BREEDING HEIFERS AT ONE YEAR OF AGE: BIOLOGICAL AND ECONOMIC CONSIDERATIONS[1]

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INTRODUCTION

Heifers raised in a cow-calf operation are selected for breeding to be used as replacements for females culled from the herd, to expand the herd or to be sold as pregnant heifers. The age to breed these heifers is an important decision for beef cattle producers. Historically, heifers were first bred at 2 yr of age, but as beef production systems have become more intensive over the last few decades, more and more producers have bred their heifers as yearlings to calve first at 2 yr of age. This shift towards earlier breeding has become the normal management system in some regions of the United States and the world as economic and management pressures have increased. However, producers in some regions that have predominately slow-maturing breeds, less intensive management systems or limited quality and(or) quantity of forages still generally breed their heifers at 2 yr of age.

Limited data are available, but indications are that beef cattle producers in the Central and Northern U. S. predominately breed their heifers as yearlings (Roger Brownson, beef cattle extension specialist, Montana State University; Larry Corah, beef cattle extension specialist, Kansas State University, personal communications). These extension specialists estimate that in their regions over 95% of heifers are bred as yearlings with the other 5% being heifers intentionally carried over to be bred first as 2-yr-olds. In a few instances heifers that were bred as yearlings but did not become pregnant are saved over to be rebred as long yearlings or as 2-yr-olds.

Producers in the southeastern and southwestern states breed a lower percentage of their heifers as yearlings than in other parts of the United States. Recent surveys in Florida (Table 1, Robert Sand, beef cattle extension specialist, University of Florida, personal communication) showed that an average of less than 50% of the producers calve their heifers as 2-yr-olds. The majority of producers calved heifers at 3 yr of age except in the North Central Region where 28% of the producers calved heifers at 2.5 yr.

In Texas an estimated 65% of heifers are bred as yearlings (Larry Boleman, beef cattle extension specialist, Texas A&M University, personal communication), and if heifers are not bred as yearlings, then most would be bred at 18 mo for fall calving. However, some heifers are intentionally held over to be bred for the first time at 2 yr of age. A common problem with intentional 3 yr-old first calving is keeping heifers away from bulls to delay breeding until their second year.

These regional management differences are primarily related to limited availability of forage on desert ranges, poor quality of forages in subtropical areas and higher proportions of the

cattle being slower-maturing crossbred or purebred Bos indicus breeds.

The purpose of this paper is to review the biological and economic factors to be considered when deciding the age at which to breed heifers.

FACTORS AFFECTING DECISION FOR AGE AT FIRST BREEDING

A management decision such as age at first breeding is complicated because it involves many factors. The decisions are complicated not simply because there are many factors to be considered but also because there are interactions among the factors. When both biological and economic outcomes are considered, decisions often produce results which are in part advantageous and in part disadvantageous. As examples the following generalizations are offered.

A. As value of output (calves) increases, cost of capital (interest rates) increases and(or) cost of inputs (land, labor, feed and equipment) decrease, advantages of breeding to calve at a younger age become more important relative to disadvantages. Advantages are:

1. Shorter interval to a return on investment.
2. Increased lifetime production of each cow.
3. Increased output per year on a herd or average cow basis.
4. Less demand for pasture space for yearling heifers to separate them from the cow herd during the breeding season.

B. Conversely, as value of output and cost of capital decrease, and cost of inputs increase, disadvantages of breeding heifers to calve at a younger age become more important relative to advantages. Disadvantages include:

1. Increased costs associated with breeding heifers at younger ages.
2. Increased calf losses due to dystocia (calving difficulty) and related problems including the necessary management inputs for dealing with dystocia.
3. Lower rebreeding rates for first-calf 2-yr-olds as compared to older ages.
4. Fewer and smaller calves weaned from 2-yr-old dams.

The factors involved in the decision on whether or not to breed heifers as yearlings are both biological and economic, and it must be realized that maximizing biological efficiency most likely will not result in maximizing economic efficiency. A discussion of the biological factors is presented here only in relationship to the effects they have on the decision regarding age at which to breed heifers. They are covered individually in more detail in other presentations of this conference.

