cow and therefore, the fewer heifers of all ages in the herd. Third, in a stable herd, AFC has no effect on the number of surplus heifers for sale; AFC only affects the total number of heifers of all ages.

Number surplus heifers (V)

Either the sale of surplus heifers, or herd expansion by retaining all the heifers are very important parts of dairy farm income. The number of surplus heifers is affected by the average intercalving period (see Section on "The interaction between AFC, ICP and other reproduction parameters). The shorter the intercalving period the more calves that will be born and the greater the probability that more heifers will be born.

Total number of heifers (H)

The maximum number of heifers is deterined by both the AFC and the intercalving period. The minimum number which must be kept on the farm

for herd replacements depends on the age at AFC and the culling rate plus an allowance for infertility and mortality.

Intercalving Period (ICP)

The period in a cow's life between the birth of one calf and her next calf. The ICP is so important that an entire section of this leaflet, "The intercalving period", is devoted to it.

Total services to conception and services per conception (TSPC & SPC)

The total number of services per conception (TSPC) is the number of inseminations in the entire herd divided by the number of confirmed pregnancies. In practice this is not easy to calculate, and the usual figure quoted is services per conception (SPC) for pregnant cows only. This is an important distinction because it could happen that cows which fall pregnant do so readily, and the use of ICP could be masking a real problem amongst those which do not. Note, too, that the SPC and TSPC figures are influenced by the rate of culling. Ruthless culling of apparently infertile cows may result in a good SPC figure but hide a real problem. The figure for percentage take to first A.I. helps in interpretation (see below).

Targets: SPC 1.3 to 1.6; TSPC < 2

Take to first insemination

Usually calculated as number of cows pregnant to one insemination divided by the number of first inseminations. For example, 70 first A.I.'s and 49 pregnancies would be:-

49/70 x 100 = 70% take to first A.I.
Target: >60 %

Heats spotted or heats missed

The number of heats spotted divided by the total possible heats. The total possible heats is usually calculated by assuming that all open cows (non-pregnant) cycle every 21 days. Due to cystic ovaries, and many other causes, not all cows cycle and the length of the oestrus cycle is very variable. Therefore it is impossible to achieve 100 % success.

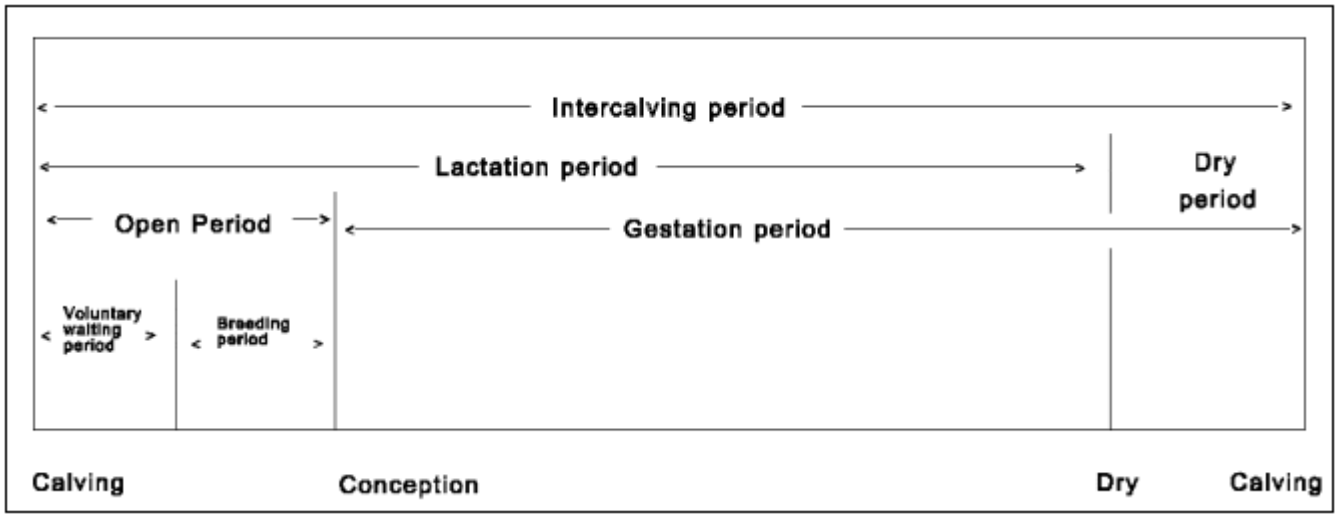
Target: >75% of theoretical possible number of heats.

