Solving the Number One Cause of Poor Reproductive Performance

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Introduction

Perhaps no area of the management program frustrates both dairyman and veterinarian alike more than reproduction. Both understand the critical importance of a sound reproduction program. As veterinarians we are trained primarily to diagnose, treat and hopefully prevent infectious disease problems. In today's modern dairy climate, where every effort is made to maximize productivity and profitability, we are increasingly faced with PRODUCTION disease problems.

In this discussion, we will attempt to dramatically demonstrate the critical relationship that exists between energy status of the herd and reproductive performance. The discussion will address three areas: 1) Establish the energy-fertility relationship; 2) Identify DHIA record parameters that serve as indicators of the energy status, to both diagnose energy deficiency **and** predict the direction of future reproductive performance; and 3) Demonstrate the use of DHIA record analysis in correcting impaired fertility by establishing improved energy status of the herd. It is the graphic analysis of reproductive performance correlated to herd productivity that can clearly demonstrate to the dairy producer the importance of spending additional money to establish a more energy dense ration.

Energy and Fertility

Numerous research studies have established the relationship that exists between fertility and conception rates. Figure 1 demonstrates the fact that cows in negative energy balance conceive at a rate of less than 35%, while cows in positive energy balance conceive at a rate of 50%.[1]

Looking at the dry matter intake curve, the energy balance state and the production curve (Figure 2), it becomes apparent why we encounter impaired fertility in high producing herds. Many reproductive programs recommend the initiation of breeding at 40–50 days post partum, at a time when negative energy balance is still present. In some very high producing herds, we will frequently see signs of heat at 35–45 days and then not see estrus signs again until 75–90 days in milk. At 50–60 days in milk, our cow is at peak production and severely stressed. She has lost a significant amount of body condition and in the ensuing two months will begin to stabilize and then start to gain weight.

FIGURE 1.

Body Condition Change: Effect on Breeding

B.C. Change from Calving to Breeding

CONDITION LOSS	CONCEPTION RATE
0	50%
1	34%
2	21%

Ferguson, J. 1989

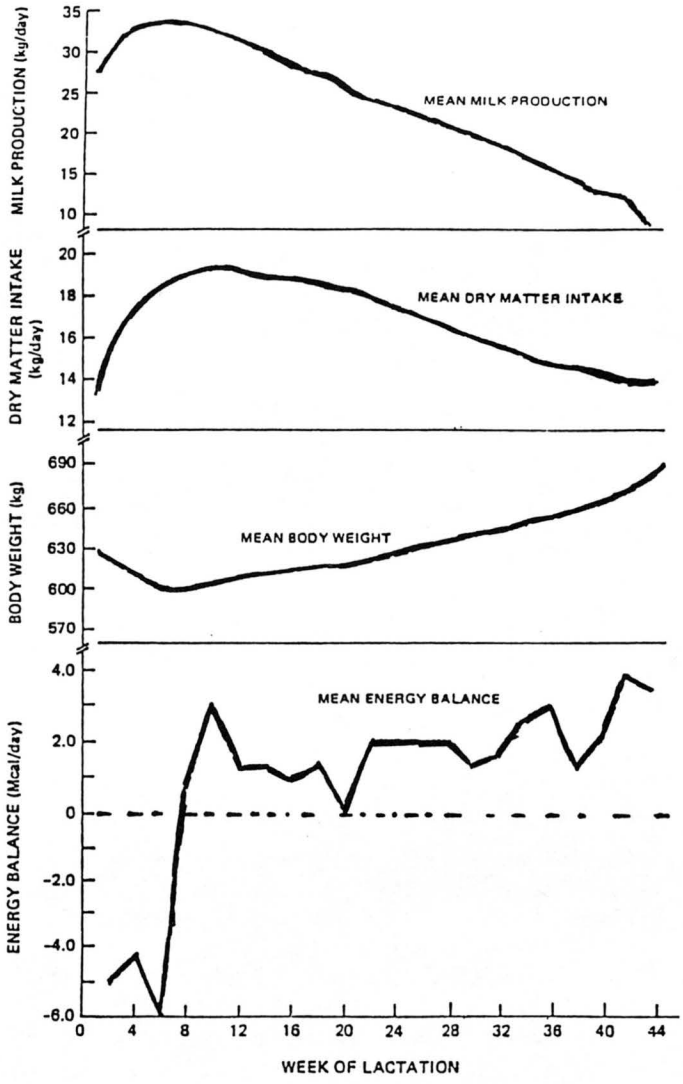
Figure 3 (Days to 1st Breeding vs Conception) depicts a typical situation for many high producing herds. At 50–60 days in milk, first service conception rates average well below 30% while we see the more normal rate of 45–55% when first breeding occurs 60–100 days in milk.

In Figure 4 we see a milk lactation curve for 3rd+ lactation animals in a high producing herd. Notice cows are peaking near 100 lbs. per day in the third test period, which usually corresponds to approximately 80 days in milk. Notice in Figure 5 (Reproduction Summary Analysis) that for this herd, third lactation cows averaged only a 23% first service conception rate, **half** that of the first and second lactation animals. The second service on these 3rd+ lactation cows revealed a 70% conception rate. If you add 21 days (one cycle length) to 88 days (the actual days to first breeding), you will see that this 70% rate took place when cows were in milk 109 days or longer. Production had started to decline and milk production was below 90 lbs. per cow per day. This corresponds to a time when these cows were establishing balanced energy status.

The records are demonstrating what is happening. If we are to solve this problem and improve conception rates, we must choose one of four possible solutions (Figure 6); 1) Delay breeding until energy status is

improved; 2) Continue to breed as we have and accept this level of reproductive performance; 3) Attempt to improve dry matter intake and therefore improve energy status (no one has done this to date); or 4) Increase the energy density of the ration.

FIGURE 2. Trends in milk production, dry matter intake, body weight change, and energy balance during a lactation period (Source: Adapted from Satter and Roffler, 1975)



Since energy status of the cow is so important to successful breeding, lets look at the DHIA information and examine some indicators present that can help us determine the energy status of our breeding cow.

DHI Record Indicators of Energy Status

Several years ago Dairy Production Consultants began to study the solids component of the milk, which led to the development of the DPC % butterfat and % protein

FIGURE 3.

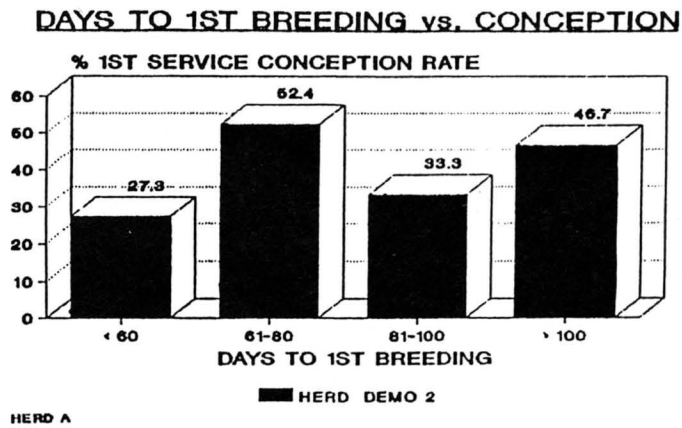


FIGURE 4

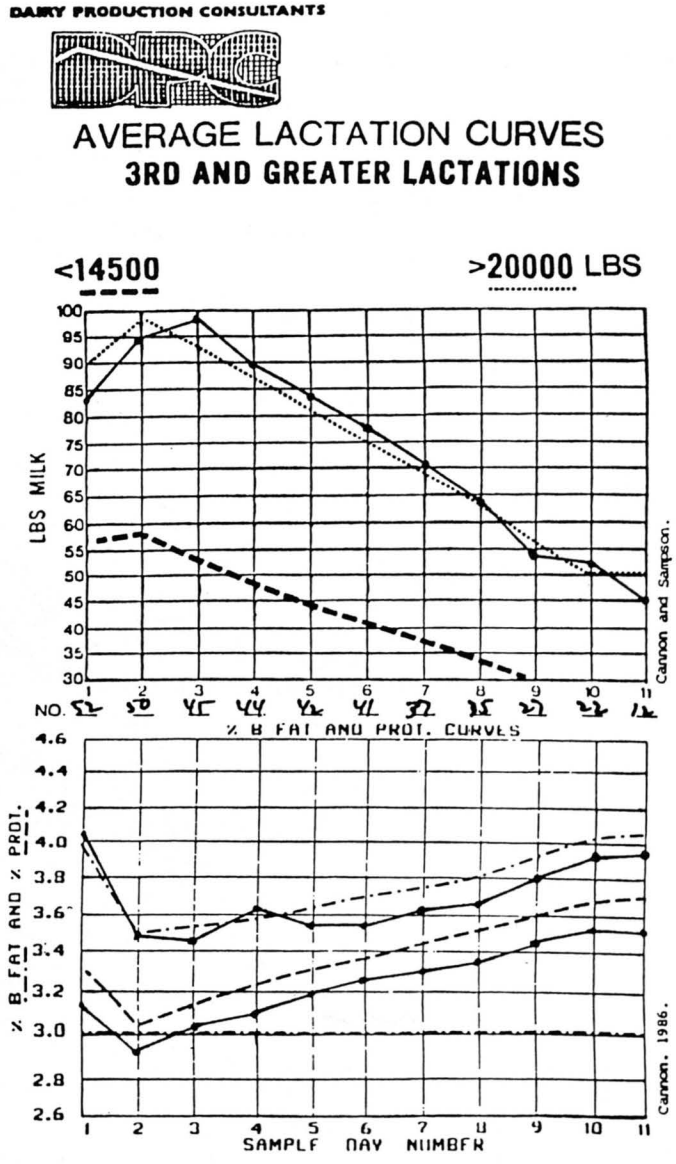


FIGURE 5.