BIOLOGICAL FACTORS

1. **Age at Puberty.** Heifers should reach puberty from 1 to 3 mo before the average age that heifers are to be bred. For example, in order for heifers to be bred as yearlings and to calve at 2 yr of age, they should have reached puberty by 12 to 14 mo of age. This slightly earlier age for puberty in relation to breeding is to ensure that a high percentage of heifers are cycling and that the effects of lowered potential fertility at the puberal estrus (Byerley et al., 1987) are minimized. It is important that heifers become pregnant early in the breeding season because earlier bred heifers will have a higher lifetime production potential (Lesmeister et al., 1973).

Age at puberty is primarily a function of the genetic makeup of the heifer and the feed level or rate of gain during the weaning to prebreeding period.

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Breed differences, sire and dam effects within a breed, as well as heterosis contribute to the genetic control of age at puberty (Wiltbank et al., 1966; Cundiff et al., 1986). Within a breed, sire is more important than dam because of the larger number of progeny produced by a sire in a given year. In general, dairy breeds are the youngest at puberty, Bos indicus breeds are the oldest and British and Continental beef breeds (Bos taurus) are intermediate in age at puberty. There are large variations both within and between these breeds. Age at puberty can be decreased by selecting a breed with a younger age at puberty, selecting within a breed for younger age at puberty or crossbreeding with another breed that has a similar or younger age at puberty.

Postweaning growth rate can have marked effects on age at puberty, within the genetic limits of the herd. Higher rates of gain induced by higher feed levels result in younger ages at puberty and higher weights at puberty (Short and Bellows, 1971). Body weight is a useful monitor for predicting when heifers will reach puberty, and feeding to a target weight for a given genotype is a practical management tool to insure high potential fertility. However, from a biological point of view we must be aware that age at puberty is not determined by weight but by some set of physiological conditions that also result in a given weight (Greer et al., 1983).

When a particular breeding age is being considered, make sure that the genetic composition of the herd will have a young enough age at puberty to allow breeding at that age. If it is determined that the genetic composition of the herd would not allow advancing to breeding at an earlier age, then consider different breeds, breed crosses or sire lines. When the genetic composition of the herd is set, then determine the target weight necessary before breeding to give a high proportion cycling and then manage grazing and feeding to obtain the necessary gains to reach that target weight.

2. **Dystocia**. The significance of dystocia or calving difficulty becomes more important as age at first calving decreases. The major cause of dystocia is a disproportion in size between birth weight of the calf and pelvic area of the dam. The major consequences of dystocia are higher death losses and lower reproductive potential the next year. Precalving nutrition levels of the dam have only small effects on dystocia, and any attempts to reduce dystocia through nutrition will usually result in lower reproductive efficiency the next year. Bos indicus and Jersey dams have a unique ability to lower birth weight and incidence of dystocia. Hormonal relationships before and at calving are different in heifers with dystocia than those without. A major problem in dealing with dystocia is that less than 50% of the variation in incidence of dystocia has been related to specific independent variables such as birth weight and pelvic area. The best approach to minimizing the effects of dystocia is to select sires that will give a low birth weight to pelvic area ratio, grow out heifers so body size is not limiting and manage heifers separately before and during calving so that appropriate assistance and management can be provided (Anthony et al., 1986; Bellows et al., 1971, 1982; Brinks et al., 1973; Cundiff et al., 1986; Laster et al., 1973; Short et al., 1979).

3. **Postpartum anestrus and milk production**. A heifer calving at 2 yr of age is only about 80% of her mature weight and will continue to partition nutrients into growth. This partitioning of nutrients into growth creates a competition for nutrients available for lactation and reproduction. Consequently, 2-yr-old heifers wean lighter calves (80% of weaning weights of mature cows), have longer intervals from calving to first estrus and have lower pregnancy rates their second year (Bellows et al., 1982; Laster et al., 1973). These problems can be partially solved by careful attention to management, but if they are

not addressed, they can have a significant impact on the success of a production system.

