Herd Health Monitoring and Records Analysis

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Food animal veterinarians who wish to do more than just react to their clients' problems need to become involved in the management of the farm. To do so, they must become information managers. They must be able to extract information from farm record systems. They must also become computer literate and be comfortable with data and numbers. While there will always be a need to look at the individual animal, more and more herd problems will be investigated by examining record systems, not just animals. To do so efficiently, veterinarians must be adept at data management. In addition to information about the specific farm, veterinarians must also understand the general conditions facing agricultural industries in the area.

It may seem odd that the farmer needs an outsider to help manage information about their own farm. In fact, farmers have always depended on outside consultants for information management. Accountants, extension personnel, feed company representatives, veterinarians, and others have long played a role in analyzing some aspect of the farm's status and made recommendations for management changes. Coordinating the collection and analysis of information can be a significant part of the food animal veterinarian's service to client farms. If veterinarians do not take the initiative to earn the position of information analyst, then the veterinarian's other problem solving roles may be significantly weakened and may be lost. The person who identifies a problem is the one most likely to be asked to solve it. That person does not necessarily have to be a veterinarian. (Goodger 1982)

Herd Monitoring

Monitoring is an essential process in all systems that must respond to outside influences. In food animal production, there must be a system whereby the farmer or veterinarian can recognize when problems arise or changes need to be made. Without effective and timely monitoring, problems may remain uncorrected until they grow to catastrophic proportions. Herds that made use of DHIA records, for example, are more profitable than herds that don't. (Azzam 1989)

In the farm management feedback cycle, the role played by monitoring is illustrated in Figure 1. Within the management cycle, current status is monitored and assessed. Based on the evaluation, decisions are made, plans are developed, and actions are taken. Those actions modified by external events, result in some performance outcome. The cycle begins again when the new outcome is monitored and evaluated. (Stein 1986, Fetrow 1987)

As Figure 1 illustrates, there are two aspects of the system that are external to the basic cycle. The first aspect is the external influences that have an impact on the farm. Examples might be feed changes, labor problems, weather conditions, management decisions, disease, machinery failures, and financial changes. When operating as a management consultant, the veterinarian provides assistance to farmers as they adapt to these new circumstances. This broader definition of what veterinarians do opens many new opportunities for veterinary service. It means for example, that client and personnel training is an appropriate veterinary service, as are nutritional consultation, preventive program design, housing consultation, and financial advice. As an individual, a veterinarian may not yet have the expertise to serve the farmer in all of these arenas, but the opportunities exist for those who wish to develop the skills.

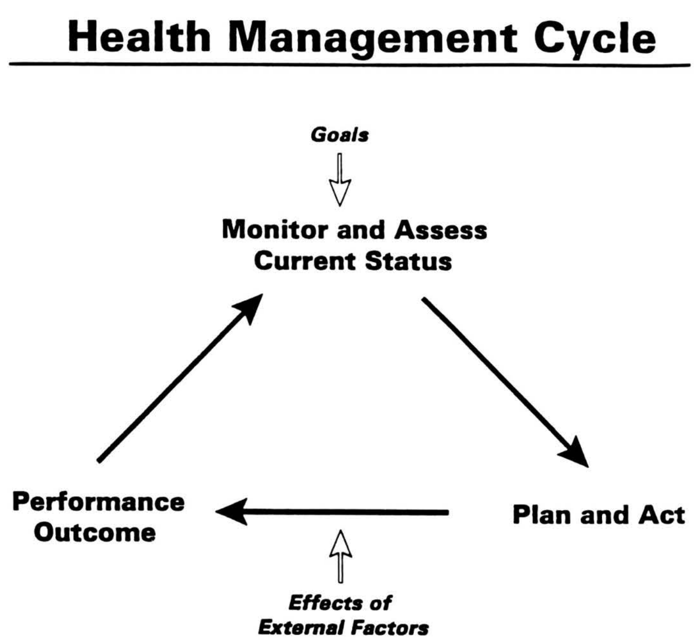

Figure 1.

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The second aspect that is external to the system is the goals, targets or standards against which the current status is compared. Without a benchmark for comparison, there is no way to determine whether action needs to be taken. Goals may be difficult to set, and they are influenced by economic constraints, physical restrictions, time and management limitations, and personal and emotional considerations. Goals for a particular farm are almost always subject to change over time.

Monitoring is the fundamental basis of planned veterinary service to food animal production. Monitoring can highlight problem areas and focus efforts and resources where they are most needed. Monitoring can help restore the farmer's perspective, shifting attention from day-to-day pressing demands to the less urgent but perhaps more important long-term needs of the farm. Monitoring can highlight trends that might otherwise escape notice. Monitoring can motivate corrective action. Monitoring also serves to document the direction and time course of improvements on farms as they adopt veterinary recommendations.

Monitoring Production and Nutrition

There is probably no aspect of a dairy enterprise that has wider impact than the feeding program. Dairy farm feeding programs have direct effects on production and growth, and set the stage for future productive potentials. Most health problems on a dairy relate in some way to the feeding program. Feed costs on the average dairy account for more than 60% of total operating expenses in the United States (USDA 1990). A significant part of the average dairy's labor force devotes their time to planting, growing, harvesting, mixing, and feeding rations to a variety of animals. Investments in equipment used in feeding programs are an important part of the dairy's debt load. Small changes in feeding programs may bring about large changes in productivity, health, income, feed costs, labor allocation, and debt load. The total savings from small changes can be substantial. Without considering improved production or health effects, one study has shown that routine nutritional consultation by veterinarians saved 14 percent of total feed costs on dairies. (Ferguson 1987)

For all of these reasons, veterinarians who intend to serve their dairy clients on a herd basis must become actively involved in the herd's feeding program (Gerloff 1991). Dairy herds are commonly fed unbalanced, expensive rations (Ferguson 1987). By serving as independent consultants, veterinarians can provide unbiased advice to their clients. Those veterinarians who wish to serve their clients at a herd level will constantly find their attention focussed on the feeding program. The next recumbent, hypocalcemic cow is also a question about dry cow feeding. The next anestrus, thin cow with smooth ovaries is a question about early lactation energy levels in the ration and dry matter intake. The next time herd average mature equivalent milk production falls by 500 pounds, the problem will generate the same sense of urgency as a cow with a prolapsed uterus. As a profession, dairy veterinary medicine must come to grips with the fact that it cannot truly serve client needs by practicing therapeutic medicine separate from nutritional consulting. Veterinarians must train themselves to deal with nutrition directly, consistently and knowledgeably.

If a veterinarian is providing full nutritional consulting service, then a routine, consistent monitoring service for production and nutrition is essential. There are many parameters that can provide insight into the adequacy of a feeding program. A well conducted production medicine program will incorporate these into its routine monitoring services on the dairy.

Dry matter intake: This should be measured routinely, best daily. Actual measurements are a must. Some method needs to be arranged for measuring the total feed fed and feed not consumed so that an accurate picture of intakes is available. Wherever dry matter goes, milk production will soon follow.