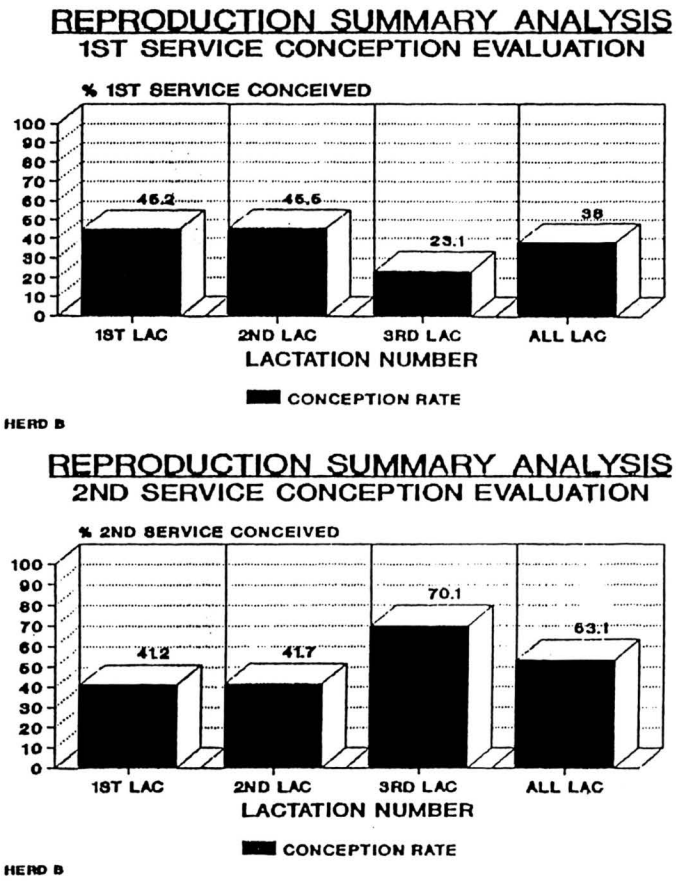


FIGURE 6.

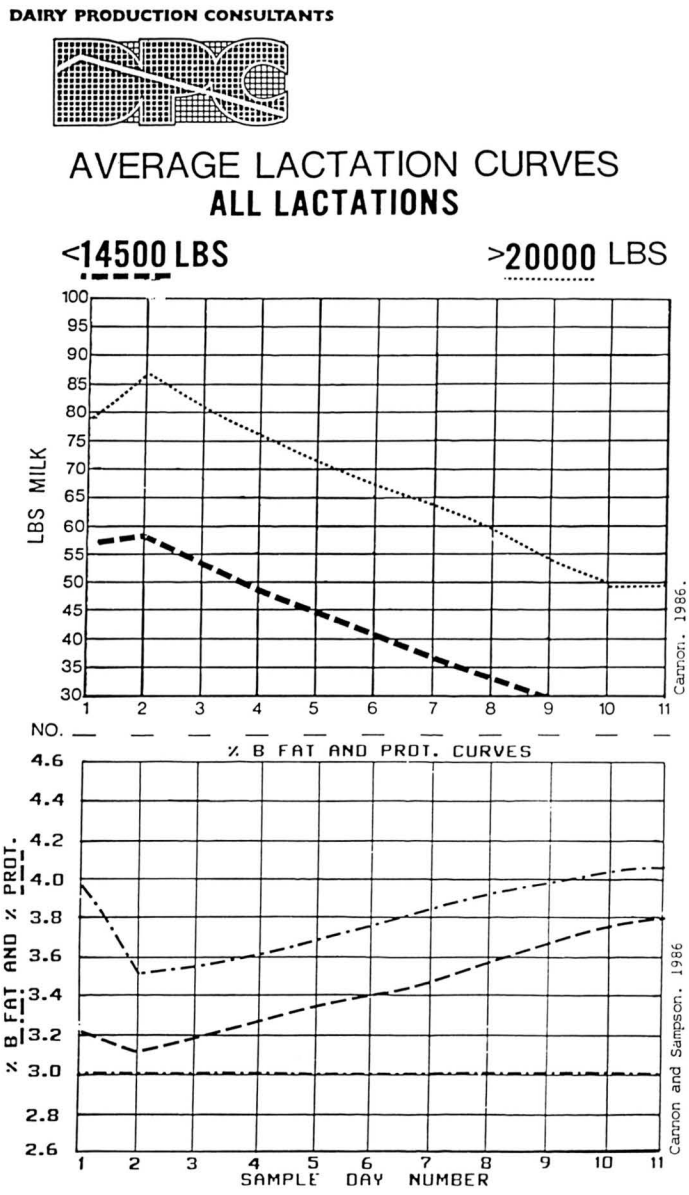
Solving the energy deficit problem

- (1) Delay breeding
- (2) Accept poor conception rates
- (3) Increase dry matter intake
- (4) Increase the energy density of ration

curves (2) (Figure 7). We learned that, used in conjunction with the milk pounds lactation curve, considerably more diagnostic information could be obtained relative to the nutritional balance of the herd than with the use of milk curves alone. Time does not permit an in-depth discussion of lactation curves. However, two important observations are worth discussing with reference to the condition and energy status of our fresh and breeding cow.

From research in Washington State came the statement "80% of the first butterfat test is coming off the cow's back." Cows that freshen in good body condition, body score of 3.7 to 4.0, will have a good first butterfat test.

FIGURE 7



California research (3) showed that "Rations low in energy can cause a drastic reduction in solids non-fat (SNF). Cows fed their maintenance requirement and about half of their milk production requirement dropped .3 to .5% in SNF tests. The loss was primarily in the protein fraction." Therefore, if we observe depression in percent protein in the early part of our % protein curve, a reasonable assumption is that we are dealing with an energy deficient ration relative to our productivity and will likely see an unreasonable weight loss in our fresh cow. The % butterfat on first test tells us what the cow looks like at calving, the % protein tells us what is happening to that body condition. Percent protein is, in effect, measuring energy status.

There are many other factors that affect percent milk

protein (Figure 8). If one is aware of these factors, then use of the % milk protein can be an important tool in predicting future reproductive performance.

FIGURE 8.

Factors affecting % milk protein

- (1) Genetics
- (2) Environment
- (3) Production
- (4) Percent butterfat
- (5) Health
- (6) Nutrition
  - (A) Energy
  - (B) Bypass protein
  - (C) Fat content of ration
  - (D) Pasture
  - (E) Dry cow nutrition
- (7) Seasonal influence

Figure 9 demonstrates some clinical research conducted in 13 herds in 1987–1988 (4). These herds averaged approximately 18,000 lbs of milk with a 3.67% butterfat. There were 1483 cows in the 13 herds and 738 were confirmed pregnant. Of the 738 confirmed pregnant, 85% conceived at a time when the milk protein percent was 3.0 or greater, and 7.8% conceived with a test of 2.9%. When milk protein percent dropped below 2.8%, only 2.3% conceived. Obviously fewer cows were bred at a protein level of 2.7% or less. However, we suspect that conception at this level is severely depressed. More controlled research needs to be done in this area. In the authors' opinion, you will find both reduced conception and reduced estrus symptoms at very low milk protein percentages.

FIGURE 9.

Percent protein vs. % conception

% Protein	>= 3.0	2.9	2.8	<= 2.7	All
# of cows					1483
# conceived	629	58	36	17	738
% conception rate	85	7.8	4.9	2.3	100
# of herds					12

Summarizing the information thus far:

1. Cows in positive energy balance (gaining weight) conceive at a rate of 55% or greater.
2. Cows in negative energy balance (losing weight) conceive at a rate of less than 30%.
3. The percent butterfat of the first test is reflective of the cows' body condition at calving.
4. The percent milk protein appears to be useful as a diagnostic tool to measure energy status.
   a. When percent milk protein is dropping, more than likely cows are in a negative energy balance.
   b. When percent milk protein drops below 2.9, it appears to result in reduced conception rates.

Therefore, actions that could be taken to improve reproductive performance of the herd would include:

1. **INCREASE THE ENERGY DENSITY OF THE RATION.**
2. When conducting pre-breeding examinations, the decision to code her "READY TO BREED" should be based on more than the palpated condition of the uterus and ovaries.
   a. *Score the body condition of the cow.* A drop of more than one body condition score (5 point scale) results in reduced fertility. One that drops below 2.8, suggests we have a cow very likely incapable of supporting a pregnancy.
   b. *Observe the % milk protein* of questionable body condition cows. If it is down from the previous test and 2.8 or less, delay breeding until this situation has been corrected.
   c. *Reserve the use of prostaglandins for cows* that are physically *capable of responding*—both internally and externally.
3. **Tailor your reproductive programs to the specific herd.** Study the DHIA reproductive performance of each of your client's herds and know when successful breeding is taking place. If the herd is doing well breeding at 50 days in milk, proceed as usual. If it is not, adjust the program. Records analysis gives us the power to offer *professional advice. Advice based on the facts* for a given situation in a specific dairy.

In the clinical cases to follow you will see the dynamic impact of how improving the energy density of the ration and using DHIA records can markedly enhance your clients' reproductive management performance.

Herd Example I—JML Farm

JML Farm consists of 275 cows on DHI test. The cows are milked 3x. The rolling herd average is 16,300 pounds of milk. Fat test is 3.55% on a rolling herd basis. Currently the herd averages 53 pounds per cow and the calving interval (projected minimum) is 14.5 months.

Does this herd have a reproduction problem? Most of us would agree that an obvious problem does exist.

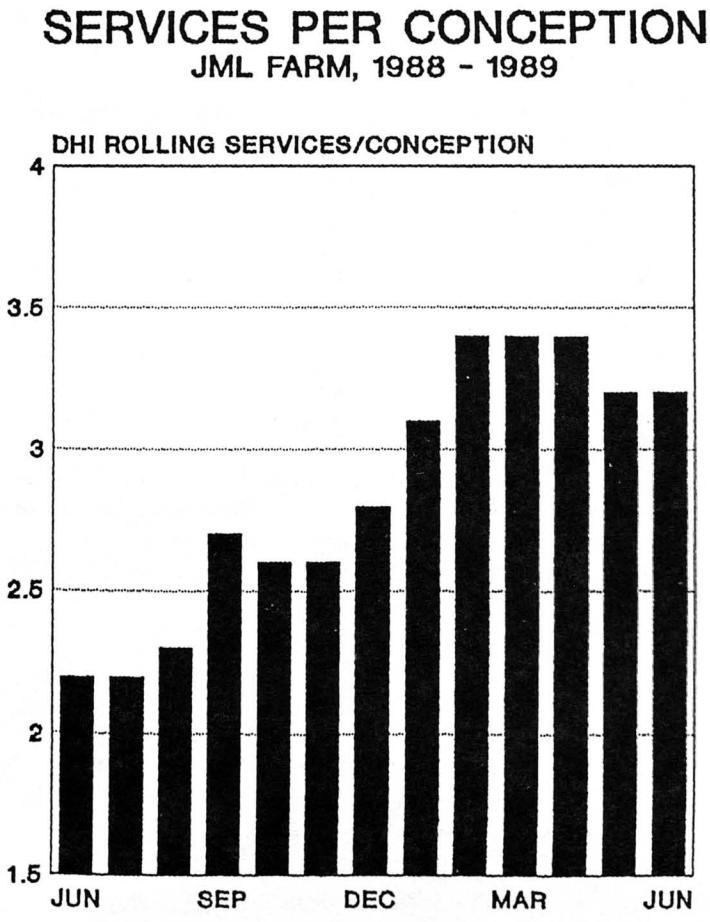
Further information. .

