AN ABSTRACT OF THE THESIS OF

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Abstract approved _____
Frederick J. Smith

This study was designed to test the economic feasibility of estrous synchronization for selected Oregon beef ranches.

Data on livestock production, sales, equipment, and management practices were obtained for selected ranches. These data in conjunction with synchronization data were used in developing partial budgets representing adoption of estrous synchronization. Three synchronization partial budgets (one for each of three assumed synchronized conception rates) were structured for each ranch. These partial budgets revealed that as the SCR (synchronized conception rate) was reduced from 76.5 to 60.75 percent the percentage of ranches having a positive difference (credits minus debits) per cow decreased from 47 to 7. Ranches exhibiting a positive difference resulting from the adoption of estrous

synchronization generally had a lower pre-synchronization conception rate and cow-bull ratio than the ranches exhibiting a negative difference. The per cow cost of adopting estrous synchronization was between $13.30 and $14.52.

The pre-synchronization ranch values of conception rate, weaning weight, cow-bull ratio, and number of cows were regressed (stepwise regression) on the difference per cow associated with the three SCR's. Only conception rate, weaning weight, and cow-bull ratio exhibited a significant effect on the difference per cow. Conception rate and cow-bull ratio parameters were negative, while the weaning weight parameter was positive. Hence, it would be more profitable for ranchers having a low conception rate and cow-bull ratio in conjunction with a high weaning weight to adopt estrous synchronization.

Three prediction equations were derived from the above stepwise regressions. These equations and other equations derived from them can be used by ranchers to estimate their expected per cow profit or loss resulting from the adoption of estrous synchronization.

The ranchers operating under adverse breeding conditions generally had low pre-synchronization conception rate, weaning weight, and cow-bull ratio; however, they benefited from the adoption of estrous synchronization since the low conception rate

and cow-bull ratio effects, which are conducive to adopting estrous synchronization, outweighed the low weaning weight effect, which is not conducive to adopting estrous synchronization. Ranchers operating under favorable breeding conditions generally had a high conception rate, weaning weight, and cow-bull ratio; however, they did not benefit from the adoption of estrous synchronization since the high weaning weight effect, which is conducive to adopting estrous synchronization, was overshadowed by the high conception rate and cow-bull ratio effects, which are not conducive to adopting estrous synchronization. It was concluded that ranchers located in areas of adverse breeding conditions might adopt estrous synchronization as a means to increase ranch profitability. Those ranchers located in areas of favorable breeding conditions should seek other ways to increase ranch profitability.

Results and conclusions should be evaluated in light of the fact that this study considered only the short-run effect of adopting estrous synchronization. Also, no allowance was made for the managerial effect.

Economic Feasibility of Synchronization of Estrus for Selected Beef Cattle Ranches

by

Emit Bernard Deal

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ECONOMIC FEASIBILITY OF SYNCHRONIZATION OF ESTRUS FOR SELECTED BEEF CATTLE RANCHES

I. INTRODUCTION

Cattle production has long been important in the economy of Oregon. In 1967 the total receipts from marketing agricultural products was 524 million dollars (12) of which beef cattle receipts represented 23 percent.

The beef rancher faces a changing scientific and technological environment. This has been especially true in the field of animal breeding where fertility testing of bulls, pregnancy testing of cows, and artificial insemination have been recently developed. This has contributed much to livestock production in Oregon. A more recent development that has special significance to beef cow operations is the synchronization of estrus. A synthetic progesterone hormone administered to the cows suppresses both estrus (heat) and ovulation during the period of its administration. Duration of the treatment approaches the length of the estrous cycle, i.e., 18-24 days. Termination of treatment permits the animals to come into heat as a group (referred to as synchronization of estrus), and to ovulate in conjunction with estrus.

The present study is designed to investigate the economic

feasibility of the synchronization of estrus for selected beef ranches, and should be of benefit to decision makers considering synchronization of estrus as a means to increase ranch profitability. The nature of this study is different from most cost studies in that the technology being analyzed has only recently been developed and has not generally been adopted on a commercial basis.

The synchronization of estrus with a subsequent satisfactory fertility level could have many advantages in a beef herd. Natural service at the synchronized estrus is unlikely, due to the high cost of maintaining a sufficient number of bulls to breed all cows during the concentrated period. Therefore, artificial insemination (A. I.) is assumed to be used at the synchronized estrus. In turn, artificial insemination would be made more efficient due to the reduction in the length of time that manual and technical assistance is required. As few as 14 days would be needed to detect estrus in highly synchronized herds, whereas normally 40-50 days would be required.[1/] It could thus be possible to artificially inseminate many females on the same day, thereby concentrating the efforts to a more limited period of time. Semen requirements could be ascertained with greater accuracy and the technician would have a

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1/ This is based upon the time required to detect two estrous periods.

more definite insemination schedule.

Semen from bulls of outstanding genetic merit could be used for insemination. Replacement heifers could be selected from calves sired by these outstanding bulls, thereby providing greater improvement in the herds than if replacement heifers were produced by the kind of bulls commercial producers normally purchase. Also, market animals, produced by the outstanding bulls, could receive a higher price than those sired by bulls normally used.

The use of artificial insemination could result in higher calving percentages, especially in herds generally bred under adverse range conditions. The use of synchronization of estrus with subsequent artificial insemination could also result in an earlier conception rate by most of the cows. In addition, parturition would be confined to a limited period so that more attention could be given at calving, resulting in a larger percentage of the calves being saved. The above three conditions would aid in the attainment of increased pounds of beef produced per cow at weaning time.

Synchronization of estrus would allow for a more efficient increase in nutritional status during the breeding period and would contribute to a more uniform calf crop. Uniformity of age and size of the calf crop could allow more of the total calves to be marketed at the same time and possibly result in their

receiving a higher price. There would be less need for segregation of the young, by age and size, during the growing-fattening period; also feed requirements would be more uniform resulting in more efficient supplying, storing, and handling of the feed.

The use of artificial insemination will allow a reduction in the number of bulls required per ranch. Thus, more cows and calves can be maintained without incurring any additional cost. Managerial advantages such as better planning of calving dates could also occur.