Feed quality: Monitoring feed quality means many things. First, look at the feed itself. Is it fresh, clean smelling, free of foreign material, homogeneous, and free of evidence of mold? Run laboratory analyses for nutrient content and where appropriate for toxicants, particularly mycotoxins.

Fecal consistency: Easily monitored at each herd visit, fecal consistency and content can provide valuable insight into the cow's digestive status. Overly firm feces suggest too much fiber or too little water. Very fluid feces may reflect too little fiber (too much readily fermented carbohydrates). Whole grain in the manure suggests inadequate rumen fiber mat formation to trap grain until it can be fermented. "Greasy" manure may suggest too much rumen degradable protein.

Cud chewing: If undisturbed, most cows should be either eating at the bunk or lying and chewing their cud. If many cows are seen standing while chewing their cud, it is a clear indication that the freestalls or stanchions are uncomfortable. At any given time, more than one half of all cows lying down should be chewing their cud. If not, total effective fiber intake may be inadequate. If cows show an unusual habit of chewing on walls or fences or eating dirt, consider too little fiber as a possible cause as well as pica from inadequate phosphorus intake.

Body condition scoring: The body condition of dairy cattle can be easily and consistently scored on a 1 to 5 scale. (Wildman 1982) The system is fairly simple to learn, and there are excellent charts to guide the scoring process. (Edmonson 1989) The changes in body scores provide an indication of weight loss and weight gain during lactation. Under normal conditions, cows lose weight in early lactation as milk production exceeds their ability to consume enough dry matter to supply their nutrient needs. Excessive losses of body condition in early lactation are associated with reduced reproductive performance. (Butler 1989, Britt 1991) Cows that lose more than one body score have significantly reduced first service conception rates and increased days to first ovulation and first observed estrus. Cows should calve with body scores of 3.5 to 4 and should lose no more than one score during early lactation. Ideally, the loss should not exceed 1/2 of a body score. Weight is most efficiently gained during the end of lactation, rather than during the dry period, so mid and late lactation rations should allow for extra energy to support increasing body condition. (Moe 1971) Body condition gains during the dry period may lead to "fat cow syndrome" and peripartum disease. (Morrow 1976)

Milk production: There are many different parameters that will monitor milk production. Most are derived from DHIA reports, although more and more dairymen are using on-farm testing equipment that can provide daily and summary milk production data. No single parameter is adequate for monitoring milk production on a dairy. When using a parameter to monitor milk production over time, one must keep the "momentum" of the parameter in mind. The momentum of a parameter is the rate at which the parameter can change as the actual farm situation changes. Parameters that include a great deal of history in their calculation have high momentum, i.e. they cannot quickly reflect a sudden change in the herd's status. Rolling herd average, for example, carries a full year's history in its calculation. Short term production fluctuations will do little to change rolling herd average. High momentum parameters have the advantage of giving a better measure of the general trend, but can obscure sudden changes for the worse that deserve immediate attention. Low momentum parameters such as milk per cow per day can change quickly in response to changes on a farm. They are sensitive measures of change, but using them as the sole monitoring index can lead to erratic and "reactive" management. Frequent changes of management in response to low momentum parameter shifts can actually lead to wider swings in performance as consistency is lost to inappropriate responses to each next "crisis".

Whatever the parameters, keep in mind that monitoring is about trends much more than about absolutes. Keep track of the same parameters month to month and watch the changes over time. For many parameters, it is also often useful to partition the herd into categories by lactation number and stage of lactation for monitoring purposes. For example, milk production may be fine in older cows, but a change in bunk space or cow numbers may have created havoc with first lactation animals in early lactation.

milk per cow per day: perhaps the most easily collected number, milk per cow per day can be calculated by taking the amount of milk shipped and dividing it by the number of cows milking and the days since the last milk pickup. It should be adjusted for cows whose milk was not added to the bulk tank, e.g. treated cows, fresh cows, or mastitic cows. Milk per cow per day can vary quite widely day to day in response to feeding changes, cows dried off or newly freshened, weather, and milking crew. It is probably too sensitive (too low momentum) to be relied on heavily, particularly in small herds. Like dry matter intake, it should be monitored frequently, but one should avoid over reaction to small variations.

rolling herd average: is a calculated estimate of the amount of milk produced by the average cow in the herd during the past year. If milk per cow per day has the least momentum of milk production indices, rolling herd average has the most. Major changes in overall herd productivity can occur and rolling herd average will be largely unaffected for several months. Rolling herd average is, however, the measure most often watched by most farmers, because it correlates quite well with annual income for milk sales. The "quality" of a dairy is usually summarized by citing the herd's rolling herd average. Rolling herd average does not necessarily correlate well with a herd's profitability, since two herds with the same level of production (revenue) may have very different levels of debt, operating and feed costs (expenses).

Even accepting the inadequacy of rolling herd average in characterizing a herd's current biological or financial status, it still is useful to understand the "forces" that drive it. Rolling herd average is affected by three major factors:

1. "real productivity": how well is each cow in the herd milking in terms of her genetic potential? Obviously, this is affected by a host of factors, nutrition, housing, health, etc. This "real productivity" consumes most of the attention of the production medicine clinician.

2. herd demographics: how many first lactation

animals versus how many older cows are milking? For example, the rolling herd average will likely drop in the near term in a herd that is actively culling cows for Staphylococcal mastitis and replacing them with heifers. Neither the remaining cows nor the heifers are milking less than expected. Heifers simply make less milk than older cows on average.

3. reproductive efficiency: herds where average days open creeps up will gradually find that cows are spending more of each lactation at the end, i.e. where production is lower. The cows' milk production is not reduced from normal, the cows are simply spending more time at a less productive stage of lactation. Thus some drops in rolling herd average reflect inadequacies in the reproductive program, not the nutrition or genetic program or other aspects of management.

adjusted corrected milk, standardized milk, management level milk: As a seasonally calving herd moves through the year, there will be times when most of the herd is in early lactation (fresh herd) and times when most of the herd is at the end of lactation (stale herd). Milk per cow per day will be less in a stale herd than in a fresh herd, even with the same cows at the same level of "real productivity". Because of the desire to compare production between several months without the confounding of the herd's seasonal status, several different calculated measures of production have been developed. Each attempt to adjust for the herd's average days in milk, and some adjust for the herd's demographics and herd butterfat production. (Nordlund, 1987) In general these measures are superior to monthly milk per cow per day in monitoring for real changes in productivity. In Minnesota, management level milk is the first number a veterinarian should look at on the DHIA report.

lactation curves: Lactation curves of milk production are typically summarized by two parameters, peak (or summit) milk and persistency. Peak production is the point of maximal daily milk output, usually within the first two months of lactation. The magnitude of peak determines much of the shape of the total lactation curve. For every kilogram of additional peak milk production, the cow will give approximately 200 kilograms of milk more in the first ten months of lactation. Persistency refers to the rate of decline in production beyond peak. Good persistency means a relatively low rate of decline. Mature cows typically decline between 8 and 10 percent per month. Heifers have lower peak productions than they will as cows, but the persistency of their lactation is generally better than for cows. Declines in heifers are usually between 4 and 6 percent per month.