JML Farm has a voluntary waiting period of 50 days. The heat detection rate is 60% and services per conception are currently 3.1 on a rolling herd basis. Does the problem lie in the management of the voluntary waiting period, the heat detection or in conception?

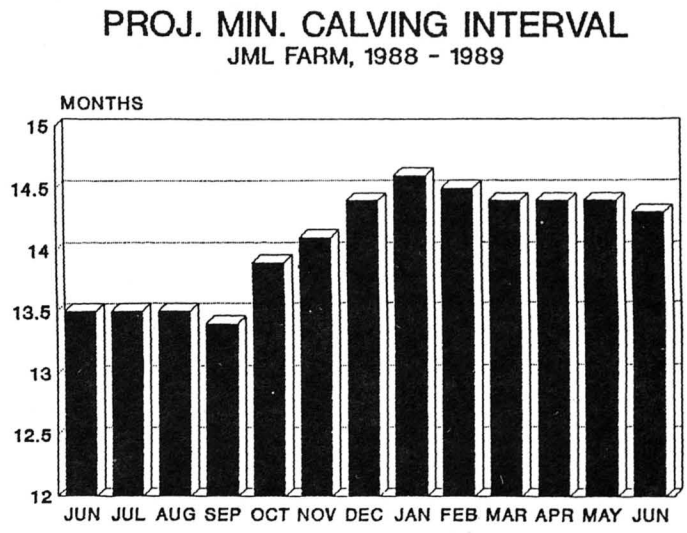
The history of JML Farm is as follows: I was contacted in August of 1988 to come and provide Production Management Assistance to this herd. This service consists of records evaluation, records presentation, and advice in four cow management areas: Production, Udder Health, Reproduction, and Replacements.

In Graph A, note that as soon as we started graphing records in this herd, the services per conception started going up. (Not good for the newly employed management assistant.) Notice also on Graph B the projected minimum calving interval started going up, reaching a point higher than ever seen before on this particular dairy. Graph C shows the percent of the herd that were problem breeders each month. A normal level is 8–10% of the milking herd or less. This category includes cows bred three times or more and not yet confirmed pregnant.

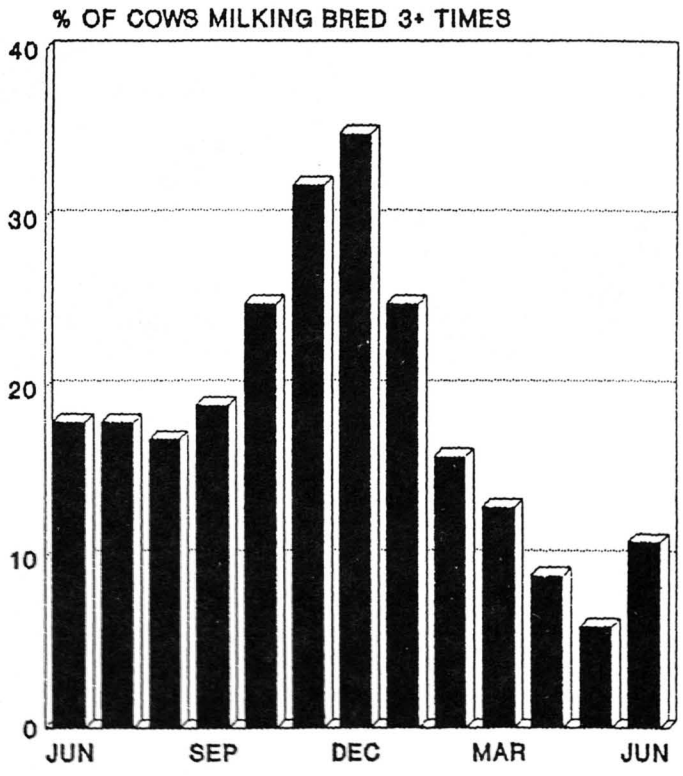
GRAPH A



GRAPH B



GRAPH C



Does this herd have a reproduction problem?

It is fairly obvious that this herd does have a reproduction problem. All of us would agree on this quickly. However, in order to solve the problem, we need to know which factors are contributing to it.

Waiting Period

The waiting period in this herd is far too short. It was recommended initially that the waiting period change from 45 to 60 days on adult cows and from 45 to 65 days on first calf heifers. Because of the owner's fearful trepidation that we wouldn't get any cows bred in this herd unless we started early, we decided to postpone this change for six months to a year in our initial discussions in August of 1988.

Conception Rate

Conception rate has been an historical problem in this herd, running between 35 and 40%. It was my contention that improved energy balance in the cows would result from fewer retained placentas, decreasing the amount of grain in the milking diet and increasing available energy to the milking cows. This would be **the largest factor in improving conception rate: IMPROVED ENERGY MANAGEMENT.** The other item that was decided upon, finally carried out in March, was sending the on-farm inseminator to a refresher course.

Heat Detection

My contention is that the heat detection is okay in this herd, running at 60% of possible heats being bred. This goes against the trend in the country, with most of us suggesting that heat detection is at the root of most reproductive problems. I do not believe this is the case in many herds with good to excellent management.

Setting the Scene at the Farm

Here we are in May of 1989 facing a herd owner that is wondering when the reproductive problem is going to be fixed. Notice in Graph B that the calving interval is 14.3 months. When we started with this herd in August, it was 13.5 months. The dairyman would like to know if we have indeed fixed the problem or not. Fortunately, from the veterinarian's standpoint, we have excellent records to help us answer that question.

Conception Rate—Definition of Terms

In our DPC records analysis, we use three different groups of cows in looking at conception rate. The first is the yearly conception rate.

1. *Yearly conception rate* is defined as the number of cows confirmed pregnant, divided by the number of services used on these cows. Yearly conception considers all of the cows that are confirmed pregnant in the herd at this time and *reflects conception between 55 and 280 days ago.*

2. *Eight months conception rate* is defined as the number of cows confirmed pregnant divided by the number of services used on those cows, but it considers only the cows that have freshened within the last eight months. Because we have a voluntary waiting period and time required to check cows pregnant, this *reflects conception between 55 and 150 days ago.*

3. The *recent overall conception rate* is defined by the services used on the cows that were confirmed pregnant during the last DHI test period. These will be animals that *conceived 55 to 85 days ago, as of test day.* This is reflective of the most recent conception factors that we can put our hands on. This will give us hints as to energy status, protein status, inseminator competence, semen quality, etc. This reflects, on the average, how cows freshened, cleaned and involuted four to five months ago.

One caution on the recent overall conception rate is that it may look good in a particular month, but we may in fact be adding to the numbers of problem and delayed breeders in the herd. Like all of these conception figures based on confirmed pregnant cows, we are looking at the cows we have successfully bred. We must keep our eyes on the cows that are due for breeding but not yet bred, and on the cows that have been bred multiple times and are not yet confirmed pregnant. We would define these as delayed breeders (cows 80 days in milk and not serviced yet) and problem breeders (cows serviced 3+ times and not yet confirmed pregnant).

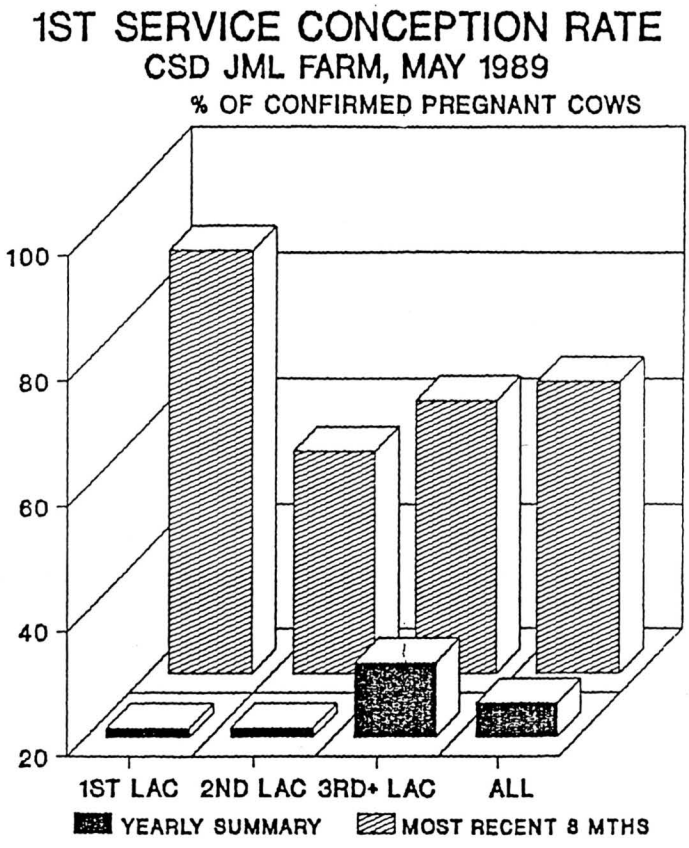
The Records on JML Farm Rescue Production Medicine

In Graph D we have the breakdown of first service conception rate by lactation. It is also broken down to show us the yearly summary of conception rate vs the conception rate in the animals that have freshened in the last eight months. It is very obvious that the 25–30% overall conception rate has changed tremendously to a 65% overall conception rate on animals fresh in the most recent eight months.