Synchronization of estrus with subsequent artificial insemination could also result in certain nonbeneficial factors which would tend to offset the above. These nonbeneficial factors include:

1. cost of hormone used to achieve synchronization of estrus,
2. cost of additional facilities needed,
3. cost of additional feed,
4. cost of semen,
5. cost of technician if the artificial insemination is performed by hired personnel, and
6. cost of possible additional labor.

This leads to the particular problem of this research which is to determine as closely as possible with the tools and data

available whether it is economically feasible to synchronize estrus.

Objectives

With respect to the given problem the following are the objectives for the research described on the ensuing pages.

1. To determine under what conditions it is economically feasible to adopt estrous synchronization.
2. To identify those factors which significantly affect the profitability of adopting estrous synchronization and to determine the extent of this effect.
3. To identify those factors which are affected as a result of adopting estrous synchronization and to determine the extent of the effect upon such factors.
4. To propose optimum conditions under which estrous synchronization can be profitably adopted.

Such information will be a useful aid to ranchers considering synchronizing estrus in their beef cows. Also, it will provide a basis for determining (1) whether further research in this area is justified, (2) what research is needed to improve physical efficiency, and (3) what conditions must exist to make it profitable.

Study Area

Most beef-cattle operations of Oregon are located in the eastern half of the state. Data were taken from and results are applicable to ranches located in Benton, Grant, Harney, Josephine, Klamath, Morrow, and Wheeler counties (see Figure 1). The ranches were selected on the following basis:

1. Each ranch had previously carried out a synchronization of estrus experiment in cooperation with Oregon State University Animal Science Department and Cooperative Extension Service.
2. The ranches were of various sizes, as measured by number of cows.
3. The ranch operations were of various types--mountain valley, desert sagebrush, and nonrange.

These types differ in geographic location, climate, topography, and method of livestock management. The Benton County area in the Willamette Valley of western Oregon includes a ranch located on slightly sloping nonrange land. The climate is characterized by mild winters and summers. The Grant County area in east-central Oregon includes ranches located along the John Day River or on small tributaries which flow into the river. The topography consists of irrigable flat land, rolling hills, and steep slopes.

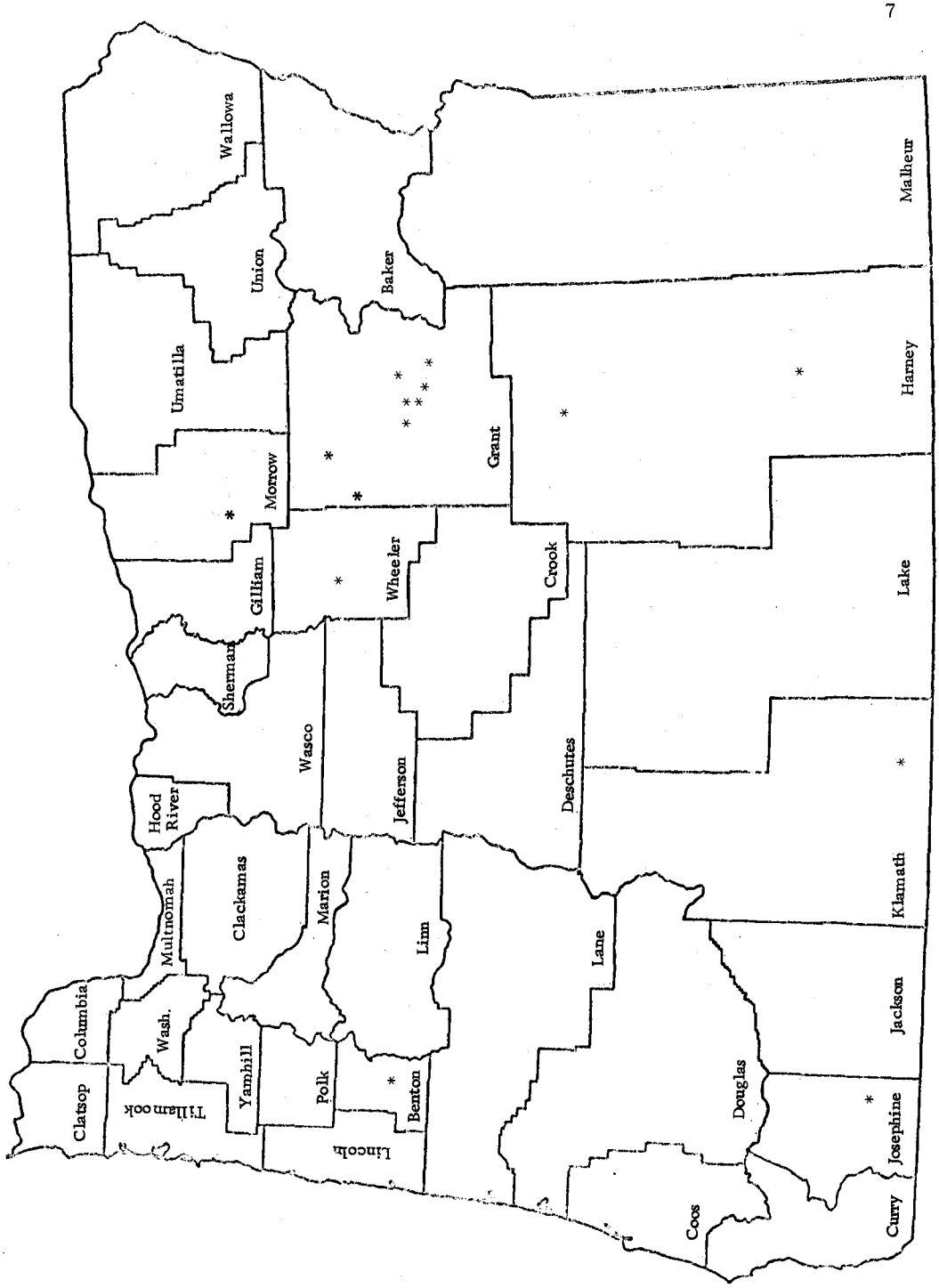

Figure 1. Location of sample ranches. (Each star (*) represents one ranch)

The climate is characterized by hot summers and cold winters. The Harney County area in southeastern Oregon includes a ranch located along the Alvord Desert and another along the Silvies River. The elevation is above 4, 000 feet, and the terrain is generally unfavorable with rough steep slopes. The semi-arid climate near the Alvord Desert is characterized by hot, very dry summers and cold winters, while the vegetation consists mostly of desert grass and sagebrush. Along the Silvies River the summers are warm and the winters cold. The Josephine County area in southwestern Oregon includes a ranch located along the Applegate River on sloping nonrange land. The climate is characterized by hot summers and moderately cold winters. The Klamath County area topography consists of slightly sloping irrigable land, rolling hills, and steep slopes. The climate is characterized by warm summers and cold winters. The Morrow County area in northern Oregon includes a ranch located on the fringes of the grain area. The topography consists of rolling hills and steep slopes. Warm summers and cold winters are characteristic of the area. The Wheeler County area in north central Oregon includes a ranch located on the John Day River. The topography consists of irrigable flat land, rolling hills, and steep slopes. Hot summers and cold winters are characteristic of the area.