Much has been made of graphing lactation curves for cows. Milk by stage of lactation, as well as butterfat, protein, and somatic cell counts can all be graphed. Generally, one of two types of herd or group curves are generated. In the first, the data from one day's herd DHIA test are used to plot production by days in milk. In a sense, this is like milk per cow per day in that it is low momentum, and reflects only the herd's current status. This sort of graph may be useful for identifying cows that are "outliers" in terms of expected production. This type of graph suffers from the fact that the cows graphed in early lactation are different from those graphed in later lactation. It is easy to be tricked into thinking that those early lactation cows will follow the pattern set by those in late lactation. This may not be the case. For example, cows in early lactation in July in the southeastern U.S. will follow very different lactation curves than their herd mates who calved in the previous winter.

In the second kind of lactation curve, all test day data for each cow's current lactation is used to construct the graph. This is akin to rolling herd average and has a high amount of momentum. It risks masking serious current early lactation problems by mixing recent performance with performance from as much as ten months ago.

Both sorts of lactation curves can suffer from the danger of using averages alone to describe a population's status. They can mask a great deal of variability and trouble in individual cows as they aggregate the data into a smooth curve of average points by stage of lactation. Curves based on few individuals can be skewed widely by a single "outlier cow". Curves are confounded by season, calving order, and parity distribution. (Galligan 1992) Viewed as a diagnostic test, lactation curves run a risk of both false positive and false negative diagnoses for significant herd problems, and must be interpreted with caution. (Galligan 1991 and 1992)

305 mature equivalent (ME): These are numbers calculated by DHIA and some microcomputer records programs that provide and "apples to apples" method of comparing two cows of different age and stage of lactation, or for comparing the same cow over time. The calculation process involves first projecting the cow's actual milk production in her first 305 days of the current lactation. For this reason, 305 mature equivalents cannot be calculated for cows until they have more than one DHIA test and are far enough into their lactation so that an accurate prediction can be made. Once the actual 305 day projection is made, it is multiplied by a factor that adjusts for the cow's age at calving and her season at calving. The adjustment factors are specific for each region and reflect the regions average effects of season, age, and genetics.

Although no single measure is a sufficient monitor of productivity, of all DHIA milk production parameters, 305 mature equivalent milk production is probably the best single monitoring parameter for real productivity and therefore for the effectiveness of a nutrition program. Mature equivalent production takes out the effect of the herd's reproductive status by considering only the first 305 days of lactation. Thus a cow with prolonged days open is not penalized in the measure of her lactation productivity. By adjusting all 305 day projections to a mature equivalent basis, heifers are not penalized for being naturally less productive than older cows. The herd's average 305 mature equivalent, perhaps broken down by lactation number, is thus an excellent measure of the real productivity of the herd. It has a moderate amount of momentum, and is a very useful parameter if trends are followed month to month. Changes in 305 mature equivalent milk or 305 day predicted milk production can also be compared using paired t tests or sign tests to determine whether an observed change is likely real or just normal variation. (Galligan 1991 and 1992)

Milk components: monitoring the levels of butterfat and protein in milk are useful approaches to monitoring certain aspects of the feeding program. In general, low butterfat reflect inadequate effective fiber in the diet. Protein content in the milk may reflect the type and quantity of protein in the cow's diet, but just as commonly reflects the balance of rumen available energy in relation to protein sources in the diet.

Disease: many clinical disease have their origins in nutrition. Monitoring the incidence of metabolic disease serves as another window on the feeding program. Table 1 lists some of the common nutritionally related diseases and suggests target performance levels for those diseases for monitoring purposes.

Income over feed costs (IOFC): Although overall profitability is the final goal, farm profit is affected by too many non-feeding program factors to be a effective monitor of the impact of a feeding program. The most useful practical measure of the economic impact of a feeding program is income over feed costs for milking cows. To calculate this number, the cost of feeding the milking herd is subtracted from the value of milk produced. This remainder is the money left to the dairyman for all other purposes: living expenses, farm labor, interest, other feeding costs, etc. Calculating IOFC can be difficult because many farms do not account for feed expenses in a way that allows the costs for the milking herd to be segregated out of total feed expenditures.

Table 1. Salient Features of the Etiology, Occurrence, and Prevention of Nutritionally Related Diseases or Suboptimal Performance in Dairy Cows.

Disease or Suboptimal Performance	Etiology	Occurrence	Prevention
Simple indigestion < 2% of calvings	Change of feed a few days before or at parturition	Within a few days after calving	Avoid marked changes in nature of feed in peri-parturient cows
Fat cow syndrome < 3% of calvings	Excessive intake of energy during dry period	Within a few days before, but most commonly a few days after, calving	Feed for maintenance and pregnancy during dry period. Feed dry cows separately. Monitoring body condition score
Parturient hypo-calcemia (milk fever) < 5% of cows	High calcium intake during dry period; anion/cation imbalance	Within 48 hours before or after calving. Mid-lactation cases occur too	Low-calcium diets during dry period. Injection of vitamin D metabolites before calving
Hypomagnesemia (lactation tetany) rare or none	Relative deficiency of dietary magnesium in lush pasture; stress of cold weather	Within first few weeks after calving	Supplement diet with magnesium at strategic times
Downer cow < 10% of hypocalcemias	Complication of milk fever (traumatic injuries, prolonged recumbency)	Recumbent cases of milk fever fail to rise following treatment with calcium	Recognize and treat cases of milk fever in first stage
Left side displacement of abomasum < 5% of calvings	Uncertain. Epidemiologically related to feeding grain before calving	Within a few days to a few weeks after calving	Unreliable. Feed liberal quantities of low-energy forage during dry period; begin feeding grain only 10 days to 2 weeks prepartum and provide exercise
Right side displacement and torsion of abomasum rare	Uncertain. Epidemiologically related to high grain feeding in early lactation	Usually 2 to 3 weeks after calving	Ensure high intake of high-quality forage in early lactation
Cecal dilation and torsion rare	Uncertain. May be related to high grain feeding in early lactation	Usually within 2 to 4 weeks after calving	Ensure high intake of high-quality forgae in early lactation
Primary acetonemia < 3% of calvings	Insufficient energy intake due to physcial inability to consume, lack of energy in diet, or secondary disease affecting appetite	Usually 2 to 6 weeks after calving just prior to peak milk production	Ensure an increasing plane of energy intake in early lactation
Postparturient hemoglobinuria rare	Deficiency of phosphorus intake	2 to 6 weeks after calving	Ensure adequate level of phosphorus in diet
Early lactation drop in milk production	Insufficient intake of energy and low body condition score at calving, thus providing no body fat for mobilization	6 to 8 weeks after calving	Ensure adequate intake of energy and protein during first 6 to 8 weeks after calving
Postpartum uterine infections < 10% of calvings	May be due to mismanagement of dry cow rations	first month postpartum	Check dry cow ration Ca, Se, Vit A, watch for overconditioning during dry period
Lameness; laminitis, ulceration, white line weakness & abcessation	Inadequate effective fiber	Most common in early lactation, effects long lived	Maintain adequate ration effective fiber
Milk fat depression	Inadequate fiber	Any stage of lactation	Maintain adequate ration fiber
Delayed onset of estrus	Inadequate heat detection. May be due to inadequate energy intake and excessive loss of body weight in early lactation	8 to 10 weeks after calving	Provide good heat detection of cows beginning 40 days after calving. Monitor body condition, adequate energy intake too

Cost of feedstuffs: Feed costs account for 40 to 60 percent to all costs on a dairy. There is a major potential to reduce operating expenses by selecting feeds that minimize the money spent on feeds for a given level of production. (Galligan 1991) The most effective approach to monitoring costs of feeds is to collect routine feed prices from normal market channels and to use a linear programming package to set substitution prices for a particular farm.