THE INTERCALVING PERIOD

This is the period in a cow's life between the birth of one calf and her next calf. The recommended targets for ICP are:

> A mean of 365 days.
> No cows should have an ICP less than 330 days,
> 90% from 330 to 400 days,
> and less than 10% an ICP of more than 400 days.

Figure 1. Diagrammatic representation of the periods and events in the intercalving periodof the dairy cow



The ICP is best understood if broken up into its component periods and events as illustrated in Figure 1. The reader is advised to commit this diagram to memory because successful dairy farming is inextricably linked to a thorough understanding of the implications of the factors affecting the intercalving period and their management.

The intercalving period can be broken down into the following:

Lactation Period

The time from calving until the cow is dried off, *i.e.* the time during which the cow is producing milk.

Target: 300 to 305 days (43 weeks);
Range: 265 to 340 days (38 to 49 weeks);

The length of the lactation period depends on the open period and level of production.

Open Period (OP)

The time from calving to re-conception. The length depends on the voluntary waiting period and the breeding period.

Target: Mean of 85 days (12 weeks);
Range: 45 to 120 days (7 to 17 weeks).

Voluntary Waiting Period (VWP)

The minimum time the farmer decides to allow between calving and the first mating. Usually 45 to 60 days.

Breeding before 60 days (8 weeks) after calving is not normally recommended. If the VWP is less than 60 days, then it must not be less than 45 days and the cows must be clean and showing at least the second observed heat.

Breeding Period

BP = OP - VWP, *i.e.*, the time from the end of the VWP until conception. Length depends on the number of services per conception and the per cent heats observed.

Gestation Period

The time from conception to calving. Usually 280 to 285 days. This varies slightly between breeds, and depending on the sex of the calf, but for practical purposes can be taken to be 280 days (40 weeks).

Dry Period

The time from the end of lactation until the cow calves again. Usually 56 days (8 weeks) calculated from the conception date, *i.e.* conception date plus 224 days gives the date on which to dry off the cow.

Target: >45 but <57 days.

Low producers, cows which have been sick, or cows with extended service (open) periods may reach uneconomically low levels of production before 56 days from when the next calf is expected, and thus have a dry period longer than 56 days. The length of the gestation period is also variable and may not be exactly 280 days, causing the length of the dry period to vary by approximately a week. The dry period is necessary to allow the cow time to replenish body reserves, especially minerals which were depleted during lactation and to allow the udder tissue to involute, and to be renewed before the next lactation. A dry period of less than 45 days will have a markedly deleterious effect on the next lactation.

Pre-calving Period

Starting about 6 weeks before the anticipated calving date, the cow may be fed extra feed for replenishment of body reserves to ensure that she calves in good condition (the cow should not be over-conditioned) and to ensure that her rumen micro-organisms are adapted to concentrate feeding.

Calculation of averages

See section on "Fertility analysis" in KwaZulu-Natal Dairy Leaflet 4.1 for full details on the calculation of averages and other summaries of herd data.

Mean Intercalving Period and Breeding Period

Mean intercalving period is an indication of calving percentage. The lower the ICP, the greater the number of calves born per year. Intercalving periods are not normally (evenly) distributed. The distribution about the mean is skew. Thus a geometric rather than an arithmetic average must be calculated. Mean ICP is calculated as follows:

$$\text{Mean ICP} = \text{Mean BP} + \text{VWP} + 280$$

$$\text{Mean BP} = \exp\{[\ln(BP)_1 + \ldots + \ln(BP)_n]/n\}$$

where exp = exponent (natural antilogarithm); ln = natural logarithm; and n = number of cows.