RESULTS FROM BIOLOGICAL EXPERIMENTS

The question, "At what age should heifers be bred?" has been around for several decades. Some good work was reported earlier, but there has been relatively little recent research on this question, especially research that would include extensive production systems with limited feed resources and a breeding program that would involve continental and Bos indicus breeds. These breeds would have the potential for a much higher incidence of dystocia and(or) later puberty. This type of research is expensive and often considered too practical to devote the necessary resources.

Morris (1980) thoroughly reviewed worldwide literature, and from experiments specifically designed to test effects of age at first breeding, concluded that lifetime production would be increased by about .7 calves by breeding heifers as yearlings rather than as 2-yr-olds. Several references cited by Morris (1980) as well as others are relevant and will be discussed.

One of the first studies comparing age at first breeding was reported by Pinney et al. (1972) from research conducted in Oklahoma. In 1948 they started 90 Hereford heifers on a study to determine the effects of breeding first at either 1 or 2 yr of age. Each breeding age group was split three ways and wintered on a low, medium or high winter protein supplement. Weaning weights of calves from heifers bred first as yearlings were lighter, but in later years, there were no effects of age at first breeding. Percent calf crop weaned over the lifetime of the study was not affected by age at breeding or feed level. This should result in increased lifetime production for yearling bred heifers. However, longevity was lower in the yearling bred heifers on the high winter supplement. This study reported a nonsignificant increase in lifetime calf production (340 lb) over

all three feed levels by breeding as yearlings, but the response depended on feed level with cows bred as yearlings and on the high winter supplement group actually weaning fewer total pounds of calf over their lifetime. This result seems contradictory to our knowledge of nutritional effects on reproduction. The main reasons for actual culling, which decreased longevity, seemed unrelated to reproduction.

Parker et al. (1974) also used Hereford heifers to study the effects of age at first breeding and winter supplement on calf production. Their study was conducted in a semiarid region of southern New Mexico. They reported an increase in pounds of calf weaned over the 4 yr of the study in the yearling bred heifers, and this increase was largest for the high winter supplement group. Winter supplement level had no effect on production in the heifers bred at 2 yr of age. Culling rates were higher for the yearling bred heifers. They concluded that productivity could be increased by breeding as yearlings but questioned whether the increased feed resources necessary to maximize the response were justified.

A long term study in New Zealand was reported by Carter and Cox (1973) in which Hereford and Angus cattle were switched from first breeding at 2 yr of age to breeding heifers as yearlings. In the year the switch was made, there was a direct comparison on the effects of age at first breeding at two of the four locations in the study. They concluded that in both locations, breeding as yearlings achieved the highest lifetime performance, but the best response was when heifers were over 500 lb before breeding started, especially at the one location where productivity was lower. It should be noted that the relatively small prebreeding weight for these heifers was consistent with the relatively small mature weight of the cows.

A similar situation as that reported by the New Zealand workers existed in a crossbreeding study conducted at Ft. Robinson, Nebraska, with Angus,

Hereford and Shorthorn cattle. During this study management of heifers changed from first breeding at 2 yr of age to breeding as yearlings, so in 1 yr there was a direct comparison of age at first breeding. Cundiff et al. (1973) reported the first five year's reproduction data, and then a subsequent report by Nunez-Dominquez et al. (1985) covered total lifetime production and an economic evaluation. In their original analysis, where production was measured up to 5 yr of age, they concluded that 2-yr-old first calving is favored because of the increased calf weaning weight available the first year with little effects in subsequent years. The more recent analysis that included production up through 12 yr of age basically arrived at the same conclusion concerning lifetime production. However, they questioned whether heifers bred as yearlings should be culled if open the next year provided they had been pregnant their first year. Lifetime production was not as relevant as annual production especially on an economic basis. On an annual basis the first calf of a 2-yr-old was lighter, but no differences were observed in subsequent years. Their economic analysis revealed that 2-yr-old first calving was more profitable by over $2000 annually on a 100 cow herd basis for either their actual culling method or what they called an imposed or alternative culling method. The main benefit was a lower cost for heifers. This conclusion, as they point out, is only valid to the extent that their economic assumptions remain valid.