Hypotheses

As a guide to this study the following hypotheses are to be examined:

1. Synchronization of estrus with subsequent artificial insemination for beef cattle reproductive herds is economically feasible, i.e., it will increase profit.
2. The increase in ranch profit from using synchronization of estrus with subsequent artificial insemination will be affected by the following pre-synchronization values:
   a. number of cows during breeding season,
   b. weaning weight,
   c. ratio of cows to bulls during breeding season,
   d. conception rate. 2/

2/ Percent of total cows exposed that carry calf full term.

II. METHODOLOGY

In order to fulfill the objectives of this study considerable emphasis is placed on partial budgets and stepwise regression.

The partial budget, according to Castle and Becker (8), is an appropriate tool for analyzing possible changes in a ranch organization. Thus, this tool is used to determine whether it is profitable to synchronize estrus. In the partial budget an effort is made to estimate the effect of synchronization of estrus and artificial insemination on the costs and returns of the existing ranch organization.

Partial Budget Outline (8)

1. Additional receipts--expected additional returns for products sold and services rendered as a result of the changes under consideration,
2. Reduced costs--estimate of annual costs which will no longer be incurred if the changes are made,
3. Additional receipts plus reduced costs (total credits),
4. Additional costs--additional direct costs that would occur in a year's business as a result of the change,
5. Reduced receipts--returns that will no longer be received after the change has been made,

6. Additional costs plus reduced receipts (total debits), and
7. Difference (total credits minus total debits).

The stepwise regression is a technique to determine how much effect each independent variable exerts on the dependent variable. Thus, stepwise regression is used to identify variables which significantly affect the profitability of estrous synchronization and artificial insemination and to determine the extent of the effect of such variables. In addition, the stepwise regression is used to obtain a prediction equation, i.e., an equation whereby a rancher may predict whether or not it will be profitable to adopt synchronization of estrus.

Livestock Extension personnel of Oregon State University provided a list of beef producers who were familiar with synchronization of estrus. Personal interviews were held with the operators of these ranches. Data on livestock inventories, production, sales, equipment, and management practices were obtained from all ranches. In some cases, where ranch data are lacking, synthesized data are used. These data are combined with data on synchronization of estrus and artificial insemination, obtained from Oregon State University Animal Science and Livestock Extension personnel and related references, to synthesize the partial budgets for each beef ranch. The

synchronized conception rate (SCR) is allowed to vary.[3/] Thus, there is more than one partial budget for each ranch, i.e., one for each synchronized conception rate. Each partial budget is analyzed individually.

Pre-synchronization ranch values for conception rate, weaning weight, cow-bull ratio, and number of cows are combined with the results of the partial budgets to form the inputs of the stepwise regression. These ranch values (independent variables) are regressed on the difference between credits and debits (dependent variables) obtained from the partial budgets. Each ranch represents one observation.

Synchronization of estrus and artificial insemination data, obtained from university personnel and related references, are uniform for all ranches. Representative prices, as well as input-output data assembled from ranches, used to synthesize partial budgets and regression equations are applicable for 1966.

3/ It is not known what the synchronized conception rate will be on these ranches; therefore, synchronization partial budgets for a high (76.5%), medium (69.04%), and low (60.75%) synchronized conception rate are structured for each ranch (Appendix D).

III. BASES FOR FORMULATING MODELS

Survey of Supporting Data

Reproductive cycle of the cow

A current publication (23) describes the reproductive cycle of the cow in the following manner.

In the absence of pregnancy, the cow will be in estrus (heat) and ovulate at intervals of about 21 days. This normal pattern is determined by cyclical changes in the ovaries. Structures called follicles grow during the time between two periods of estrus, and shortly after estrus one follicle usually ovulates (ruptures and releases the contained egg). The ruptured follicle changes into a gland called the corpus luteum (yellow body). The corpus luteum then prevents ovulation until it regresses, apparently by the production of progesterone. This is the "natural" method of control of the estrous cycle.

Control of the estrous cycle

The reproductive cycle of the cow can be controlled with the use of a synthetic derivative of progesterone, which has a greater potency in farm animals than does the parent hormone (23). The synthetic progesterone, capable of replacing the corpus luteum

for inhibition of ovulation, suppresses both estrus and ovulation during the period of its administration. Duration of the treatment approaches the length of the estrous cycle, i.e., 18-24 days. Upon termination of the treatment the cows come into estrus as a group, which is referred to as synchronization of estrus.

Methods of administering the synthetic progesterone

Bogart (6) presented the following discussion on the four methods of administering the synthetic progesterone.

a. The daily injection of progesterone. The daily injection of progesterone or some synthetic progesterone will hold females out of estrus. This can be done for 18-22 days and then discontinued. Cows will come into estrus and can be inseminated with generally good results on the second or third day following cessation of injections.

The daily injections of progesterone to hold cows out of estrus has been a very effective method for synchronization of estrus. It is biologically sound, and there appear to be no harmful side effects from its use. There are, however, definite practical disadvantages of these daily injections. Cows must be kept near facilities for handling them at the time of injection. Also the cows must be put into a squeeze chute at the time of injection, and thus much labor is expended in making daily injections for 18-22 days.