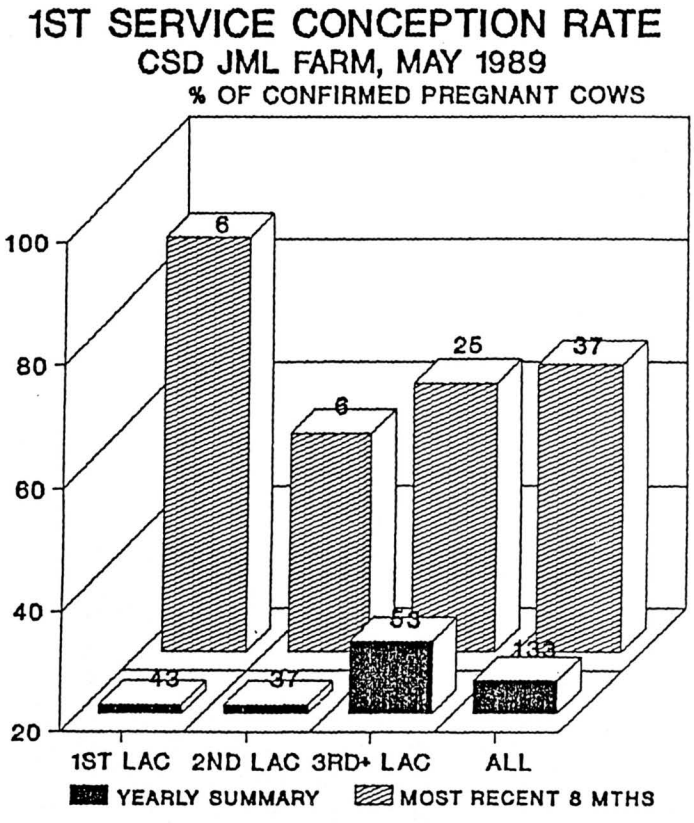
This graphic demonstration is the first concrete evidence we have that the reproductive problems are indeed being fixed, in spite of the projected minimum calving interval still looking absolutely horrible at 14.3 months. Notice that the progress has been tremendous in all lactations, especially first calf heifers. However, the numbers of cows, seen in Graph E, are few in the first lactation and second lactation categories. Third lactation and above has half of the pregnant cows being fresh in the last eight months.

It should be pointed out that of the 133 confirmed pregnant cows in the herd, 37 of them freshened in the last eight months. Thirty-seven cows are included in the 133 cows. Therefore, the yearly conception rate is better than it would be without the 37 head performing well at 65% conception. Please observe also that if we are talking about animals fresh in the last eight months, it would be normal in a truly year-round calving herd to have roughly

GRAPH D



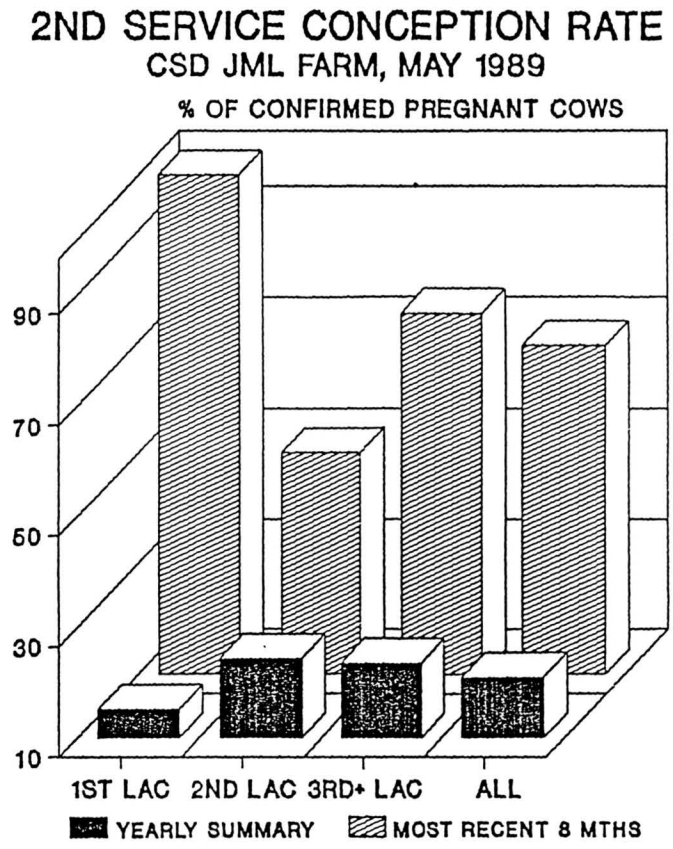
GRAPH E



25–30% of the animals that are pregnant being fresh in the last eight months. This is due to the lag time in getting cows fresh, bred and confirmed pregnant.

The second service conception rate at JML Farm is also vastly improved, as you can see from Graph F. Days to first breeding, as seen in Graph G, is also headed in the right direction. The graphic representation of recent reproductive performance gave confidence to the owner and the on-farm inseminator such that they had started to wait longer on the animals for first breeding. As of August, 1989, this herd does not breed any cow before 60 days and no heifers before 65 days.

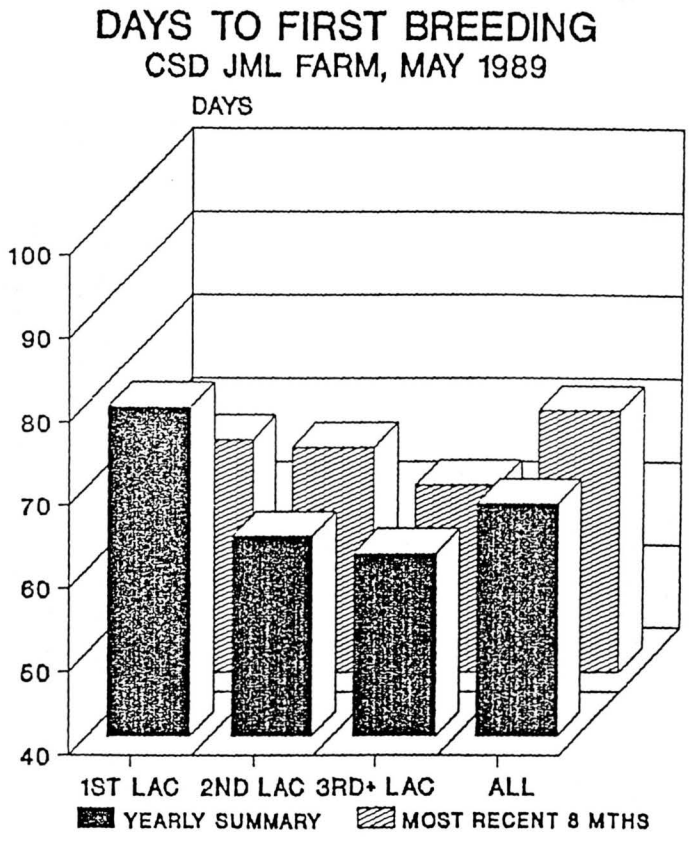
GRAPH F



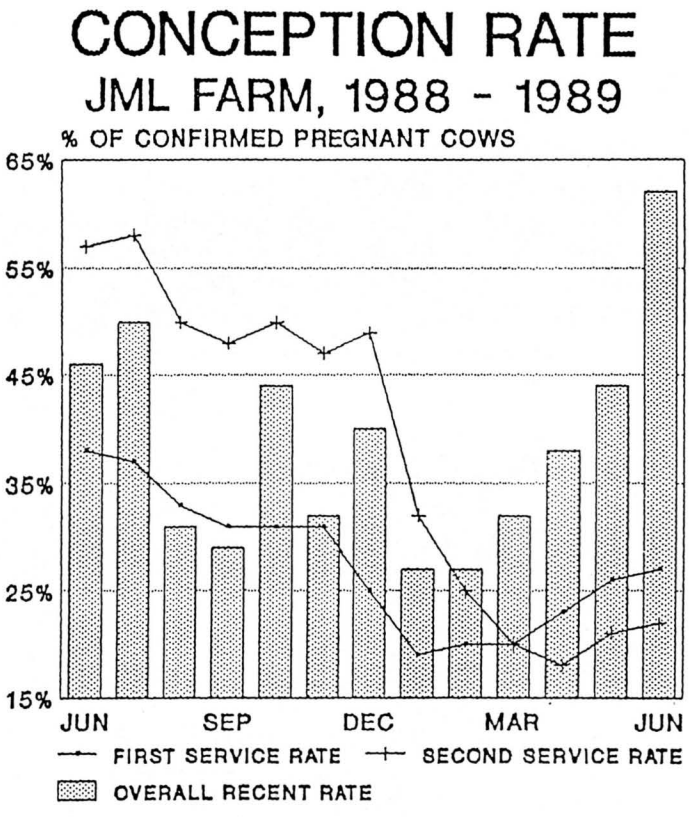
Finally, in Graph H, we have represented the type of conception record that we keep monthly on each of the contract farms. On the same graph we plot 1, the yearly first service conception rate, 2, the yearly second service conception rate and 3, the overall recent rate. Please notice that the overall recent rate started to increase in March and became a trend in April, May and June on this dairy. In reality, the energy balance problems in this herd were on their way to correction as early as November or December of 1988. Remember that we started intensive ration and records work in August of 1988 and it takes some time to have cows presented for freshening and subsequent breeding with more adequate energy status.

One final note on conception rates: When comparing

GRAPH G



GRAPH H



first service conception rate versus second service conception rate, I would propose that they should be nearly the same if energy status is managed properly. Notice in Graph H that the first service conception rate from June through February is very low in comparison to the second service conception rate. If the inseminator is the same, the semen is handled the same, and heat detection accuracy is the same, we are left with energy balance being the big culprit in depressing first service conception rate in this herd. Notice, in the months from March through June of 1989, the reversal in the yearly conception rate. The first service is now higher than second. To have things under control in this herd we will need to have first and second service conception rate be about the same, and of course at the normal level of 45–55%. This herd has a long way to go in getting a proper handle on reproduction management—but they are started down the right road.

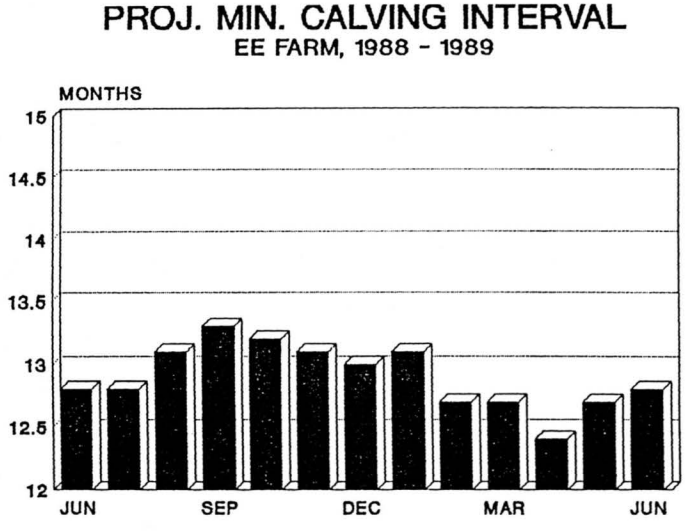
I can tell the owner of JML Farm with confidence that reproduction is going better based on the fact that we have record systems good enough to bring into focus recent reproductive performance.