Services per conception (SPC)

The fewer the services per conception the shorter the breeding period (see section "Breeding period") provided that heat spotting is good. See section on "Fertility analysis" in KwaZulu-Natal Dairy Leaflet 4.1 for details on how to calculate SPC.

Percentage heats spotted

Unless cows are seen to be in season they cannot be inseminated. Therefore, the better the heat spotting the shorter the breeding period. See "Fertility analysis" in KwaZulu-Natal Dairy Leaflet 4.1 for methods of estimating heat spotting success.

MANAGEMENT OF HERD FERTILITY

The interaction between AFC, ICP and other reproduction parameters.

Variations in the age at first calving (AFC), the inter-calving period (ICP) and the culling rate (S) in a dairy herd has profound effects on the possible replacement rate (R), the net rate of increase in the herd (E = R - S) and the number of surplus heifers (V) which could be sold annually. These parameters also affect the make up of the herd in that an extended AFC means more heifers (H) in relation to cows, an extended ICP means more dry cows, and so on.

The interactions between these factors can be illustrated in a simple way by considering the life histories of two hypothetical cows (Figure 2.). In this example it was assumed that the two cows had identical milk productions. Thus the difference in lactation production and calves born is entirely due to the different AFC's and ICP's.

Table 2 extends the argument by showing examples of the interactions between the age at first calving (AFC), intercalving period (ICP), culling rate (S), rate of replacement (R), rate of increase (E), the number of surplus heifers (V) and the number of heifers of all ages (N) in stable and expanding herds. The data in the table make allowance for heifer infertility and mortality.

Note the dynamic interaction of these factors. In particular, note how important AFC is to the expanding herd. Therefore, in the well managed herd a short ICP means more calves and, as will be shown, more milk. In the expanding herd the stockman must aim for the shortest possible AFC commensurate with good husbandry (well grown-out heifers whose masses meet or exceed breed targets), and the possible need to produce milk for seasonal demands (e.g. the need to build up the quota).

Table 2. Examples of the interaction between herd reproduction parameters in stable (S) and expanding (C) herds