Monitoring Culling and Inventory

A careful summary of cows entering and leaving the herd provides information on overall inventory turnover as well as the reasons that cows are sold or culled. The reasons for culling are at best general summaries of the reasons. Cows are very often culled for more than one reason (bad feet, mastitis, poor production). The farmer is forced to place such a cow in only one category. This may distort the picture depicted by this summarization (Fetrow 1988). Other inventory information is also provided, including breakdowns of the projected herd demographics as cows calve and dry off in the future.

Monitoring Reproductive Performance

General role of the veterinarian

The basic objective is an average days open of 85 to 115 days (calving interval of 12 to 13 months), with the first calf born at 24 months of age. In a herd bred year-round it is possible to observe performance from month to month and recognize trends early. This enables the veterinarian to recommend changes in management and environment and then observe the effects of the changes over the next month or two. The essence of veterinary reproductive services in these herds is a repetitive cycle of monitoring (using records, observations and palpation) and intervention.

Essential characteristics of monitored herds

The indices recommended for us in assessing reproductive efficiency are shown in Table 2. Goals for reproductive disease rates are shown in Table 3. All of them require:

- accuracy of observation, especially in estrus detection. The dairyman must be motivated to commit specific time to estrus detection and can be helped by concentrating the times and the groups of animals that have to be watched. Estrus detection aids (heat mount detectors, tail chalk, etc.) can be valuable in this process.

- accurate, easily understood recording systems. The system should record the event when it happens and not rely on memory.

- a system of analyzing that data that is quick and efficient, reports areas of inadequacy, and enables the dairyman and veterinarian to explore the likely causes of problems.

The measurement of the calving interval is too historical to be of real value in the regular assessment of reproductive performance in continuous calving herds. To obtain a mean figure for the herd, all cows must calve twice so that the calving index will include events that, for some cows, will be 1.5 to 2 years old. Thus average days open is the preferred general measure of overall fertility. Ideally, both the mean and its distribution should be considered. It is the latter that indicates when there are cows in the group that have very long calving to conception intervals. These cows can give a distorted view of the reproductive performance of the group as a whole.

Table 2. Fertility Targets to be Calculated With a Range of Goal Levels

	Target
1. Calving interval (days)	365-395
2. Calving to conception interval (days)	85-115
3. Mean calving to first service (days)	60-70
4. Conception rate to first service (%)	50-60
5. Conception rate to all services (%)	45-55
6. Services per conception	1.7-2.2
7. Percent problem cows	< 20 %
8. Average age at first calving (months)	23-25
9. Culling rate for reproductive reasons (per cent of breeding animals per annum)	<8
10. Average number of lactations in lifetime (years)	>3
11. Abortion rate (per cent of pregnant animals with abortion or early embryonic death per annum)	<5

Table 3. Goal Levels for Reproductive Disease

Disease	Target
Dystocia	< 10 %
Parturient paresis in cows	< 10 %
Retained fetal membranes	< 10 %
Postpartum uterine infection	< 10 %
Follicualr cysts	< 10 %

Source of days open

If the focus of most of the reproductive program is on days open (and thereby on calving interval and average days in milk), then it is reasonable to ask what contributes to days open in cows. Assuming a normal healthy cow being bred by artificial insemination (AI), then the following example will show how days open might be derived (Barr 1975, Esslemont 1974):

assume a management decision to wait 50 days postpartum before breeding any cow (voluntary wait period = VWP = 50 days)

assume a 50% conception rate on all services (2 services per pregnancy)

assume a 50% estrus detection rate

The voluntary wait period contributes 50 days to the open interval. Although some cows will be in estrus on day 51, and some on day 71 following the 50 day VWP, the average cow will have their next estrus one half of an estrus cycle (11 days) after 50 days, on day 61. If it takes 2 services for conception in the average cow, then the one failed service causes another 21 days to be added to the open interval. If the cow must have four estruses to allow the dairyman to observe the two estruses needed for breeding, then the two missed estruses provide another 42 days to the days open. The final sum then, in cows without disease, comes to

50	days due to management's voluntary wait period
11	days for one half of the cycle while waiting for the first estrus
21	days due to conception failure: (services - 1) * 21
42	days from failure to detect estrus {1/estrus detection rate) - 1} * services *21
124	total days open or a 13.3 month calving interval

With a slightly better estrus detection rate (70%), the following numbers are possible (again without disease):

50	days due to management's voluntary wait period
11	days for one half of the cycle while waiting for the first estrus
21	days due to conception failure: (services - 1) * 21
18	days from failure to detect estrus {(1/estrus detection rate) - 1} * services * 21
100	total days open or a 12.5 month calving interval

This second example would represent better reproductive management than is achieved on the vast majority of dairy farms. It serves to emphasize the fact that few herds can achieve a 12 month calving interval without culling some cows that do not become pregnant within an acceptable window of days open. A twelve month calving interval (85 days open) can be achieved with a 45 day voluntary wait period, 70% estrus detection, and a 60% conception rate. Few herds achieve these levels of performance consistently over time. Essentially all herds cull cows to improve their average reproductive performance. It is unlikely that extensive culling to achieve an artificial target like a twelve month calving interval is economically justified. A reasonable and achievable target for the calving interval in a continuously calving dairy is 12 to 13 months, or average days open from 85 to 115 days.

Given the above schema to segment the days open in a herd using AI for breeding, the various segments can be monitored as discussed in the sections that follow. The actual calculations for each parameter is not standard between record systems; not even all DHIA centers calculate the same parameter equivalently. Record systems vary particularly in how they incorporate data from cows that have been culled from the herd, or cows that have been designated as "do not breed" cows. This can lead to confusion when comparing performance between record systems. There are suggested standardized calculations for several parameters. (Fetrow 1990) These have not as yet been adopted.