Example Herd II—E Farm

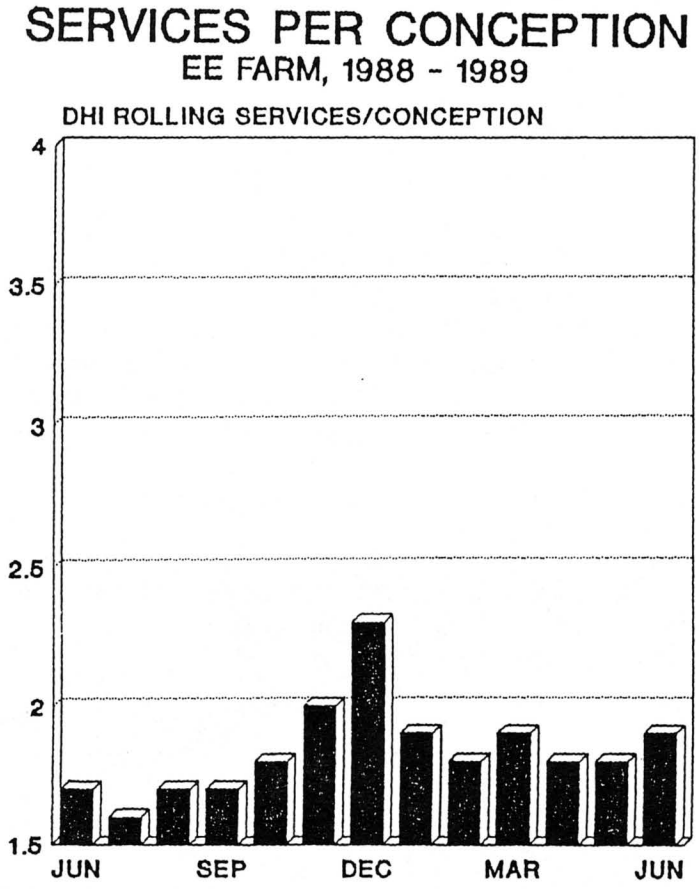
This farm has 75 cows on 2x milking. Rolling herd average is 17,500 lbs of milk with 3.5 % fat test. They are currently averaging 60 lbs a cow in April of 1989. Calving interval is 12.4 months. Does EE Farm have a problem reproductively? More information would be helpful.

Voluntary waiting period on EE Farm is 50 days. The heat detection rate is 60% and services per conception are 1.8 on a yearly basis on DHI records. The calving interval (projected minimum) on EE Farm from June 1988 through June 1989 is shown in Graph I. Services per conception are in Graph J for the same time period. Does EE Farm have a reproductive problem?

GRAPH I

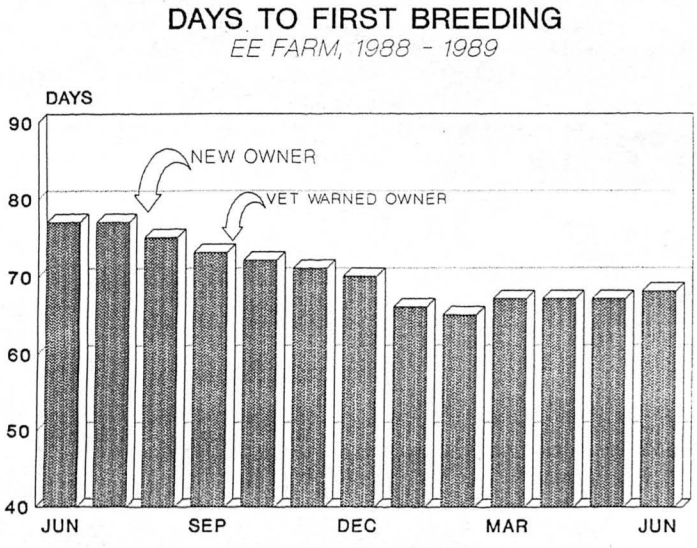


GRAPH J



If we only look at traditional calving interval, days open and services per conception on DHI, this dairy does not have a problem. It is important for one to know that 22% of this herd has been culled in the last year because of failure to breed. Looking at Graph K we can collect some more historical information.

GRAPH K



This herd, while owned by the previous owner, was on contract with Dairy Production Services for Production Medicine services. The herd was sold to a new owner and he elected to stay on this service for a few months to see what we provided. Note in Graph K, the monthly graph of days to first breeding, a declining days to first service starting in September and continuing on through February. The new owner took over herd management August 1 of 1988. His Dairy Production Medicine veterinarian warned him of breeding cows too soon at the September herd visit. Based on the above information, does this herd have a reproductive problem?

We predicted in September of 1988 that he would have a problem unless he changed his breeding policy. It is unfortunate that on many dairies *early breeding is fueled by trying to reach an average projected calving interval or average days open that looks good on paper,* without regard for overall breeding performance on individual animals and/or the reproductive cull rate. Because the services per conception and the calving interval on this herd looks good on paper, it is easy to ignore reproduction as a management problem unless we investigate further.

Breeding cows too soon, in an dairy, no matter what level of energy management we have, will get us poorer conception than waiting an appropriate time interval. For those of you that do not have access to days to first breeding as part of your DHI records, a formula follows.

Days to First Breeding Formula

If you will add the **voluntary waiting period** in days to the additional days we will have because of **random cyclicity** in the cows, plus the days we have because of less than 100% **heat detection efficiency**, we will end up with an approximate days to first breeding for the average cow in a given herd (See Figure 10). In Figure 11 you can see an example of the calculation. Voluntary waiting period is assumed to be 60 days in this herd. We add one-half of a heat cycle, roughly eleven days, because of the fact that cows are cycling randomly. If we decide to breed cows at 60 days the average cow will be bred 11 days later. We also add the number of days that our heat detection

FIGURE 10.

Days to First Breeding Formula

Voluntary Wait	_____	Days
Plus		
Random Cyclicity	_____	Days
Plus		
Heat Detection %	_____	Days
Total	_____	Days to First Breeding

FIGURE 11.

Days to First Breeding Formula Example

Voluntary Wait	_60_	Days
Plus		
Random Cyclicity	_11_	Days
Plus		
Heat Detection % e.g. 50%	_11_	Days
Total	_82_	Days to First Breeding

efficiency will postpone the average days to first breeding. The example shown is a 50% heat detection rate which will add another half of a cycle. The total of these three figures gives us the average days to first breeding for this example herd.

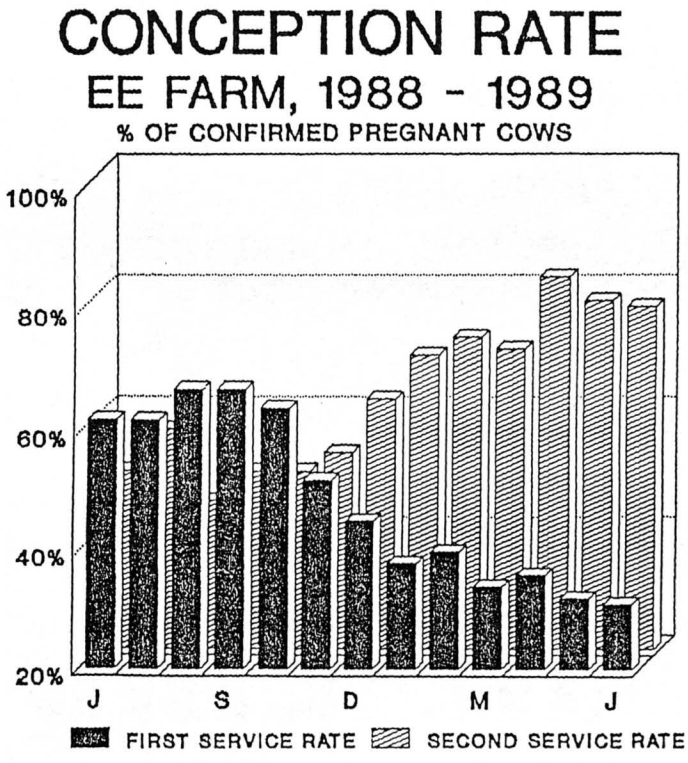
It should be noted that if you have the days to first breeding calculated and not heat detection efficiency, you can back-calculate and figure out the efficiency of heat detection.

Back to our EE Example Farm...

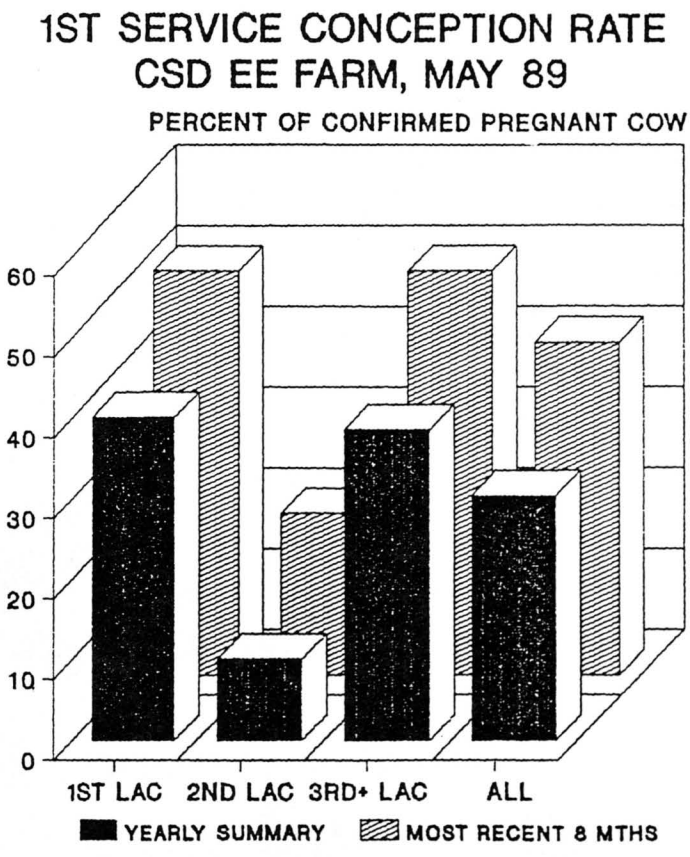
In Graph L, you can witness what we witnessed month by month in the conception records on EE Farm. In September, the owner was warned of breeding cows too soon. First service conception rates looked fine on a rolling average basis at that time. However, by the time December came around, first service conception rate on confirmed pregnant cows had dropped to slightly less than 45%. Notice that second service conception rate increased as the first service conception rate decreased. By May of 1989, first service conception rate was less than 35% and second service conception rate was over 70%. This kind of split in first and second service conception rates tells us that cows are in negative energy balance and not ready for first breeding at the time they were bred.