Shorthorn cattle were used in a Canadian experiment reported by Bernard et al. (1973) and Herefords in an experiment conducted in Mississippi and reported by Chapman et al. (1978). Both of these studies compared the production potential of heifers bred first as yearlings vs 2-yr-olds, and each study included a nutritional variable. Results from these studies were consistent with previous conclusions that production potential was increased, that 2-yr-old

first breeding did not catch up even by 8 yr of age and that calving first at 2 yr of age was a satisfactory practice.

The studies reviewed up to this point have only considered calving at either 2 or 3 yr of age. These are the only options if once-a-year calving is practiced with a relatively short breeding season (< 90 d). If twice a year calving is an alternative or breeding seasons are relatively long (5 to 6 mo), then it would be possible to breed heifers at an intermediate age. Heifers born in one season would be bred in the alternate season as long yearlings and would calve at about 30 mo of age. Only a few studies have considered such an option.

Lusby et al. (1979) and Goodrich et al. (1985) considered the alternatives of breeding heifers to calve first at 24 or 30 mo in two separate experiments conducted in Oklahoma. The first of these studies was conducted in North Central Oklahoma with Hereford heifers. In this study (Lusby et al., 1979) they found that the older heifers were larger at calving, had higher conception rates in both their first and second years, had earlier breeding dates and weaned heavier calves. The second Oklahoma study (Goodrich et al., 1985) was conducted at the Ft. Reno experiment station in Central Oklahoma, again with Hereford heifers. The heifers to be bred to calve at 24 mo were wintered on a high feed level whereas the heifers to calve at 30 mo were wintered on a moderate or low level. They concluded that if heifers are wintered at an adequate level, then there is no reduction in conception rate at first or second breeding for heifers bred to calve at 24 vs 30 mo. Heifers calving at 30 mo did have an advantage over the 24 mo calvers in calving difficulty, weaning weight of their calves and amount of supplemental feed.

All of the above studies used only English breeds of cattle and compared only two potential first calving ages. The last study to be reviewed is unusual because it includes all three mentioned

calving ages (24, 30 and 36 mo), it had a wider sampling of genotypes and it was conducted in a subtropical environment near Baton Rouge, Louisiana. This study was recently reported by DeRouen and Franke (1989). Heifers were managed to calve first at either 24, 30 or 36 mo of age. Performance of heifers was compared among straightbred Angus, Hereford, Charolais and Brahman breeds and their 2-, 3- and 4-way crosses. Bos taurus breeds and their crosses performed about equally in terms of calving rate and calving date regardless of age at calving. Brahman heifers had much lower calving rates and a later calving date with the difference being caused by lower reproductive potential at 24 and 30 mo. Mating Brahmans to Bos taurus breeds removed much of the depression in reproductive potential, but even without crossbreeding, reproduction in the straightbred Brahmans was high enough to be able to select for early maturity. The genetic aspects of reproduction are covered in other reports. Prebreeding weight of heifers was an important criterion in determining reproductive potential at all ages, and age at breeding was also important in 2-yr-old calving.

The results of these experiments leave little doubt that calving at 24 mo is biologically more efficient compared to calving at 36 mo. There is little evidence in favor of calving at 30 mo, especially when the management difficulties of a 30 mo system are considered. Research with 30 mo calving has looked only at using spring-born heifers bred to calve in the fall. What happens if fall-born heifers are bred to calf in the spring? Most difficulties encountered with 24 mo calving can be corrected by adjusting the breeding program by crossbreeding and(or) selection and improving nutrition. However, as we will see below, there is much more to this question than, "Can it be done?" Much of the research reviewed above has been done under fairly good conditions compared with what might be seen in some of our beef producing regions.