Voluntary wait period

The voluntary wait period is the period from calving until the dairyman elects to begin breeding a cow. Most herds have a general policy that an estrus before a certain time (45 to 60 days in milk) will go unbred. The policy may vary based on lactation number, production, body score, or postpartum disease. Usually, some arbitrary fixed point can be used as an estimate of the real farm policy. It is seldom economically advisable to delay the voluntary wait period past 60 days in herds bred AI. Unless estrus detection is very poor, average days to first breeding should be within 30 days after the stated policy about voluntary wait period. If the interval is longer, reconfirm the farm's actual policy about VWP.

Measuring estrus detection intensity

The following parameters measure the intensity of estrus detection. They are not measures of the accuracy of estrus detection. It is possible to have high apparent estrus detection intensity and poor reproductive results. In some herds 10 to 30 percent of cows are not in estrus based on milk progesterone tests when they are bred. (Smith 1982) These cows do not conceive when bred.

Percent of possible estruses detected:

This number is derived from calculations that first determine the theoretical number of estruses that should have occurred in the breedable cows over a time period (usually a month). This number is the denominator. The number of breedings and estruses reported in those cows during that time period is the numerator. Under usual management, 50 percent or fewer of all estruses are seen. Pushing to exceed 70 percent estrus detection rates (without hormone analysis) is likely to lead to inaccuaracy and be counterproductive for most dairies. Even if estrus detection remains accurate, there are diminishing economic returns to improvements as estrus detection moves past 70 percent. (Oltenacu 1981, Rounsaville 1979)

Days to first breeding:

Days to first breeding is an indirect measure of estrus detection intensity. With effective estrus detection programs, days to first breeding should be 20 to 28 days past the voluntary wait period. Thus if voluntary wait period is 50 days, days to first breeding should be less than 78 days.

Percent of cow pregnant at pregnancy examination:

Cows that are open when checked for pregnancy by the veterinarian have been missed in estrus at least once and sometimes twice in the interval between breeding and the pregnancy examination. If there are many such cows, then estrus detection intensity must be poor. This is a crude measure. It is confounded by conception rate and is often based on few cows at any single herd visit. It also depends on the frequency of veterinary herd visits and the stage of pregnancy at which cows are examined. In herds with 50% estrus detection rates and 50% conception rates, that schedule a herd visit every two weeks, and that begin pregnancy examinations at 35 days after breeding, no more than 20 percent of cows checked for pregnancy should be open.

Measuring estrus detection accuracy

Milk progesterone tests:

The most effective way to assess the accuracy of estrus detection is to have the dairyman collect and freeze milk samples from each cow when she is bred. After a suitable number of samples have been collected, they can be assayed for progesterone. While a low progesterone does not guarantee that the cow is in estrus or that insemination was correctly timed, a high progesterone does guarantee that the cow was not in estrus. With accurate estrus detection, fewer than 10 percent of cows bred should have a high milk progesterone. (Smith 1982)

Interestrus intervals:

Another approach to evaluating estrus detection accuracy is to examine the intervals between one estrus and the next. If estrus detection is accurate, the interestrus interval should be either 18 to 24 days or 38 to 45 days, and at least 60% of second estruses should be in these intervals. (Weaver 1987) If not, then the presumption is that at least one of the two cycles are incorrectly detected. This approach can be useful in some herds, but can be difficult to implement in others. It is confounded by early embryonic deaths and by the use of prostaglandin. For estruses two cycles from the first, the variability of the timing of the second cycle is such that it can be difficult to be confident which estrus is within the appropriate window of time.

Measuring conception efficiency

Services per pregnancy in pregnant cows:

Also commonly called services per conception in pregnant cows, this number provides a measure of the efficiency of conception when fertile cows are bred. In that way, it is a rough proxy for the "male" side of insemination process: semen quality, insemination technique, timing of insemination, and accuracy of estrus detection. These aspects are confounded in some herds by factors that affect all cows such as inadequate nutrition, heat stress, infectious infertility, etc. Depending on climatic conditions and how soon postpartum cows are bred, services per pregnancy in pregnant cows should be between 1.5 and 2.5. The inverse of this measure is conception rate for pregnant cows, and should be 40 to 66 percent.

Percent problem cows:

This measure reflects the "female" side of the system, particularly those cows that are slow to conceive despite adequate performance on the "male" side. As a reasonable goal, fewer than 20 percent of the cows in a herd should be reproductive problem cows.

Conception rates by subgroup:

In evaluating a conception problem, it is often useful to examine conception rates for subgroups in the herd. The subdivision can be done in several ways: by service number (first service conception rate, etc.), by parity (conception in first calf heifers, etc.), by season (conception in summer), by insemination technician, by sire, or by combinations of these. First service conception rates are particularly useful because the first service is generally the breeding with the largest proportion of fertile cows. Thus first service conception rate provides information similar to services per pregnancy in pregnant cows.

Measuring reproductive efficiency in herds that use a bull

Many dairies use a bull for breeding the milking herd, either as the sole breeding method or more commonly as a "clean up" breeder. Cows are penned with clean up bulls after a period of artificial breeding effort. The AI breeding period should extend at least past the desired average days open period and can be tracked by calculating the average days in milk of cows when they are "turned with the bull" (Fetrow 1990). Economic evaluation of bull breeding programs has shown that if artificial insemination can increase the genetic merit of offspring by 500 lbs of milk per lactation compared to the bull's genetics, then average days open can increase by 10 days and still break even compared to bull breeding (Hillers 1982). Average days open with the bull and conception rates from the bull can be calculated as long as turn in dates are recorded and the veterinary palpation and records program can distinguish between conceptions from AI and those from the bull. The use of bulls severely complicates the interpretation of reproductive records unless calculations specifically take exposure to the bull into consideration.

Abortion

Abortions can be broken down into early embryonic death (cows declared pregnant and then found open without visible signs) and visible abortions. Obviously, the distinction is clinical and arbitrary. Abortion can also be classified by stage of lactation. Some recommendations suggest that abortion rate should be less than 3% on a dairy, but careful veterinary attention in most herds will usually show that pregnancy wastage is higher than 3 percent if monitored across the entire gestation period. A reasonable goal is for total losses of confirmed pregnancies to be less than 5 percent. (Weaver 1987)

Reproductive culling

The reason for culling that is assigned to a particular cow is often arbitrary and misleading. Obviously, cows culled for failure to conceive or following abortion are reproductive culls. In addition, if cows are culled that would have been retained if they had conceived earlier, then they should also be considered reproductive culls. In general, no more than 8 percent of the herd should be culled for reproductive reasons per year.

Reproductive disease

Rapid involution of the uterus and return to normal ovarian cyclicity are prerequisites of good fertility. Dystocia, retained placenta, and endometritis will cause delays in the interval to first estrus and subsequent fertility. Table 3 provides some goal levels for reproductive disease. (Weaver 1987)

Clinical Investigation of Reproductive Inefficiency in a Dairy Herd

General Procedure

The recommended procedure for examination of a fertility problem in a dairy herd is the same whether the problem appears in a herd served by a production medicine program or whether a farmer calls for help with a herd that is not under constant veterinary surveillance. In herds on a computerized herd health program, a decline in reproductive performance will become obvious early if the responsible veterinarian is paying close attention to the reproductive indices produced at monthly intervals by the program. In other herds, the problem is often much further advanced. It is a great advantage in these herds, (if they have sufficient good data) to begin the investigation by analyzing their records before plunging into farm or cow examinations. Thoughtful examination of the records can often narrow down the likely problem area. This can make the on-farm part of the investigation much faster and more effective.