As of May, 1989, breeding at EE Farm *was* going better. In Graph M, notice that first service conception rate has improved considerably across all lactations while second service conception rate (Graph N) has not changed significantly. This improvement is not due to longer days to first service. They had not changed (Graph O). The improvement was from slightly better condition on cows in the herd, plus a vastly improved dry cow ration.

GRAPH L



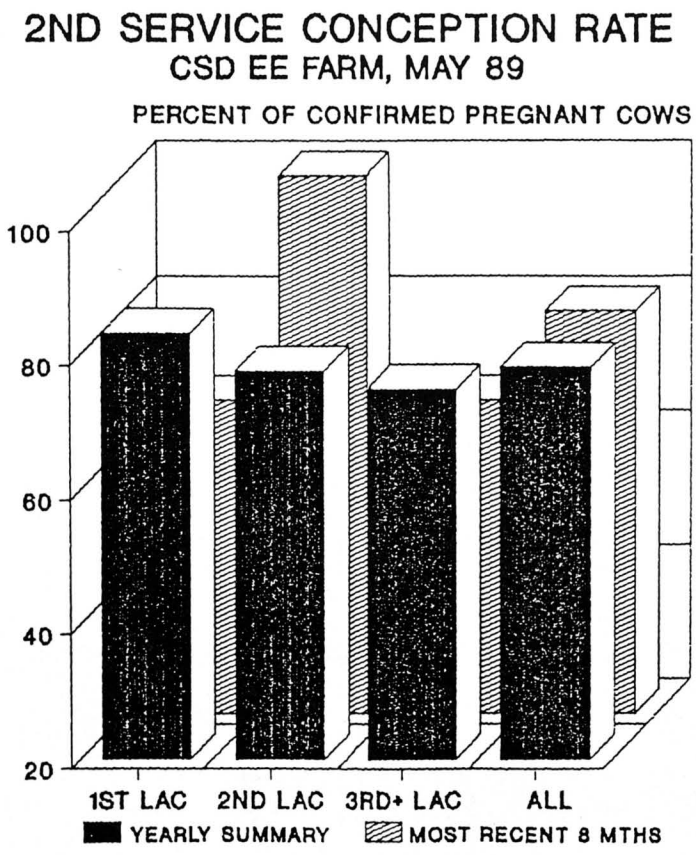
GRAPH M



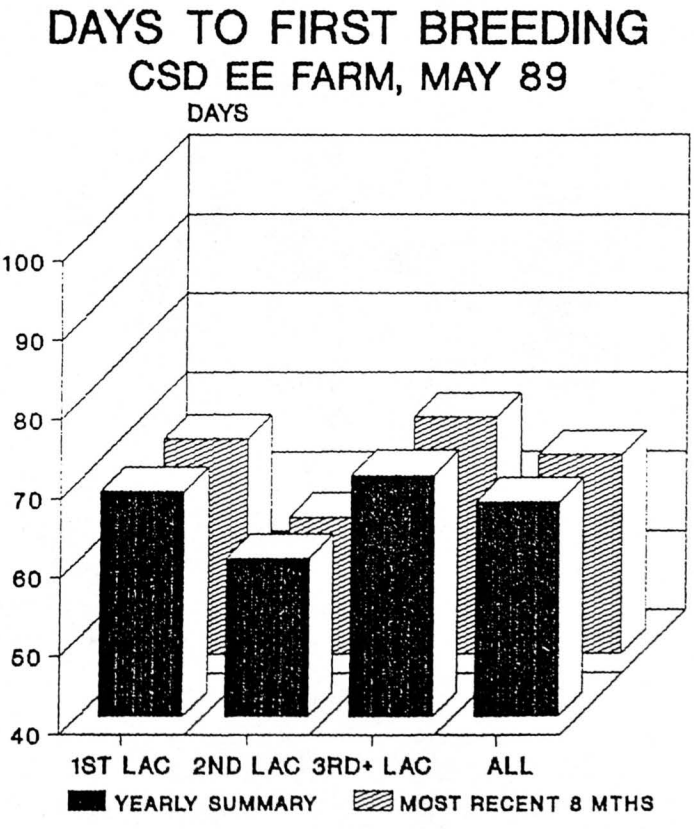
Problem Definition and Recommendations

1. The waiting period is too short. Change this from 45 to 60 days.
2. Heat detection is okay. No change necessary.
3. Conception rate is too low on first service.
   a. Waiting longer to breed cows the first time will help this.

GRAPH N



GRAPH O



b. Increased energy density has helped, we need more.

4. Improve dry cow ration so that cows are equipped to freshen, milk and breed.

Conclusion: EE Farm

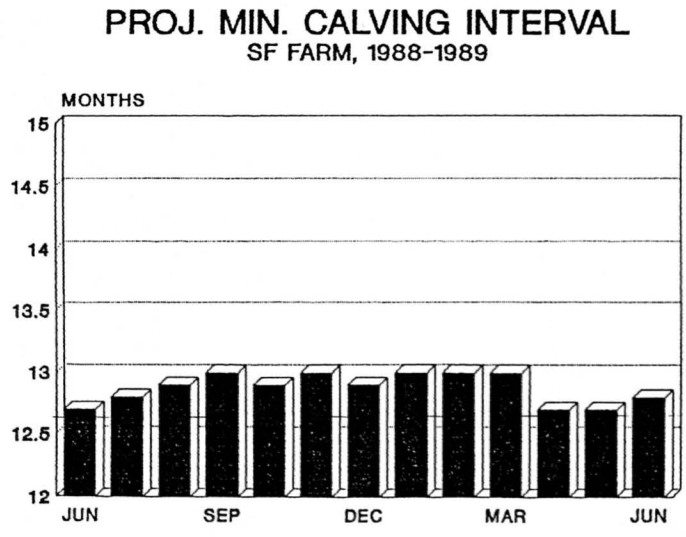
The jury is still out on this dairyman. Will he decide to manage energy in the long-term for payback in improved reproduction and production? Will he heed the writing on the wall, writing supported in facts collected solely, specifically in his dairy? Time and the dairyman will decide these answers. . . .

SF Farms—Example Herd III

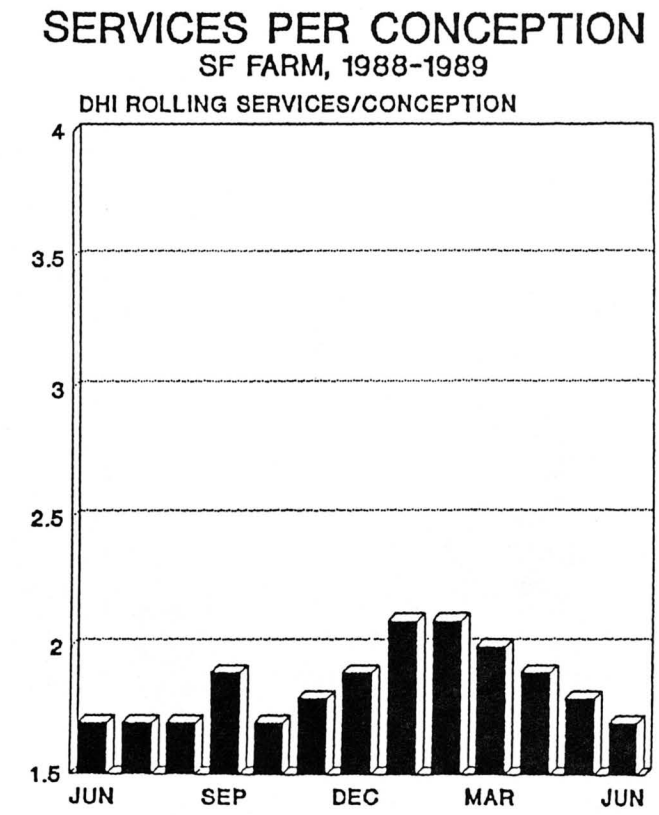
SF Farms basic information as of August, 1989 shows 105 cows on 2x milking. Rolling herd average is 21,100 lbs of milk with 3.6 % fat test. Currently averaging 70 lbs of milk produced per cow per day, the calving interval is 12.7 months. Does this herd have a reproductive problem? We need more information.

Voluntary waiting period is 60 days. Heat detection rate is 65%. Services per conception on DHI are currently 1.6. The projected minimal calving interval can be seen for the last year in Graph P. Services per conception have varied between 1.7 and 2.2 as seen in Graph Q. The current sample day analysis comparing first and second service conception rates by yearly summary and most recent eight months are shown in Graphs R and S. Notice that conception rate has improved significantly in all lactations on first service. Second service conception rate has improved drastically in the adult cow category. Graph T shows that days to first breeding is managed very consistently in this herd, but in the last eight months we have been waiting longer to breed first calf heifers the initial time.