ECONOMIC FACTORS

The answer to the question, "At what age should heifers be bred?" cannot be arrived at by considering only what will happen to output. Changing age at first breeding to a younger age than is now practiced will involve increased expenditures, and the amount of the increase will depend on the structure of the individual enterprise. Age at puberty may have to be decreased by increasing the forage and feed inputs and(or) changing the genetic composition of the herd. The potential increased incidence of dystocia for heifers calved at younger ages will need to be addressed by increased labor for surveillance and assistance as well as the need for increased feed and management resources necessary after calving. The cost of these changes will have to be determined for each enterprise and that cost balanced against any potential increase in value of output.

Biologists and economists argue whether bigger calves and more calves is best management strategy (maximum vs optimum). If only biology is considered, then we would make our decision based on the concepts illustrated in Figure 1. In Figure 1 the relationship between age at first breeding and biological efficiency is shown. In this illustration biological efficiency is measured by the pounds of calf that are weaned by the average female that was bred in that herd. This measure of efficiency considers the losses due to females not becoming pregnant, any losses between conception and weaning, and factors which would affect the size of the calf at weaning. In general, as age at first breeding decreases, biological efficiency increases. Of course that only works until some biological limit is reached, after which it would be anticipated that biological efficiency would start to decrease because of high death losses of both dams and calves as size of the dam at calving becomes very small. Very little data is available on what outcomes would be observed when breeding at ages less than 15 mo.

Also illustrated in Figure 1 is the effect that potential age at puberty and replacement rate for heifers in the herd will have on this relationship. If age at puberty is limiting, then it is more difficult to increase biological efficiency by decreasing age at first breeding. For example, if the management and genetic composition of a given herd is such that heifers don't generally reach puberty until 24 mo, then very little is gained by breeding before that age. On the other hand, if heifers can reach puberty at 12 mo, then large increases in biological efficiency can be realized by decreasing age at first breeding. The magnitude of this increase will be affected by the replacement or culling rate in the herd. The higher the replacement rate, the greater is the effect of decreasing age at first breeding.

A very important point should be made concerning the effects of culling rate as illustrated in Figure 1. High culling rates appear to have adverse effects on biological efficiency. Such is not the actual case because this illustration considers only calves that are marketed, when in reality both calves and cull cows are marketed. Higher culling rates may decrease total pounds of calf sales, but beef marketed as cull cows will markedly increase because of the larger number of cows sold and because a culled cow is replaced by a smaller heifer which is still growing. Optimum culling rate is not the topic of this paper, but that decision will have a bearing on the outcome of the decision regarding age at first breeding.

The best approach to any management decision is to include both biological and economic considerations. That approach is illustrated in Figure 2. In Figure 2 the relationship between age at first breeding and economic efficiency is illustrated for three hypothetical enterprises (A, B and C). Here we see that profit profiles differ markedly from biological profiles and that optimum age to breed heifers will vary according to the characteristics of given enterprises. When costs involved with manipulating biology within a given enterprise are considered, the rank ordering of alternatives can differ quite markedly. Enterprises in which overhead costs are high can more readily afford increased inputs, especially if those inputs are relatively inexpensive in relationship to outputs (i.e., enterprise A). On the other hand, other enterprises may operate more extensively with low overhead, and their cost of inputs to increase outputs is high relative to value of output (i.e., enterprise C).

To understand the complexity of the complete biological and economic system, it is often useful to construct a simple model. The first step is to construct a model which describes the system output, which in this case would be calves weaned from a cow herd. Figure 3 shows the three basic points in a reproductive cycle that determine production output. These points are whether a bred female is pregnant or open, whether that pregnancy will result in the birth of a live calf and whether a live calf at birth will still be alive at weaning. This cycle is repeated for each subsequent age until the animal is culled. This model describes the number of calves that are produced in a herd.

Now let's take this simple model and expand it to include components describing size of calf (weaning weight) and value of weaned calves as well as putting a probability value on the respective outcomes at each of the three points in the reproductive cycle. Let's also put the model in a mathematical form so we can use it to calculate results for evaluation. The model is:

Eq. 1: INCOME FROM CALVES (\$) =
$$\sum [(PC_i \times PCB_i \times PCW_i)n \times WWt_i]V_i$$

where,

i = age of dam at calving for a complete reproductive cycle (i.e., i = 24 mo, 36 mo, etc.)