Beyond the need to respond to the dairyman's concerns, the first step should be to attempt to estimate the degree of the problem and its general costs. Overall reproductive performance (days open, abortion rate, culling rate, disease rates) should be examined. If excess days open is the major problem, then the next step is to break the days open into major sources as done in the source examples earlier in this chapter. The general scheme for the investigative process is shown in Figure 2. Assuming an acceptable voluntary wait period and no excess pregnancy wastage, excess days open can be attributed either to poor conception, poor estrus detection, or both.

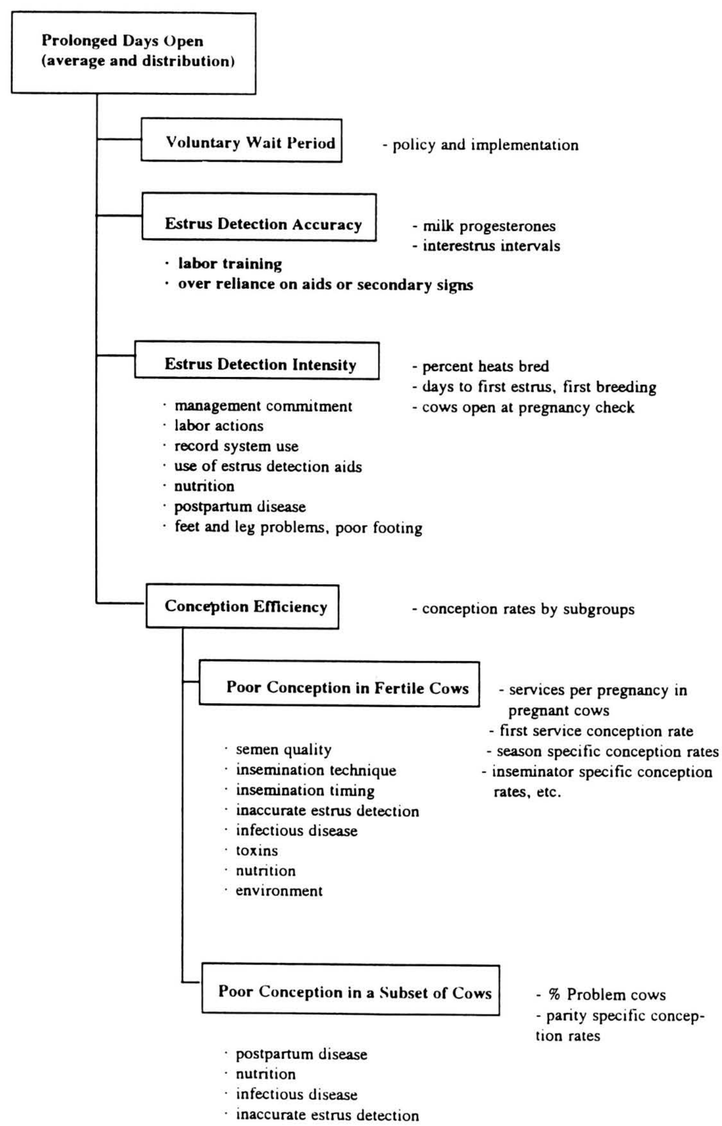

Figure 2.

Conception problems can be further segmented by looking at conception rates for various subgroups of cows (all cows, pregnant cows, heifers, etc.). If conception rates in pregnant cows is high, attention can be directed at estrus detection accuracy, insemination and semen quality and at problems affecting the herd as a whole like under nutrition or high environmental temperatures. If conception rates in pregnant cows is acceptable and in all cows is poor, then causes affecting specific subgroups of cows can be addressed, like postpartum disease, infectious disease in younger animals, etc. Once the investigation is focussed on a more specific area, the investigation of conception problems can move onto the farm.

Estrus detection problems usually lead directly to the farm to consider management and labor, housing, nutrition, and feet and leg problems. If estrus detection accuracy problems are suspected, then the dairyman can be asked to collect milk from cows at breeding for milk progesterone levels.

Abortion problems require both on farm and laboratory investigations, as do most cases of excess clinical reproductive disease. Excess culling for reproductive reasons is usually best approached by first examining the individual records of cows culled for reproduction to determine the underlying problems in those cows.

The specific on-farm investigation will be different depending on the major problem area(s). By gaining a broad view of the farm's problems through records analysis, problem areas that have not come to the farmer's attention are not overlooked. For example, a herd that is having a problem with so-called anestrus often also has a problem of repeat breeders or early postpartum disease.

Whatever the problem, it is usually productive to obtain a general history about breeding practices, artificial or natural breeding, timing of mating, techniques employed, method of estrus detection, status of nutrition and body scores, disease control programs, and the introduction of new animals.

At the point where individual cow information is needed, using a combination of each cow's reproductive record for the past year and the findings on physical examination of the genital tract make it possible to define the cow's reproductive status. It is much easier to do this if the breeding history of the herd has been submitted beforehand, the cow's records evaluated, and a comprehensive list of cows to examine has been produced. This will indicate those cows that need examination and also outline their immediate past histories and the reasons for selecting them for examination.

Common problems

The step of passing from a definition of the mode of the infertility to the specific cause requires some knowledge of the relative frequency of the common causes. This knowledge will ensure that, when an investigation is undertaken to determine the cause, the most likely one is not left until the end of the investigation before it is considered. The most common causes of reproductive inefficiency are, in order of descending frequency:

1. *Inadequate estrus detection.* As herds have increased in size and labor input per cow has been reduced, management of details often has declined. Detection of estrus is the most sensitive activity in breeding management, and failure to breed cows is the result. This commonly leads to an erroneous snap diagnosis of "anestrus". The diagnostic exercise required is not a laboratory one, although whether a cow has been in estrus or not can be deduced from blood or milk levels of progesterone. What is required is a careful clinical examination of ovaries of so-called anestrus cows to demonstrate that they are, in fact, cycling. As a subset of this group, a careful watch for a high proportion of nonpregnant cows among those presented for pregnancy diagnosis is also useful.

2. *Breeding cows not in estrus.* This is one of the disadvantages of the artificial breeding program; natural service should avoid the error. Timing of insemination is also a matter for consideration, but unfortunately is not identifiable by any physical or laboratory examination.

3. *Nutritional stress.* Inadequate nutrition, mostly by way of an insufficient supply of energy, is a common cause of reproductive inefficiency. This may be because of an absolute shortage of feed or because of a shortage relative to a high milk yield. The cow's change in body condition in early lactation and milk yield are both good indicators of the cow's nutritional status. In addition, dry matter intake and feeding program evaluation are the next step, including forage analysis and levels of degradable protein.