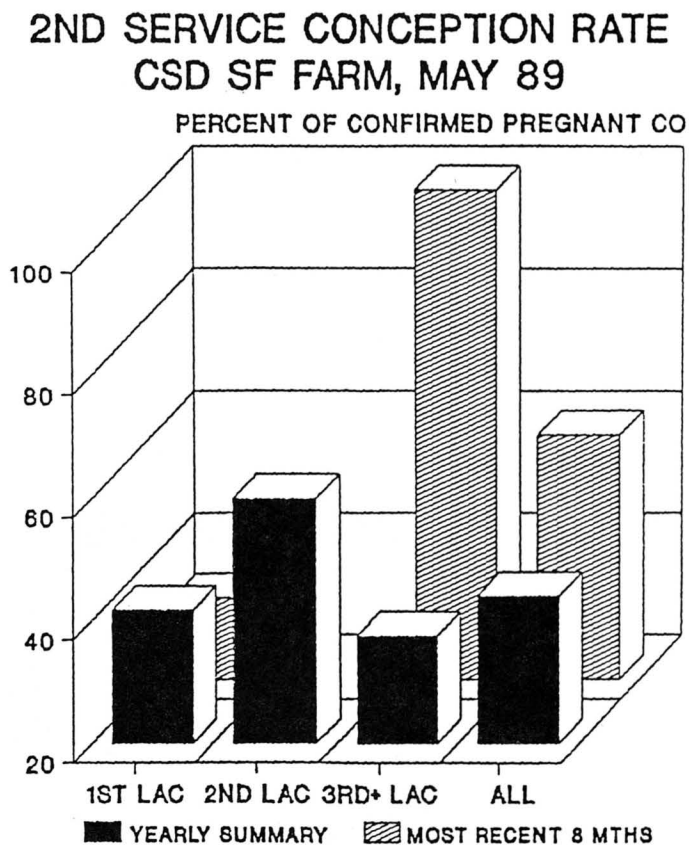
GRAPH P



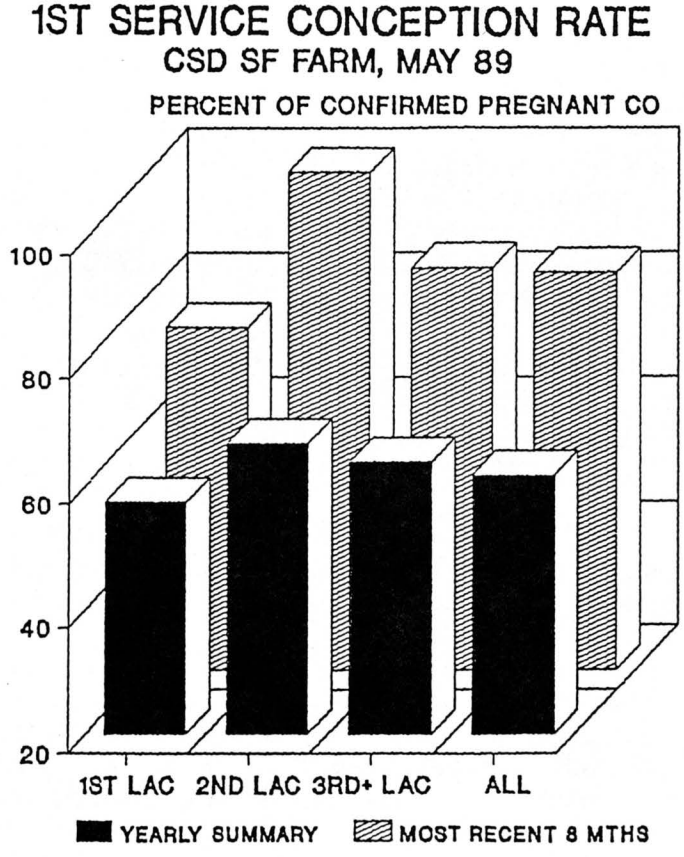
GRAPH Q



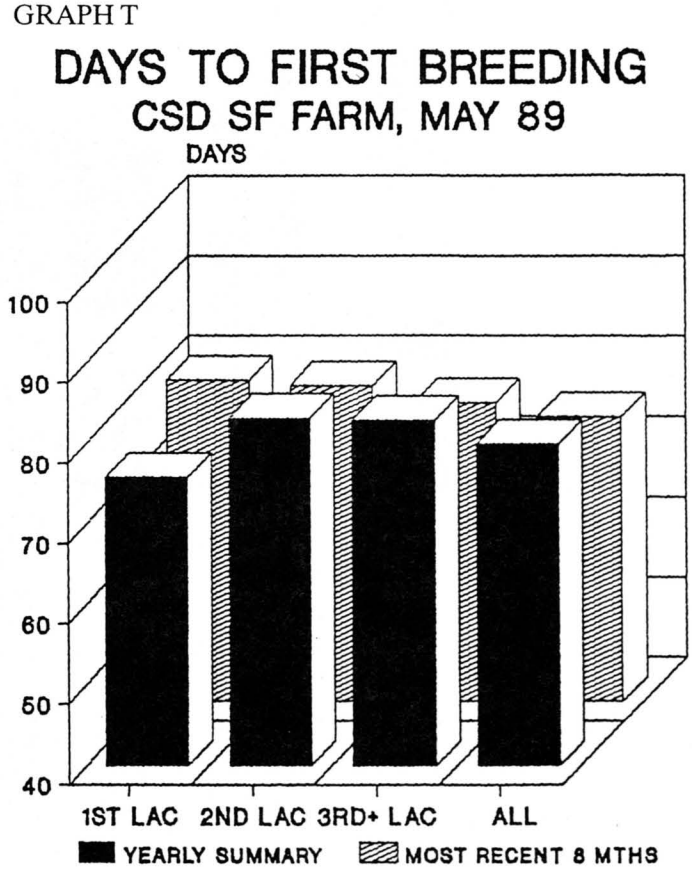
GRAPH S



GRAPH R



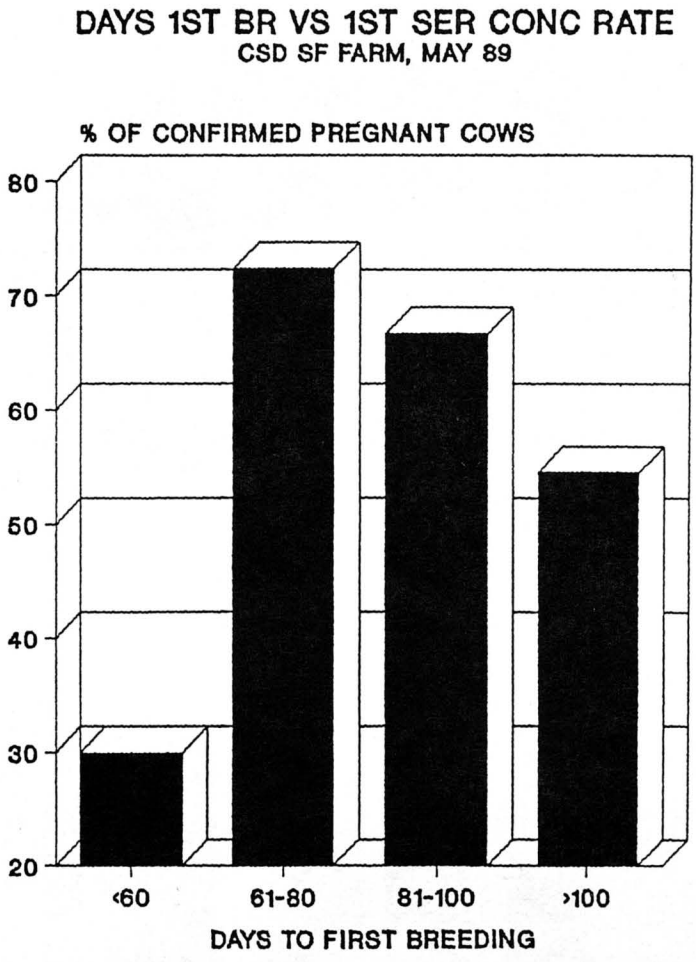
GRAPH T



Graph U shows the first service conception rate broken down by days to first breeding. Notice that there is a severe problem in that cows being bred under 60 days have a less than 30% conception rate on first service. Fortunately, this represents three cows in this 105 cow herd.

Graph U illustrates the conception rate graph that we track monthly in this herd. Notice that the yearly first service and second service conception rates have been tracking very close together up until March where a separating trend was started and subsequently established. You can see that of the cows confirmed pregnant in the last six months, the overall conception rate has been above 55%. Does this dairy have a reproduction problem?

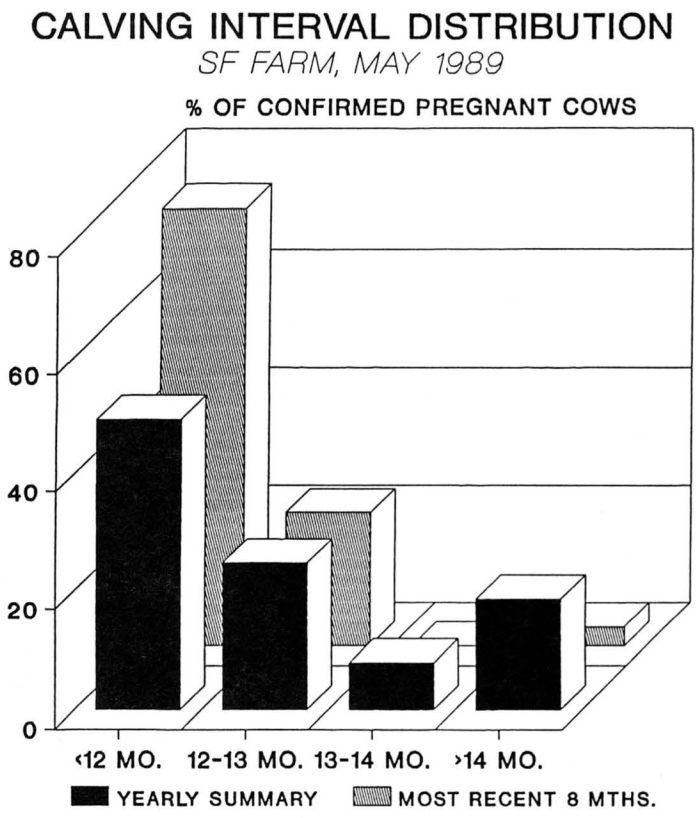
GRAPH U



SF Farm Reproduction Problem Definition

Is the waiting period too short? We decided that it was because of the evidence presented in Graph V. Note that nearly three-quarters of this herd is bred back to freshen under 12 months with the current breeding management. It is our belief that the monitoring tools are in place such

GRAPH V



that if breeding cows slightly later causes problems, we will know about it before economic consequences are significant.

This herd illustrates the fact that we can "have our cake and eat it too" when it comes to reproductive efficiencies in high producing herds. **Cows are wonderful biological factories that will perform in the tank and in sex if they are provided with sufficient raw materials to do the job.** In November of 1987 we added cottonseed to this TMR of haylage, corn silage, high moisture corn, and protein supplement. In July of 1988 we added Booster Fat (5). Booster Fat costs $.48 per pound. These dairymen are not afraid to spend money on necessary input materials when the graphic records signal that something is needed. We added Booster Fat to assist in adequately managing energy status in this high producing herd. Graphs W and X show three year graphs from the DPC AIM 7 Graphing software program (2) which illustrate the tremendous increase in production per cow plus a decrease in services per conception.