It is doubtful if commercial beef producers would be willing to spend the time and take the losses in milk production (growth of nursing calves) that this method requires.

b. Feeding orally effective progestogen. Several synthetic materials such as medroxyprogesterone acetate (MAP) and melegestrol acetate are active progestogens and are orally effective. These materials can be mixed with a feed (concentrate) at known quantities and their levels of administration controlled by the amount of concentrate feed given to each cow. After 18-22 days the concentrate containing the progestogen can be discontinued, and the animals will generally come into estrus within two to three days. The use of these materials in the feed offers both advantages and disadvantages. In many instances, the feeding of some concentrate for about three weeks just prior to the breeding season would be desirable. Many commercial herds are under a nutritional stress at this time, and the addition of about two pounds of concentrate might, in itself, help to get the cows settled.

Many commercial producers, however, object to feeding the material because it requires extra facilities and it necessitates keeping the cows in a confined area during the feeding period. Some also object to the cost of the concentrate. Perhaps the greatest disadvantage of the system resides in the difficulty of assuring that each cow gets the proper amount of progestogen each day.

c. The use of vaginal pessaries. A sponge that has been impregnated with one of the progestogens can be inserted into the vagina. The progestogen will be absorbed through the vaginal tissue and will prevent estrus. These pessaries (impregnated sponges) can be removed after 18-22 days and the animals will generally come into estrus within two to three days. This method has proven satisfactory with sheep, but not with cattle. Attempts to use this method with cattle have all failed because the cow has the ability to discharge the sponge from the vagina.

d. Implants of progestogen materials. Progestogen material may be implanted under the skin. This material is then slowly absorbed into the blood stream and prevents the cows from coming into estrus until it has been absorbed. After removal or complete absorption the animals usually come into estrus within two to three days. The most logical place for implanting is under the skin of the ear because the cartilage of the ear prevents one from putting the implant too deep to locate when removing. The removal of the implant is accomplished by slitting the skin and scraping out the remaining material. The ranch operators expressed interest in this method because it necessitates putting the cows through the chute only three times--for implanting, for removal of the implants, and for insemination. Also, the cows do not have to be pastured at any particular place between the time of implantation and

removal of the material.

Recent data collected by the author indicates that quite often irritation and subsequent infection occurs at the site of the implant. Also, it is difficult to scrape out all of the remaining progestogen, even when the scraping is followed by wiping out the site with a wet sponge. When some material is left at the implant site, the cows do not synchronize.

Commercial availability of estrous synchronization hormone

Presently medroxyprogesterone acetate (MAP) is the only synthetic derivative of progesterone that has been approved by the Food and Drug Administration for the use of synchronizing estrus in beef cows (18). MAP, an orally effective progestogen, is available to feed manufacturers in the form of millfeed premix called Repromix. Repromix has been approved to be fed at 180 to 250 milligrams per head daily for 18 to 30 days (22).

Effectiveness of Repromix

The Repromix Story (23) presented the effectiveness of Repromix with the following tables and discussion.

Six trials with Repromix conducted at the Upjohn Farms resulted in 196 (92%) of the 214 treated animals being synchronized (Table 1). Conception rates varied from trial to trial in the Upjohn

Table 1. Results of six Upjohn Farms Repromix synchronization trials.

Number of studies		6
Number of animals	Repromix fed	214
	controls	55
	total	269
Synchronized	number	196
	percent	92%
Synchronized conception rates	first service	47%
	second service	78%
Control conception rate	first service	69%
Range [a/]	low	26%
	high	75%
Conceived with two services	Repromix fed	88%
	controls	89%
Conceived within 26-day period	Repromix fed	76%
	controls	69%

a/ Refers to the range of first service synchronized conception rates.

Source: The Repromix Story (23).

studies. The percentage of the cows conceiving at first service was somewhat lower for synchronized cows (47%) than for untreated cows (69%). The range of conception rates in the synchronized cows at

the first service was 26 to 75 percent. The conception rate of the second service of the treated cows was slightly greater (78%) than that of untreated animals of first service (69%). This indicates that any reduction in conception rate due to synchronization of estrus is only temporary. The percentage of the group conceiving with two services was similar for treated and control groups, 88 and 89 percent, respectively. Within a 26-day period a slightly higher percentage (76%) of the treated cows conceived than did the control cows (69%).

Nine trials with Repromix conducted at various universities had a mean synchronization rate of 88 percent (Table 2). The mean conception rate at first service was somewhat lower (31%) and more variable for treated cows than for untreated cows (55%). The mean percentage conceiving with two services was similar for the Repromix treated (63%) and untreated control (69%) groups.

Field trials with Repromix

In 1962-63 fifty-two trials with Repromix were conducted to study its effectiveness under field conditions in a variety of different geographic areas and under different systems of management. As reported in The Repromix Story (23), the mean percentage considered synchronized was 74 percent (Table 3). The mean conception rate at the first synchronized service was 36 percent for the Repromix

Table 2. Results of nine university beef cattle Repromix synchronization trials..

Number of studies		9
Number of animals	Repromix fed	606
	controls	383
	total	989
Synchronized	mean percent	88%
Synchronized conception rates (mean)	first service	31%
	two services	63%
Control conception rates (mean)	first service	55%
	two services	69%
Range[a/]	low	24%
	high	55%

[a/] Refers to the range of first service synchronized conception rate.

Source. The Repromix Story (23).

Table 3. Summary of 52 Repromix synchronization field trials in 1962-63.

2, 401 Repromix cattle	synchronized	74%
	pregnant 1st service	36%
	pregnant 2nd service	64%
1, 068 control cattle	pregnant 1st service	37%
	pregnant 2nd service	53%

Source. The Repromix Story (23).

treated groups, while the untreated groups had a first service mean conception rate of 37 percent. However, the mean percentages of the groups conceiving with two services was higher for the Repromix treated groups (64%) than for the untreated control groups (53%).

In 1964 eighteen additional field trials were conducted with Repromix. The Repromix Story (23) reported that the mean percentage considered synchronized was 78 percent (Table 4). The first service mean conception rate was considerably lower for the

Table 4. Summary of 18 Repromix synchronization field trials in 1964.

Number of animals	Repromix	1, 975
	control	831
	total	2, 806
Repromix		
Synchronized (mean)		78%
Conception rate (mean)	first service	36%
	two services	62%
Conceived within 26-day period		57%
Control		
Conception rate (mean)	first service	51%
	two services	65%
Conceived within 26-day period		37%

Source. The Repromix Story (23).

synchronized groups (36%) than for the untreated groups (51%). Although the mean conception rate for two services was similar for treated and untreated groups, 62 and 65 percent, respectively. Within a 26-day period the mean conception rate for Repromix treated groups (57%) was higher than the untreated control groups (37%). The results of the individual 1964 trials are shown in Appendix A.