4. *Inadequate male input.* Artificial insemination provides assurance against poor genetics. It does, however, have the disadvantage of allowing error by an incompetent inseminator.

5. *Infectious agents.* Although the infectious agents usually account for very few of the infertility problems and are specifically diagnosed in only 30% of the abortions, they are still a significant cause of loss in individual scattered herds. Brucellosis, vibriosis, and trichomoniasis have almost completely disappeared as significant causes of infertility. Other infections are probably of more importance, with no single one domi-

nating the others. These are the diseases that lend themselves to diagnosis by serological examination and diagnostic laboratory examination of aborted fetuses; by bacteriological examination of uterine discharge, placenta, or fetus; by pathological examination of tissues; by uterine biopsy; or by examination of tissues from necropsied animals or animals slaughtered for meat. The easiest approach to most of these causes of abortion is to assure that the farm implements an aggressive vaccination program beginning with their youngstock.

Laboratory Investigations

Laboratories can provide needed information in a variety of areas:

1. *Metabolic profile tests:* Blood urea nitrogen, serum copper, glutathione peroxidase for selenium deficiency, serum calcium, and phosphorus estimations will provide a guide to the cow's nutritional status with respect to each of these dietary ingredients. With the exception of selenium status and perhaps BUN metabolic profiling has been largely unrewarding as a diagnostic technique because the animal's basic homeostatic mechanisms try to hold blood parameters at normal even in the face of severe nutritional imbalance.
2. *Feed analysis.* A complete analysis of the feed for energy, fiber, protein and minerals are the best indicators of overall nutritional adequacy in the herd. This needs to be accompanied by an accurate estimate of total feed intake per cow per day.
3. *Abortions.* Aborted fetuses and placenta must be submitted for laboratory evaluation. Acute and convalescent sera from the dam must be submitted.
4. *Semen evaluation.* The quality of a batch of semen can usually be assessed by the conception rates in other herds using the same semen. A sudden, unexpected decrease in the conception rate should prompt a laboratory evaluation of the semen.
5. *Abattoir specimens.* The reproductive tracts of cows culled for infertility may be examined when possible.
6. *Genital discharges.* Samples of abnormal genital discharges can be taken for microbiological culture. Special transport media may be necessary when genital mycoplasmosis is suspected. Bulls may need to be cultured for trichomoniasis and vibriosis.

Corrective Action and Monitoring the Results

Having made a definitive diagnosis, the next step is to introduce corrective measures and to monitor the effects. The corrective action may include improvement in the surveillance of estrus detection, the use of estrus detection aids, improvement in nutrition, the specific treatment of cows, training in proper insemination technique, etc. Before implementing the new change, some consideration should be given to whether the program is less costly than the problem, and value of the program should be weighed by its probability of success. The specific nature of the corrective action should be documented for future reference, and the results should be monitored and recorded. Failure to achieve the desired results may necessitate a reinvestigation of the problem in greater depth.

Monitoring a Dairy Herd's Mastitis Status

There have been several excellent discussions written about the use of records for mastitis control (Reneau 1986, Leslie 1983, Dohoo 1982). What follows is a quick and simple scheme for both monitoring a herd for mastitis and for investigating outbreaks or problem herds. It does not give definitive answers to all mastitis questions, but it can greatly increase efficiency with which problems are solved. At the beginning, two pieces of data are needed:

Somatic Cell Count:

The first piece of necessary data is the Somatic Cell Count (SCC). Every dairy has a somatic cell count or WMT, at least on the card from the milk plant. DHIA SCC information is much more comprehensive and useful and veterinarians should encourage their dairymen to be on the program if they aren't. The goals for individual cows are to be less than 200,000 SCC/ml. For herds, the goal level is probably under 200,000 average SCC for the herd; under 100,000 for the best herds. SCC linear score for a cow should be 4 or less. Cows with a score of 5 or greater should be considered infected.

The average linear score for a herd should be under 3. **To get an estimate of the SCC level in the bulk tank, it does not work to convert a herd's average linear score like a cow's linear score.** (This has to do with the average of logs not equaling the log of averages. Fetrow 1988)

Conversions of linear scores for cows and herds:

linear score <u>cow</u>	SCC mid-range	average linear score <u>herd</u>
1	25,000	
2	50,000	1
3	100,000	2
4	200,000	3
5	400,000	4

Notice that the herd level scores must be one smaller to match the cow scores on a cell count basis.

Clinical case rate:

Second piece of necessary data is the clinical mastitis case rate. It may be difficult to motivate the dairyman to do so, but each veterinarian should try to get their client to record each case of clinical mastitis treated. It can really be an eye opener and can pay off. If the data are not immediately available, one can get a very crude estimate of the number of cases by counting the number of boxes of lactating cow mastitis treatment used per month or per year. Assume that each clinical cases uses three tubes, so each box of tubes represents 4 clinical cases. Calculate the number of cases from there. Know your farm. Some dairymen ignore cows with flakes in their milk, some treat them. Count any case you can see as a clinical case.

In the best managed herds, the clinical mastitis case rate can be as low as 1 percent of the milking cows per month. A more reasonable goal might be a clinical case rate of less than 3 per cent. This means that over the year approximately one third of cows experience a clinical case of mastitis. Many herds average far more than this. Collect the data and be prepared to be surprised.

What do you do with these numbers?

LOW SCC, LOW CASE RATE:

This is what you want. Keep the program going.

HIGH SCC, LOW CASE RATE:

Contagious mastitis, i.e. intra-cow pathogen and transmitted during milking. (The one exception to this I've seen is a herd with a severe *Staph aureus* problem spread by biting flies in the summer.) Do a bulk tank culture to decide if it is *Staph aureus* or *Strep agalactiae*. Then go to the farm and look at:

milking technique
teat dipping
dry treatment (*Strep ag*, particularly)
milking system function
culling practices (*Staph*, particularly)

LOW SCC, HIGH CASE RATE:

This is environmental mastitis. Again, a bulk tank culture will be useful, but generally less than for the preceding group. A better approach to the microbiology is to have the dairyman **always** take a sterile sample of any case of mastitis before treating it. If he freezes those samples, they can be cultured later to identify the organism and sensitivities if a problem arises. On farm check:

- o Environment, particularly calving areas, dry cow housing, and anywhere cows lie down
- o milking system
- o milking technique, particularly excess water, overmilking
- o teat dipping
- o teat lesions

HIGH SCC, HIGH CASE RATE:

These herds are usually mixtures of both environmental and contagious organisms. They commonly are making many mistakes in mastitis management. You usually need to start a comprehensive mastitis management program to fix these problem herds. The general approach is a mixture of the two groups above. At least start with a bulk tank culture and a breakdown of SCC by lactation number and stage of lactation. When addressing the problem, be sure to go after enough big issues that an effect can be detected. If there are six major deficiencies and only one or two are corrected, the overall problem may persist. Commonly, environmental problem areas can be addressed more quickly than contagious ones.

The next question is: Who are the cases?