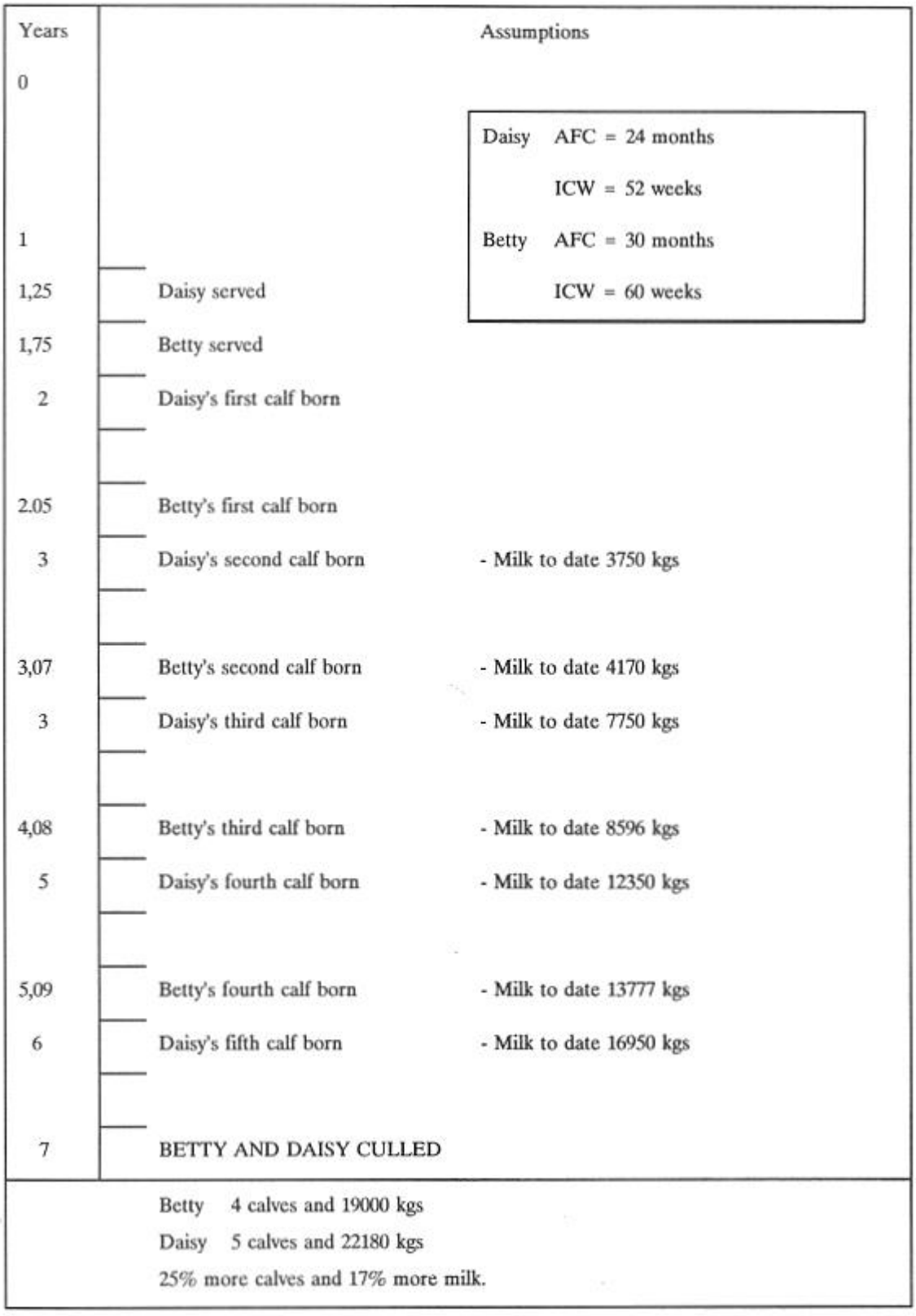
Herd No.	N	AFC	ICP	R	S	E	V	H	Milk Index
A-S	100	24	365	25	25	0	18	89	100
B-S	100	24	420	25	25	0	12	80	93
C-S	100	36	365	25	25	0	18	133	100
D-S	100	36	420	25	25	0	12	120	93
E-C	100	24	365	35	25	10	7	80	97
F-C	100	24	420	35	25	10	1	72	90
G-C	100	36	365	35	25	10	3	115	97
H-C	100	36	420	35	25	10	-3	103	90

Notes: Herds A-S to D-S are kept constant in size through sale of all surplus stock. Herds E-C to H-C are increasing at 10% per annum (E).

N	=	Number of cows in the herd.
AFC	=	Age at first calving (in months)
ICP	=	Intercalving period (in days)
R	=	Replacement rate *i.e*. number of heifers introduced per annum as a % of N.
S	=	Culling rate *i.e*. % of N culled each year.
E	=	Rate of increase in the herd i.e. R - S = E
V	=	Number of heifers available for sale per annum.
H	=	Maximum number of heifers in the herd from age 0 to age AFC months.

Milk index = Expected production relative to first herd

Figure 2. The life history of two "average" cows



Note that, with reference to Table 2, changing the AFC has no effect on the number of surplus heifers for sale (V), if herd size is constant but a changing AFC has a dramatic effect on the number of heifers (H) in the herd (herd A-S versus C-S in Table 2). The effect of increasing

ICP in stable herds is to reduce the number of saleable surplus heifers (V) (Herd B-S versus D-S). The difference between 365 and 420 days represents 6 heifers per year per 100 cows : a very large loss in gross income. If this loss is considered along with the declining milk production with increasing ICP, it is clear that farmers cannot afford extended ICP's.

Where the farmer is attempting to increase herd size as in herds 1C to 4C, the AFC has a very significant effect; compare V in herds E-C and F-C. If the effect of ICP is added to a poor AFC it is clear that a rate of increase of even 10% per annum is not possible (Herd H-C). Average AFC's in excess of 30 months and ICP's greater than 400 days are common in South African herds and explains why many farmers struggle to increase their herds. Actual AFC's and ICP's in South African herds are illustrated in Table 1 in KwaZulu-Natal Dairy Leaflet 2.1.