Recommendations for using Repromix

These field trials, in combination with the experimental studies at Upjohn Farms and various Universities, established the current recommendations for a controlled beef breeding program with Repromix. Some of the recommendations are as follows:

1. Repromix should be administered at levels of 180 mg. per cow per day for 18 consecutive days in order to synchronize estrus,
2. Each cow to be synchronized should be accustomed to the concentrate by a preliminary feeding (15 to 30 days in length) excluding the Repromix,
3. Cows must be sexually mature, normal, open, and free of disease,
4. Cows should have calved at least 45 days prior to the beginning of the feeding period with Repromix,

5. Cows to be synchronized should be confined without feed prior to the Repromix feeding long enough (usually a minimum of six hours) to assure uniform consumption of the Repromix,
6. The cows to be synchronized should be maintained in groups not to exceed 100 head.

Typical response to Repromix

Most cows treated with Repromix, according to the above recommendations, come into estrus from one to five days after the last Repromix feeding (22). This is the first synchronized estrus. Cows which exhibit estrus at this time usually have a second synchronized estrus 18 to 26 days following the last Repromix feeding. Also, those cows which do not exhibit a first synchronized estrus usually come into estrus between the fifth and eighteenth day post-treatment. Figure 2 shows the typical distribution of estrus affected by synchronization.

Artificial Insemination Procedures

Detection of estrus, according to Bogart (5) and Richter (18), is easier in the early morning and late afternoon than at other times of the day. They also recommended that for a synchronized period, 100 cows is close to the maximum size group in which one

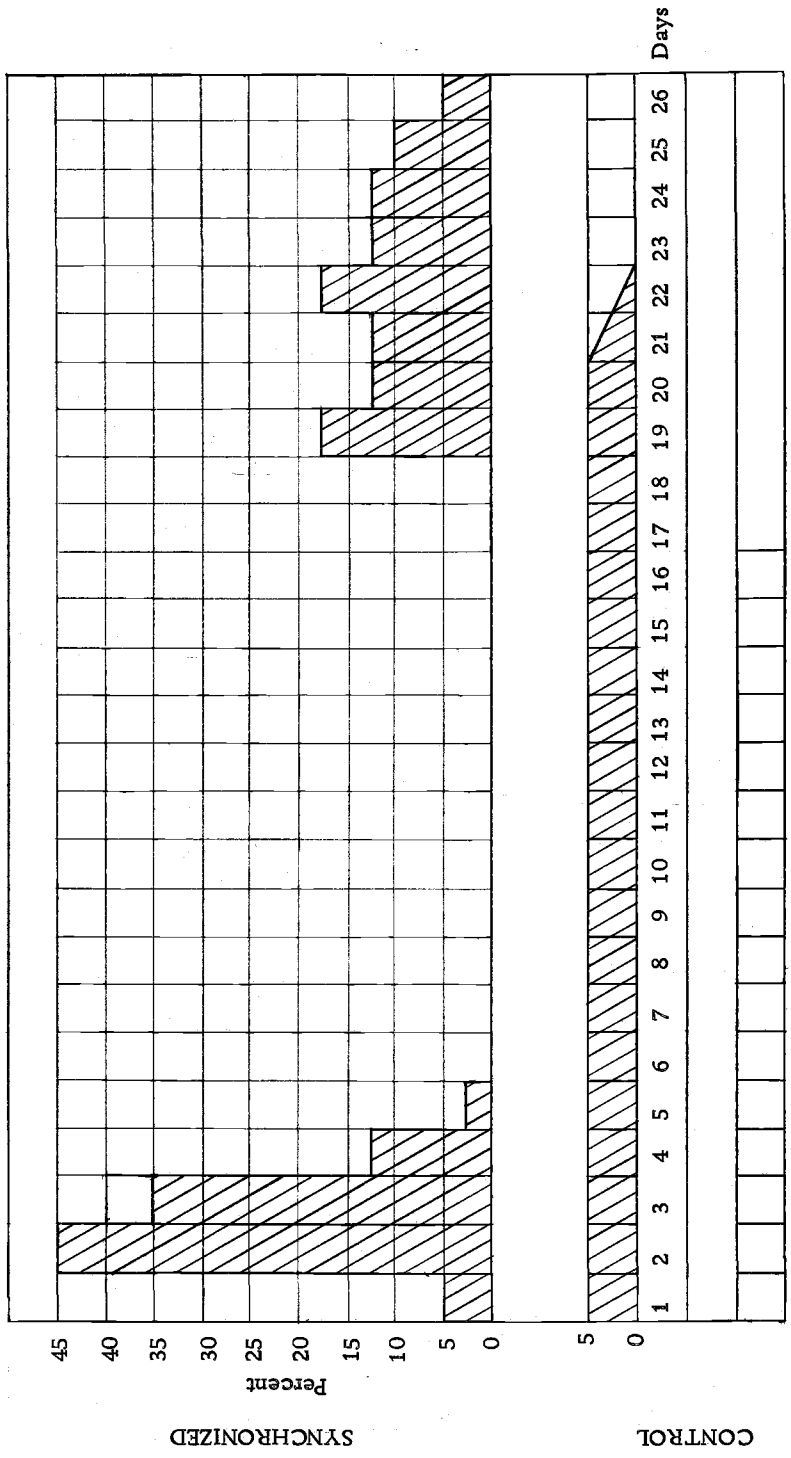

Figure 2. Distribution of estrous affected by synchronization. (Source: The Repromix Story(23).)

person can effectively detect estrus, and for this to be effective two daily observations of two hours each are necessary.

Artificial insemination (A. I.) following estrous synchronization appears to be most effective when insemination occurs 15-20 hours after having first observed the cow in estrus (18). Also, the skill of the technician is of extreme importance in affecting the conception rate. The rancher has several alternatives as to the technician who performs the insemination. These include:

1. technician from the A. I. stud services,
2. competent veterinarian, and
3. the rancher himself.

Most of the A. I. stud services sponsor a clinic where they teach interested persons the technique of artificial insemination. The climics are usually free to persons to whom they supply semen. In structuring the partial budgets the rancher is considered to perform the insemination.