PC = probability of conception and pregnancy

PCB = probability of a live calf born

PCW = probability of a live calf at weaning

n = number of females (heifers and(or) cows) bred

WWt = average unadjusted weaning weight of calves

V = value of a calf at weaning on a per pound basis (i.e., $.90/lb.)

Now let's use Equation 1 to calculate income for an enterprise where the current practice is to calve first at 36 mo and compare it to income for a proposed alternative to calve first at 24 mo. In this comparison we will assume that production after 3 yr of age is the same for both alternatives since Pinney et al. (1972) and Nunez-Dominquez et al. (1985) found very little difference in production after that age. Therefore, we are only considering the production from heifers rather than the whole herd as shown in Figures 1 and 2. We will further assume that there are no differences in cost of production for the two alternatives and that there are no loses due to death or culling between 2 and 3 yr-of-age. The only difference is that in one case heifers are bred at 15 mo to calve first at 24 mo and in the other case the heifers are bred at 27 mo to calve first at 36 mo. In each case there will be 50 heifers and the value of calves at weaning for all calves will be $.90/lb. The remaining variables are as shown in each alternative.

Example 1.

A. Income when heifers first calved at 36 mo.

Income = [(.90 x .95 x .98)50 x 500]$.90
     = $18852.75

B. Income when heifers first calved at 24 mo.

$ for yr 1 = [(.20 x .80 x .95)50 x 400]$.90
       = $ 2736.00
$ for yr 2 = [(.80 x .95 x .98)50 x 500]$.90
       = $16758.00

Income = $19494.00

In Example 1 we can see there was very little increase in total income by calving first at 24 mo because: 1) very few were expected to become pregnant due to age at puberty 20%), 2) calf survival at birth (80%) and weaning (95%) was somewhat less for the 2- yr-olds, and 3) when they were rebred the ones that had calves had a lower pregnancy rate, bringing down the average to 80%. This example might be somewhat similar to that depicted by Enterprise C in Figure 2.

Now let's add another dimension to the model and assume the costs of production for the two alternatives are not the same. Realistically, if someone were interested in breeding heifers to calve first at 24 mo to increase production, there would be a good possibility that there would be a commitment to change management and inputs to increase the likelihood of success. The model now expands to include increased costs of inputs to give a net income.

Eq. 2: Net income = Income from calves -
       Cost of production

When Equation 2 is used in the following examples, the costs of production will be only those associated with increasing productivity of

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the heifers bred to calve at 2 yr of age. All other costs will be assumed to be the same. The increased costs will mainly fall into the following categories.

1. Increased feed inputs to grow out heifers the first year to lower age at puberty.
2. Increased labor and facility inputs at calving to decrease calf and dam losses associated with calving difficulty.
3. Increased feed and management inputs for first calf 2-yr-olds to manage them as a separate herd so that conception rates the second year are not lowered.

To construct Example 2, let's use the data from Example 1 but increase inputs. The production system is still similar to that of Enterprise C in Figure 2. There is no real estate or operating capital debt, they produce most of their forage base whether it is grazed or harvested, grazed forage is often of low quality and quantity, they buy very little supplemental feeds, calving facilities and labor are very minimal and the breeding of their herd is such that the cattle are slow- maturing, disease and heat tolerant and have minimal calving difficulty problems.

Example 2.

A. Income from heifers first calved at 36 mo would be as shown in Example 1A and there were no increased costs so:

Net income = 18,852.75 - 0.00 = $18,852.75

B. Income from heifers first calved at 24 mo changes to:

$ for yr 1 = [(.50 x .90 x .95)50 x 400]$.90 = $7,695.00
$ for yr 2 = [(.90 x .95 x .98)50 x 500]$.90 = $18,852.75

Total income from calves = $26,547.75

Increased costs of production (includes costs on a herd basis).