Understanding the very important concepts illustrated by Table 2 might be helped if it is remembered that the value of N in the stable herds is always 100, whereas in the changing herds it was not 100 but 91 one year earlier and 83 the year before that. This explains why the values for E plus V do not stay the same *i.e.* E + V for herd A-S was 18 but only 17 for herd E-C and so on. Similarly, the values for H are lower in the changing herds. These principles illustrate the importance of seeking the underlying causes of, say, a high percentage of dry cows or a high proportion of heifers to cows. To simply say that the ratio of heifers to cows is wrong or that there are too many dry cows is unhelpful. The reasons for the undesirable figures must be identified and will be found in the interactions between the factors discussed in this section.

Herd Structure and Culling Rates

It has already been shown that the higher the AFC the more heifers in the herd (Table 2). Logically, the higher the culling rate, the lower the average age of the herd or, the more culls, the fewer the average number of lactations per cow. Cows seldom have twins and the generation time (AFC) usually exceeds two years. Also, cows' productive lives are seldom longer than about ten or twelve lactations. These biological facts have important implications on the highest and lowest possible culling rates.

Figure 3. The interaction between cullingand the average number of lactations

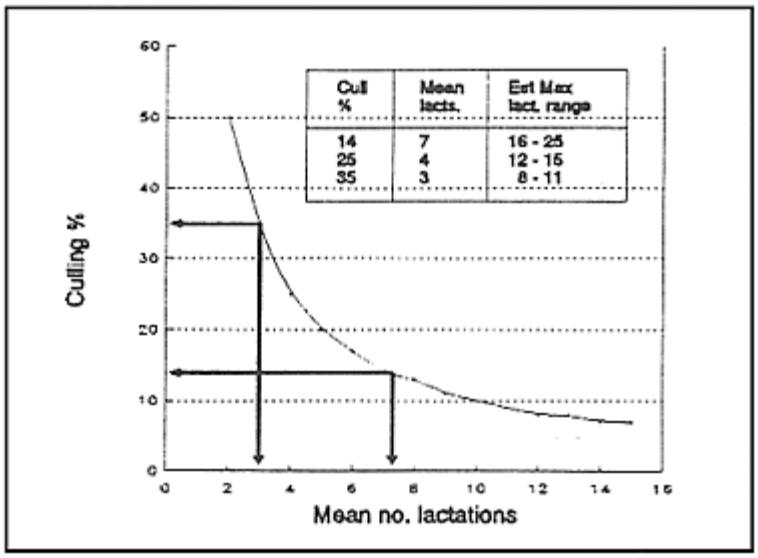


Figure 3 shows that, even under good management, the maximum culling rate is about 30 to 35%, giving an average of 3,3 to 2,8 lactations per cow, and the minimum possible culling rate is about 20% which means an average of 5 lactations, some cows having to live for 14 to 18 lactations. These comments are based on a constant rate of culling between lactations. In practice, culling rates will be higher as cows get older and the real average number of lactations and maximum ages necessary will be lower than the figures quoted above. Intercalving period also affects the culling rate. The greater the ICP, the higher the average number of lactations will be for a particular culling rate. Stable and expanding herds will have slightly different age structures as illustrated by Table 1. The differences in age structures must be considred when making comparisons between herds. For this reason, it is usual in some countries, notably the USA, to convert all milk yields to mature equivalents before calculating herd averages. The difference between a first lactation and a mature lactation is about 25% in most herds, so the conversion will make a significant difference.

Should the good herd manager aim for a high or low culling rate? The objectives of the herd manager will determine the answer. Facts to be considered are:

- The most rapid genetic progress is made at maximum culling rate.
- The most milk is produced at minimum culling rates (About 3 to 5% more milk at 20% than at 30% culling).
- There are more surplus heifers for sale at low culling rates. This is perhaps the most important consideration. If there is a very big difference between the value of pregnant heifers and cull cows then it may pay to cull leniently. But, if the slaughter value of cull cows and the sale value of pregnant heifers is similar, then it probably pays to maximise culling.