The cost of semen used for inseminating beef cows is between two and six dollars per capsule. However, American Breeders Service northwestern representative, Clyde Waddell,(26) suggests that three dollars is the average price which beef producers in the Northwest pay for a capsule of semen.

The semen must be stored in a liquid nitrogen tank until used. The rancher has the choice of purchasing a tank or renting

one from the A. I. stud service. Most ranchers who perform the insemination themselves rent tanks from the A. I. stud service, since it is necessary that the semen be shipped in the tank. Other minor items such as pipettes, gloves, and bulbs are available from several sources and are purchased, since they are disposable.

Synchronization Methods

A rancher may or may not choose to attempt to synchronize his entire herd at once. There are several ways to organize the synchronization routine. First, the rancher can attempt to synchronize his entire herd at one time. Second, the rancher can attempt to synchronize his entire herd, but stagger the synchronization groups. Third, the rancher can attempt to synchronize only part of his herd, and synchronize that portion either at once or staggered. The conditions on a specific ranch will dictate which method is most appropriate for that ranch. It is felt that most ranchers would attempt to synchronize a limited number of cows until they are more familiar with the techniques involved. However, for the purpose of structuring the partial budgets all but one rancher is considered to attempt to synchronize estrus in their entire herd.

Labor Requirements

It was previously mentioned that one person is required to

detect estrus for each group of cows being synchronized. Some small ranches may presently have an adequate number of persons for synchronizing the entire herd at once. However, considering the fact that everyone does not have the ability to detect estrus, most ranchers would find it necessary to use outside labor in order to synchronize their entire herds at one time. A rancher may solve the labor problem in one of two possible ways. First, he may organize the synchronization routine so that he does not need any extra labor (see section on synchronization methods). Second, he may hire outside labor. With respect to the second alternative, it is difficult for an individual rancher to hire part-time labor capable of detecting estrus. However, by cooperating, the ranchers may solve this problem. First, the ranchers can organize their respective synchronization programs such that they can swap their workers capable of detecting estrus. Second, they can organize their synchronization routine so as to extend the need for hired labor over an extended period and then cooperatively hire the outside labor needed to aid in detecting estrus.

Survey data tend to indicate that most ranches already have enough labor to adequately observe and aid cows during the concentrated calving period. However, it is necessary to plan ahead so that ranch personnel will not be occupied with other ranch chores.

Death Loss and Nonbreeders

Bellows (3), using post-mortem examination, found that 57.3 percent of all calf death losses at birth were due to delayed and difficult calving. Further research by Bellows at the U.S. Range Livestock Experiment Station in Miles City, Montana, indicated that with better management and closer observation at calving the calf death loss could be reduced by 50 percent.

By use of estrous synchronization a large percentage of the cows conceive within a 26-day period and hence the calving interval of these cows is also short. This short calving interval allows for closer observation during the calving period; consequently, the calf death loss of calves born to cows conceiving within the 26-day period is obtained by reducing the pre-synchronization calf death loss by 33 percent.[4/] For calves born to cows conceiving after the 26-day period the pre-synchronization death loss is used. This calf death loss is obtained from the sample ranches.

In structuring the partial budgets five percent of the cows are considered to be nonbreeders, i.e., they are not capable of conceiving. Bogart (5) has suggested this percent as a minimum.

4/ Pre-synchronization calf death loss is the sum of the calves that died during calving and between calving and weaning divided by the number of calves carried full term.

Valuation of Assets

Land values are estimated by the ranch operator. Grazing land values range mostly from $10 to $50 per acre. Irrigated meadow land and pasture land values range mainly between $100 and $400 per acre. No value is placed upon the public grazing permit held by the rancher; however, it is felt that in most cases this value is included in the above land values.

The values assigned to ranch improvements are estimates made by the ranch operators. Depreciation is based upon present value divided by the remaining years of useful life. Recently purchased machinery is valued at the purchase price less depreciation to date. Older machinery is valued at estimated cost of replacement at a used machinery sale. Depreciation on machinery is based upon the present values divided by the years of remaining use.

Livestock values are uniform for all ranches, except for bulls. The livestock values are as follows: cows, $180; coming two-year old heifers, $160; coming yearling heifers, $123; coming yearling steers, $137. Bulls range in value from $350 to $700, depending upon the purchase price. Depreciation on bulls is based upon purchase value minus salvage value divided by the number of years maintained on the ranch. All livestock inventory values are maintained constant over the year, and investment in livestock is taken

to be the sum of the average investment on January 1, 1966 and January 1, 1967, divided by two.

Cattle Prices

The sale of cattle (except calves sired by A. I. bulls) required for specific models are priced in accordance with the market prices of the specified classes and weights of cattle, as represented by the Ontario and Klamath Falls markets, for 1966 (Table 5).

Table 5. Average cattle prices per hundredweight for Ontario and Klamath Falls, Oregon, 1966.

Cows	Bulls	Heifer calves	Steer calves
$16.61	$20.71	$24.33	$28.32

The cow price is the average of all monthly prices with August, September, October, November, December, and January prices weighted double. The bull price consists of the average of all monthly prices with July, August, September, and October prices weighted double. The months for which the prices are weighted double represent the months in which the heaviest marketings occur. Feeder calf prices are the average of September, October, and November prices, as these are the months in which most weanling feeders are sold. The average prices so weighted

represent the average prices a producer might have received in 1966.

This method of weighting prices is in general agreement with Marks (16) and Breimyer and Kause (7). The prices at the Ontario and Klamath Falls markets were suggested by Marks (16) as being representative of beef cattle prices in eastern Oregon.