When sorting out a mastitis problem in a herd, it can be quite productive to use DHIA SCC data to create a profile of the kinds of cows that either have high SCC or clinical cases. Minnesota DHIA herd summary is particularly useful for its breakdown of cows into heifers and older cow groups by somatic cell count score groups.

Problems in early lactation?

Look at dry cow lots (wet). Ask about dry cow therapy (if heifers are not involved). Are calving pens clean, dry and allowed to sit empty between calvings (both cows and heifers involved)? If the problem is acute and it is summer, how is fly control (often heifers more than cows). Udder edema? (more heifers)

Problems in all stages of lactation?

Check milking equipment, water in the parlor or wet udders. Common wash rag. Dirty freestalls/stanchions. Old inflations. Cows not fed coming out of parlor. Wet "exercise lots". Uncomfortable freestalls (lying in filth). You get the idea. Are cows clean, **dry**, and comfortable?

Problems in dry cows?

Generally a major management breakdown. Check dry treatment, filthy housing, wet housing.

High Bacteria Count:

High bacteria counts (goal is to be less than 10,000) can derive from the cow (usually contagious *Strep ag*) or from the "environment". Bulk tank cultures will distinguish the two. If bulk tank cultures show environmental organisms, think milking hygiene, milking system cleanup, or cooling. Have the farmer save the milk filter (without washing it!!). If it is full of pus, he is not detecting clinical cases and holding clinical cows out of the tank. If the filter is filthy, think poor milking hygiene. If the filter is clean, check milking system cleanup, particularly wash water temperature at the end of the system wash. Look at the system for bad plumbing installation that has left unwashed corners (Yogurt corners). Test the temperature of the bulk tank. How fast does it cool down?

Obviously, there are mastitis problems that are more complex than this approach will solve. It is amazing, though, how many can be quickly and efficiently settled diagnosed by this approach.

Monitoring Youngstock Programs

Youngstock are, obviously, the future of the dairy. Often neglected, they are actually one of the easier parts of the dairy to monitor if a commitment is made to do so. Basic data should include:

Morbidity and mortality:
It is probably most useful to record disease and death separately for heifer calves and bull calves. The short period that bull calves spend on most farms and the attention they get tend to skew the program's success if they are included with the heifer calves.

Age at first calving:
DHIA provides this figure. The goal is 24 to 25 months, with adequate size and body condition. Many dairies lose at least as much to late calving in heifers and inadequate youngstock programs as they do to reproduction. How much of our time as veterinarians do we devote to these two facets of the farm? Would more attention to the youngstock be a good investment for your client?

Mature equivalent milk production in first calf heifers.
This is the acid test of the productivity of the herd's new producers. Remember that the first calf heifers have not yet been culled through; everyone gets a first chance. Older cows have survived at least one cut, so their mature equivalent average will be higher than for first calf heifers (usually by about 500 pounds), even though the herd is making genetic progress.

Weight and height graphing:
This is probably the most powerful way to monitor the youngstock program. If heifers are measured and graphed every time they are worked, an excellent picture of management and problems will quickly emerge. Height is generally easier to measure and is at least as good as weight (girth tape). Height is less confounded by the heifer's body condition. Growth charting can be done directly on the normal form on the farm, takes little more time, and yields a great deal of information. The Pennsylvania State normals for Holstein heifers is shown in Figure 3.

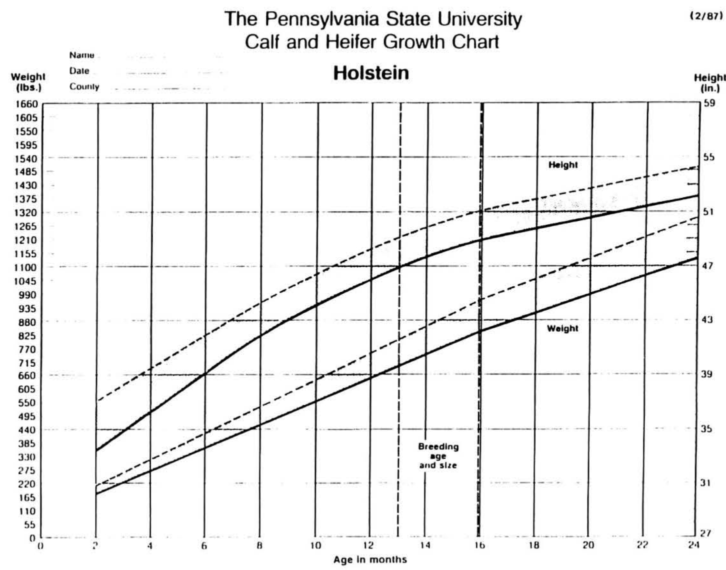

Figure 3.

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Abstracts:

Efficacy of moxidectin against gastrointestinal nematodes of cattle

J.C. Williams, S.A. Barras, G.T.Wang

Veterinary Record (1992) **131,** 345-347

Three groups of 11 naturally infected crossbred beef calves were injected subcutaneously with moxidectin 1 per cent injectable at 0.2 or 0.3 mg moxidectin/kg bodyweight or with the unmedicated vehicle. Nematode infections had been acquired during grazing from December to April. Based on the faecal egg counts and total worm counts of the control calves at necropsy (11 to 13 days after treatment) most of the calves had heavy parasitic burdens. *Ostertagia ostertagi* was predominant and the mean numbers of adults, developing fourth stage larvae (L4) and inhibited early L4 were 45,906, 10,061 and 68,918, respectively. *Haemonchus placei* and *Trichostrongylus axei* were also present in the abomasa. Three species of *Cooperia, Oesophagostomum radiatum* L4 and *T colubriformis* adults were found in the intestinal tract. Both dosages of moxidectin were equally effective ($P<0.05$) against all the abomasal nematodes (99.9 to 100 per cent) and the intestinal tract nematodes (99.4 to 100 per cent). No adverse reactions to the moxidectin treatment were observed. Abomasal pathology characteristic of heavy *O ostertagi* infection was observed in the control calves, but not in the treated calves.

Some aspects of the epidemiology and control of *Salmonella typhimurium* infection in outwintered suckler cows

T. G. Davies, C.P. Renton

Veterinary Record (1992) **131,** 528-531

Two outbreaks of *Salmonella typhimurium* infections affected outwintered, spring-calving suckler cows in late pregnancy. The infections spread rapidly both within and between groups of stock on the affected farms, with morbidity in the infected groups varying from 14.5 per cent to over 60 per cent, and mortality in adult cattle varying from 0 to 14.3 per cent. Prophylactic measures included the use of antibiotics and killed vaccines against *Escherichia coli*, *Salmonella dublin*, *S typhimurium*, and *Pasteurella multocida*. In one outbreak, use was also made of a polyvalent serovaccine and hyperimmune serum against *E coli*, *S typhimurium*, and *S dublin*. In both outbreaks no new cases were reported in the affected groups after the administration of the second dose of vaccine, and there was no resurgence of disease on the affected farms within 18 months of the primary outbreaks.