In practice, it seems that most farmers cull 25 to 30% annually. In well-managed herds there is more voluntary culling for production, temperament and conformation (type, milkability *etc.*) whereas in badly managed herds most culls are involuntary (*i.e.* cows cull themselves because of infertility, mastitis, footrot etc.). The good manager seeks

to minimise involuntary culls in order to place emphasis on production and type. A common management mistake when trying to build up dairy herds is to cull too leniently. Remember that many undesirable traits, such as very bad udders, are highly heritable and hanging on to poor cows to build up numbers is a recipe for building up a mediocre herd.

If three lactations is the average life span of a dairy cow then beef bulls should never be used on dairy heifers. If inferior bulls, or beef bulls, are used on dairy replacement heifers, the first calf, if a heifer, will be of no use as a dairy cow. Of the second and third calves, one will probably be a bull. Therefore, in a lifetime production of three calves, only one will be useful as a herd replacement, which means that no expansion of the herd is possible.

How to achieve good fertility

As implied in definition "Intercalving Period" the spread of ICP's in a herd is important. The early part of lactation is the most productive. Therefore, the shorter the ICP, the more milk that a cow will produce in her lifetime. Conversely, extended ICP's mean either long dry periods or at best an extended lactation with low milk production. Figure 2 illustrates these points.

There are four fundamental points which must considered to improve intercalving periods:-

- **Herd health and wellbeing including culling**

Figures derived from study groups have shown that there is a positive correlation between veterinary costs and profit. Money spent on regular herd checks, which result in early identification of treatable cows and the cows which should be culled, is money well spent. Similarly, good nutrition and stockmanship, which lead to contented cows, are essential to good fertility. Mineral and vitamin nutrition is as important as adequate supplies of protein and energy.

- **A.I. technique**

The best time to inseminate in relation to standing heat (see KwaZulu-Natal Dairy Leaflet 2.4) and other details of A.I. in practice are outside the scope of this guide. However, correct technique is very important and declining success with A.I. often results from lack of attention to detail, *e.g.* careless thawing of straws, or failure to deposit semen in, or just through, the cervix. If there appears to a fertility problem in a herd this is the easiest area to check on and should be eliminated before going into aspects such as nutrition.

- **Heat spotting**

This job is critically important and must not be left to the lowest paid worker on the farm. Too often, complete responsibility for this task is left to the young "herdboy". If it is assumed that all open cows cycle every 21 days (they don't) then more than 75% of the possible number of heats should be observed. See section on "Percentage heats spotted" for further details.

- **Time to first A.I. after calving**

It is clear from numerous studies that, provided that cows are adequately fed and are given at least 50 days dry, the shorter the ICP the better, from both a milk and a calf production point of view. But there are sound biological reasons why attempting to shorten ICPs simply by shortening the VWP leads to an increase in the number of inseminations per conception and the number of extended lactations. Cows may exhibit signs of oestrus as early as twelve days *post partum*. However, the uterus requires at least 45, and preferably 55 to 60, days before it has involuted sufficiently for the successful implantation of a new foetus. For this reason, many early inseminations are either entirely unsuccessful or worse, appear to be successful but the cow is pregnant only for a short while, then the foetus is resorbed and, after a few weeks, the cow re-cycles. Because no abortion was observed, the stockman tends to assume that the cow was not pregnant, simply because he failed to observe her in season. The net result of too short a VWP is that there is an increase in the number of extended lactations. The average ICP may be improved but the spread of intercalving periods has increased. This situation is commonly seen in herds where bulls are permitted to run with the cows. Cows which fall pregnant very early do not have sufficient time to regain body condition before the next lactation, and cows which take a long time to settle have long periods of low or no milk production.

SUMMARY

To sum up:

- pay attention to herd health and welfare (especially regular veterinary checks)
- ensure that A.I. technique is correct
- be really concientious about heat spotting, even on those cold, wet spring mornings
- ensure that every cow to be inseminated has been given a clean bill of health at the veterinary check

do not inseminate too soon, allow at least 45 days (but preferably 60 days) to lapse after calving, while ensuring that the cow is inseminated only on her second observed heat.