Wright (30) has observed over many years that an increase in market price of one to one and a quarter cents per pound occurs when calves are segregated according to quality and uniformity. Similar expected price increases for calves sired by A. I. bulls has been noted by Landers (14). Thus, the market price of calves resulting from synchronized artificial insemination is increased one cent per pound in order to compensate for their improvement in quality and uniformity. This increase is felt to be a minimum, especially when we consider the improvement in quality and uniformity resulting over time from using A. I. bulls. 5/

Replacement Heifers

Prior to the introduction of estrous synchronization and artificial insemination, replacement heifers on the ranches are assumed to be selected from the largest heifers, i. e., selected on

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5/ A. I. bull refers to semen from A. I. stud.

the basis of size. In structuring the partial budgets considering synchronization of estrus, replacement heifers are assumed to be selected from the largest A. I. heifers.[6/]

Cattle Weights

The estimated average weaning weight of calves, prior to using synchronization of estrus and artificial insemination, is obtained from the rancher. This weaning weight is adjusted upward in order to obtain the weaning weight of calves sired by A. I. bulls. Data collected by Woodward (29) of American Breeder Service, Inc., which covers four years and 1,555 calves, showed that the average weaning weight of calves, within herd, sired by A. I. bulls was 21 pounds greater than for calves sired by the type of bulls normally used in commercial beef herds. The bulls in the Woodward data that were considered to be of normal ranch type had been tested and rejected for possible use as A. I. bulls for American Breeder Service, Inc. Thus, this 21 pounds increase constitutes a minimum expected increase per head. Also, the 21 pounds increase is a first year concept and a rancher could not expect to increase his weaning weight by 21 pounds, each succeeding year. It is generally agreed that the increase will become smaller and smaller over time. Magee (15) has calculated that the yearling weight curve will be increasing

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6/ A. I. heifer is a heifer sired by an A. I. bull.

at a decreasing rate over time, when using A. I. bulls (see Figure 3). A similar change is expected to occur for weaning weight.

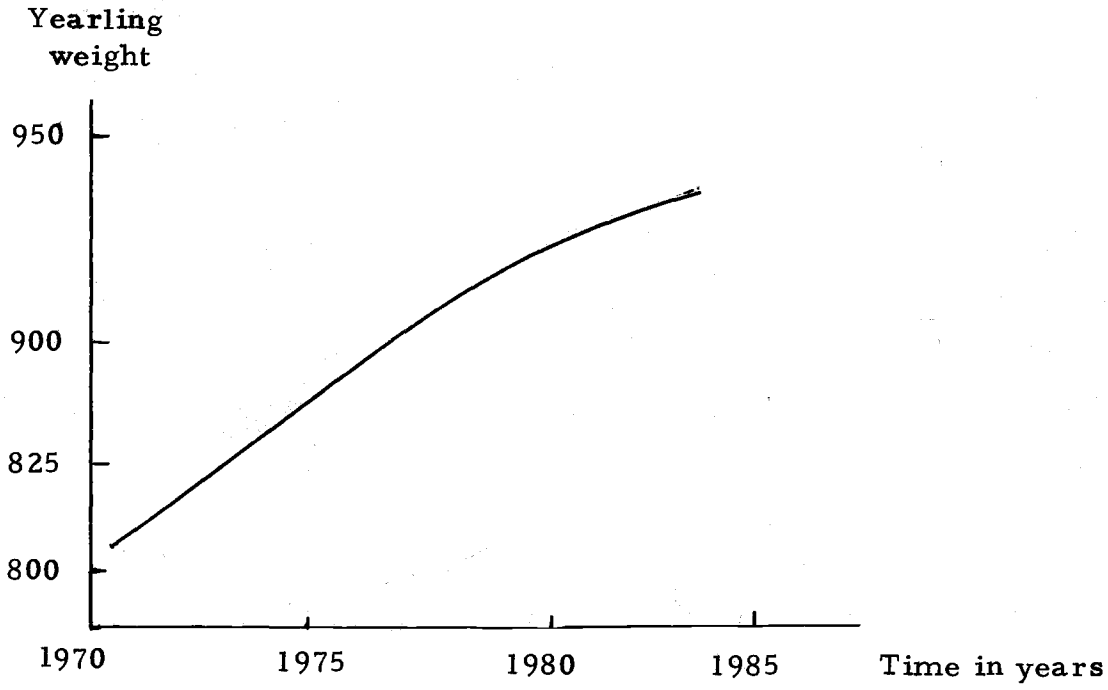

Figure 3. Increase in yearling weight due to use of A. I. bulls. Source: Magee (12).

The sale weight of weanling steers is their average weaning weight. However, the sale weight of weanling heifers is obtained by adjusting downward their weaning weight in order to compensate for removal of the larger replacement heifers.

Rations for Synchronization

Repromix can be satisfactorily placed in most any ration. According to TUCO products field representative John Richter (18), the basic things to consider in selecting the ration are its palatability,

energy content, and cost. High palatability is essential in order to insure that the cows consume the feed. A high energy level just prior to breeding tends to aid in the occurrence of estrus and in the conception rate. Since the main purpose of the ration is to serve as a base for the hormone, an inexpensive feed is desirable. The relative prices of grains in the area are considered in selecting the grain to be used. In structuring the partial budgets a high energy pelleted ration of barley and molasses is used. Pelleting the ration tends to eliminate feed being wasted due to spillage from the bunks. Cost of pelleting the ration is included in the purchase cost (Appendix C).

Extra Facilities

In order to carry out a program of estrous synchronization using oral administration of the hormone, most ranches require some additional facilities. The extra facilities budgeted include pastures, corrals, feed bunks, and waterers.

The pasture should be large enough to provide grazing for 74 days (30 days while each cow receives two pounds concentrate a day without the hormone, 18 days while on two pounds concentrate with the hormone, and 26 days without concentrate), and yet small enough to provide easy penning of the cows at night and adequate checking for estrus. The range conditions are critical in determining the space per cow necessary for providing adequate grazing. However,

in structuring the partial budgets eight-tenths of an acre per cow is used for all ranches.

The corrals, which are made of wood, are necessary to hold the cows off feed overnight. This tends to insure that each cow consumes a constant and adequate level of concentrate when it is fed in the morning.[7/] In certain areas of eastern Oregon there is an adequate supply of free poles to use in building the corral. However, due to uncertainty as to whether or not a ranch has access to these poles, all lumber used in structuring the partial budgets is assumed to be purchased. The cost of such material is shown in Appendix B. One hundred square feet of corral space is usually necessary for each cow penned with its calf overnight.

A water trough must be available for both the pasture and corral. A single trough designed so as to be accessible from both the pasture and corral is normally sufficient.

A stationary feed bunk is the type considered in structuring the partial budgets. Two linear feet per animal are allowed in constructing the feed bunks. Landers (14) feels that this amount of space per cow is necessary in order to obtain uniform consumption.