1. Labor (mainly a night calver for 60 d) = $2,400
2. Purchased feed (for increasing rate of gain on heifers the first winter and supplementing the first calf 2-yr-olds) = $7,500
3. Capital costs (depreciation on a calving facility and interest on borrowed money) = $1,000

Total production costs = $10,900

Net income = 265,47.75 - 10,900.00 = $15,647.75

The main problem with the enterprise in Example 2 was that even after spending all that money, the first year pregnancy rate was only 50%. In this case there certainly was no advantage to breeding at the earlier age.

The answers can be much different if we change the structure of the enterprise in Example 3 so that it corresponds to Enterprise B of Figure 2. In this situation they have borrowed capital for both the ranch and operations, availability of forage is not a problem, adequate facilities are available for managing calving difficulty, existing labor can be reshuffled to cover extra calving duties, the breeding of the herd is such that age at puberty can be manipulated quite easily with supplemental feeds and a cheap source of supplemental feed is available.

Example 3.

A. Income from heifers first calved at 36 mo would still be shown as in Example 1A so:

Net income = $18,852.75

B. Income from heifers first calved at 24 mo changes to:

$ for yr 1 = [(.80 x .90 x .95)50 x 400]$.90 = $12,312.00
$ for yr 2 = from 2B = $18,852.75

Total income = $31,164.75

Increased costs of production.
   1. Feed costs (heifers respond more readily so less is needed) = $5,000
   2. Increased capital costs = $ 500

Total production costs = $5,500

Net income = 31,164.75 - 5,500
           = $25,664.75

We can see in this example that considerable profits result from changing the management strategy to breeding for 2-yr-old first calving.

The results of applying this process to other real or hypothetical situations will give different results depending on the unique set of circumstances that exist for a given alternative within an enterprise. The concepts presented here for applying models which consider both biological and economic factors of the problem should be useful for answering the question, "At what age should heifers be bred?" for a given enterprise. Be aware that not all variables that affect the decision can be covered in a short presentation such as this. Care must be taken not to overlook other factors such as taxes, varying calf prices by size or breeding, etc. Another relevant question recently discussed by Gutierrez et al. (1989) is whether heifers should be raised or purchased.

SUMMARY

The age at which to breed heifers is an important management decision for producers. Production systems in some regions of the United States and the world have gradually changed over the last few decades from calving first at 3 yr of age to calving first at 2 yr of age. These regions have mainly early-maturing cattle and relatively inexpensive feed resources that are not severely limiting. Also, capital investments are relatively high with an intensive management system. In other regions the majority of heifers are still bred to calve at 3 yr of age because the cattle are slower maturing, feed resources are somewhat limiting in either quantity or quality and the operations tend to be extensively managed. The main advantages to earlier breeding and calving are primarily economic while the disadvantages and limitations are primarily biological. The main problems with younger ages at calving involve late maturity (age at puberty) that limit potential for breeding at younger ages, a higher incidence of calving difficulty with its associated problems and a potential for lower rebreeding rates for heifers calving at 2 yr of age. The answer to the question, "At what age should heifers be bred?" is not easy to answer and will vary according to the unique set of circumstances for any given production enterprise. The factors to consider in this decision have been reviewed as well as a possible mechanism for combining biological and economic characteristics so that the management alternative selected will result in the desired outcome.

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Table 1. Survey Results from Florida on age of first breeding for beef heifers[1]				
Region of Florida	No. of producers	% Calving heifers at:		
		2 yr	3 yr	Other
Panhandle	174	62	25	13
North Central	86	39	1	61[2]
Central	244	39	45	16
South	251	49	46	5

[1] Source: Dr. Robert Sand, Beef Cattle Extension Specialist, University of Florida, personal communication

[2] Twenty-eight percent of producers in this region calved their heifers at 30 mo of age.

Figure 1. Effect of age at first breeding on biological efficiency as measured by pounds of calf weaned per female in the breeding herd. Replacement rate and age at puberty are shown as variables which affect this relationship.

Figure 2. Effect of age at first breeding on economic efficiency in three different ranch enterprises (A, B, and C).

Figure 3. A model to describe the reproductive cycles to produce weaned calves over the lifetime of a cow.