Records facts do provide the basis for professional advice that is tailored to a specific dairy with their unique management conditions in such a manner that *we can plan on reproductive success* (Figure 12). There is money in reproductive success for both the veterinarian and the dairyman.

GRAPH W

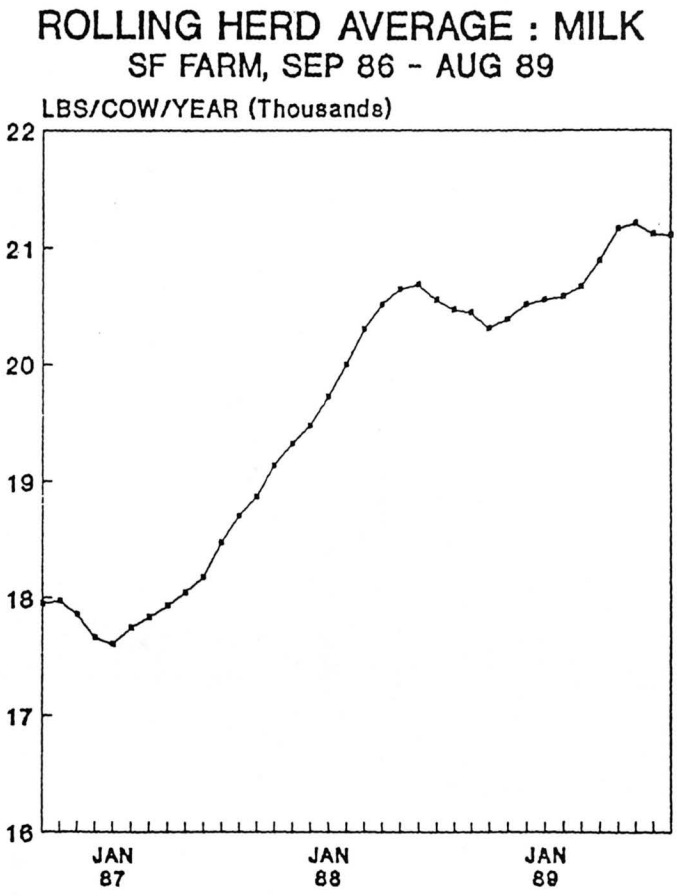


FIGURE 12

GRAPH X

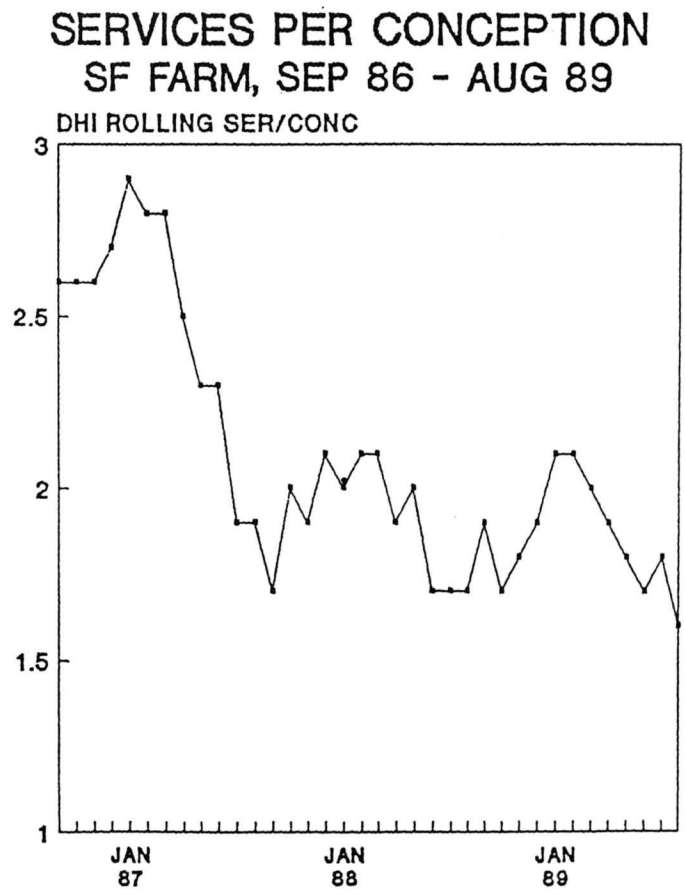
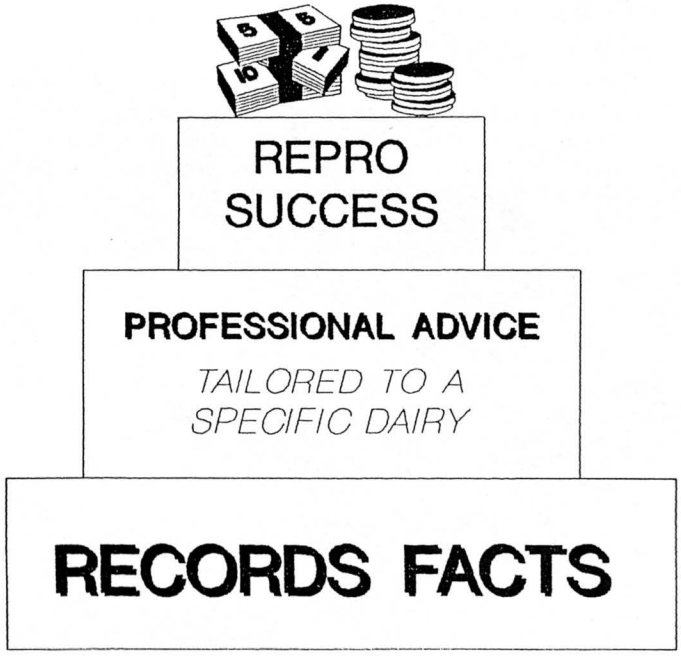
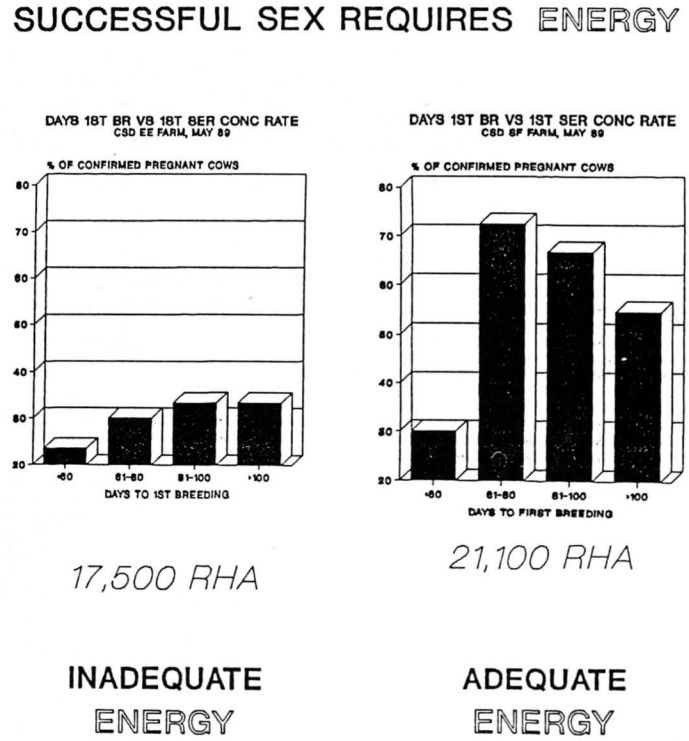


FIGURE 13





Conclusion

Successful Sex Requires Energy

Figure 13 captures the days to first breeding vs first service conception rate graphs for EE Farm and SF Farm in May of 1989.

EE Farm has inadequate energy management, a 17,500 lb rolling herd average, has normal appearing calving interval, services per conception and days open. The reproductive problem at EE Farm is severe, with a conception problem and reproductive culls that are 3 to 4 times the normal level.

SF Farm, meanwhile, with a 21,100 lb 2x rolling herd average has adequate energy management and reproduction that will top the list anywhere.

Energy is the foundation layer for the reproduction and milk production management cake (Figure 14). We can enjoy the candles on top of the cake if we remember that *successful sex requires energy.* Successful management of energy helps ensure excellent reproductive performance. *Excellent reproduction guarantees the best chance at production success* (Figure 15). The money is at the top of the cake, because, ... to quote one of my philosophical clients, "*they don't milk good 'til they freshen!*"

FIGURE 14

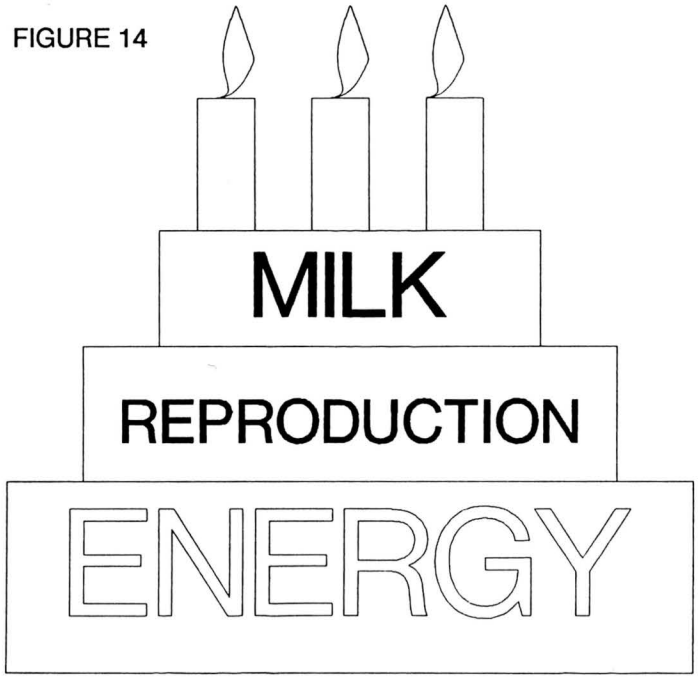


FIGURE 15

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1. Ferguson, J., Interactions between milk yield and reproduction in dairy cows. Monsanto Technical Symposium proceedings, October, 1989. 2. Dairy Production Consultants: T.J. Cannon, A.J. Nelson, and H.W. Redlus. 620 West Hill Road R D 4, Cortland, NY, 13045. 3. Bath, D. Advanced Nutrition Seminar, 1987 AABP Annual Meeting. 4. Howard W. Redlus, DVM. Production Oriented Management Services, Tulip Tree Drive, Burlington, New Jersey, 08016. 5. Balanced Energy Company. P.O. Box 946, Clinton, Iowa, 52732.