In order to determine the amount of extra facilities needed for any specified ranch the following assumptions are used.

7/ The concentrate contains the synchronization hormone and each cow needs to consume a certain minimum daily dosage of the hormone for 18 days in order to become synchronized.

1. Each ranch already has pasture, corral, and water trough for approximately 100 cows.
2. None of the ranches have a feed bunk of the appropriate size.
3. Each set of facilities will maintain approximately 100 cows. (A set of facilities includes the pasture, corral, water trough, and feed bunk.)

Table 6 lists the number of sets of facilities needed for each size ranch. A ranch with 230 cows would normally need two sets of facilities. Only one complete set and one feed bunk are built, due to the above assumptions. One hundred and fifteen cows are placed in each set.

A complete analysis of the various facilities costs is shown in Appendix B.

Table 6. Number of sets of facilities for various size ranches.

No. of cows to be synchronized	No. of sets of facilities
0-125	1
126-240	2
241-320	3
321-400	4
401-500	5
501-600	6
601-700	7
701-800	8
801-900	9
901-1, 000	10
1, 001-1, 100	11

Other Considerations

Synchronization of estrus involves artifically inseminating the cows at the synchronized estrus periods. However, in most cases, bulls are used to breed the cows which did not conceive from the insemination. This reduction in the number of cows to be bred by natural service allows for a decrease in the number of bulls needed. The number of bulls remaining on the ranch is dependent upon the number of cows to be bred by natural service, i.e., the ratio of cows to be bred by natural service to remaining bulls is to be equal to or less than the pre-synchronization cow-bull ratio. In structuring the partial budgets one cow is added for each bull that is removed (23). No allowance is made for changes in feed, facilities, etc., when using this substitution, since they are felt to be offsetting factors.

IV. MODEL

Described in this section is that portion of the beef production system which is common to each selected ranch. Data obtained from each ranch are shown with their respective partial budgets in the appendix. These data, in conjunction with synchronization data, were used in developing partial budgets representing adoption of estrous synchronization.

It is assumed that all ranchers but one will attempt to synchronize estrus in their entire herd. It is also assumed that a synchronization program on each ranch is established that requires no extra labor. Cows to be synchronized are divided into groups of approximately 100, and placed in their respective sets of facilities (Table 7). For 30 days thereafter each of these cows receives two pounds of pellets. The pellets are fed in the morning after the cows have been held off feed overnight. During the daylight hours each group of cows is allowed to run in the pasture. For the next 18 days each group is treated as above, except that each two pounds of pellets contains 180 mg. of hormone, i.e., each cow receives 180 mg. of hormone for 18 consecutive days.[8/] During the following 26 days the cows are allowed to remain in the pasture at all times,

8/ This is the level recommended to satisfactorily synchronize estrus.

Table 7. Recommended timetable for synchronization of estrus.

Day 1	Preliminary feeding period (30 days)	Cows on pasture during daylight hours and drylot without feed overnight. Two pounds of pellets per cow each morning.
Day 31	Treatment feeding period (18 days)	Cows on pasture during daylight hours and without feed overnight. Two pounds of pellets, with 180 mg. of hormone, per cow each morning.
Day 49	First synchronization period (5 days)	Cows on pasture at all times. Observe cows for estrus in morning and evening for two hours--inseminate those that exhibit estrus.
Day 54	Bull with cows (12 days)	Cows on pasture at all times.
Day 66	Second synchronization period (9 days)	Cows on pasture at all times. Observe cows for estrus in morning and evening for two hours--inseminate those that exhibit estrus.
Day 75	Bull with cows (45 days)	All cows together on range.
Day 120		

and do not receive any pellets. For the first five and last nine days of this period each group is observed for estrus twice daily for two hours, i.e., they are observed from the 1-5 and 18-26 day after cessation of hormone treatment. These two periods are the first and second synchronization of estrus periods, according to the typical response from using Repromix. Bulls are placed with the cows between the 5-18 day post-treatment to service cows which exhibit estrus during this period. Twenty-six days following the cessation of treatment the cows are placed on the range, and bulls are allowed to run with them for 45 days. It is recognized that many ranchers may not set up their program in such a manner. In such cases, ranchers will find it necessary to restructure portions of the partial budget analysis.

Ninety percent of the treated cows are considered to exhibit estrus at the first synchronization period and are subsequently artifically inseminated. Any of these cows that do not conceive are considered to exhibit estrus at the second synchronization period and are inseminated again. In structuring the partial budgets three different synchronized conception rates (SCR) are used--76.5, 69.04, and 60.75 percent (Appendix D).[9/] These rates are derived from

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9/ Synchronized conception rate (SCR) is that portion of treated cows that conceived at the first and second synchronization periods. (See Appendix K).

the various ranch synchronization and conception rates. Research data indicates that the synchronized conception rates mostly range between 50 and 76 percent.

The ten percent of treated cows which did not exhibit estrus at the first synchronization period are considered to come into estrus between the two synchronization periods. Fifty percent of these cows are satisfactorily serviced by bulls placed with the cows during this time, i.e., five percent of the treated cows conceive at this time. By combining this conception rate with the SCR, three 26-day conception rates are derived, 81.5, 74.04, and 65.75 percent. 10/

That portion of the treated cows which conceive from natural service during the 45 days following the 26-day breeding period 11/ is dependent upon the following four factors:

1. the 26-day conception rate,
2. pre-synchronization conception rate,
3. percent nonbreeders, and
4. percent of treated cows that are lost between breeding and due calving date.

10/ The 26-day conception rate is defined as that portion of treated cows which conceive as a result of insemination at the first and second synchronization periods and natural service between the two synchronization periods. The time lapse for these breedings is 26 days. Note--this definition is not necessarily consistent with that used by researchers cited in the survey of supporting data.

11/ Post-synchronized conception rate.

The 26-day conception rate is constant for all ranches, although three different rates are considered for each ranch. The other three factors generally vary over ranches with each ranch having only one value for each factor, i.e., for a given ranch the same values of these three factors are used with each of the three levels of the 26-day conception rate. Hence, there are three post-synchronized conception rates for each ranch, one for each 26-day conception rate considered. Also the post-synchronized conception rate varies over ranches.

The semen used for inseminating the cows at the two synchronization periods is assumed to come from bulls of such quality that the weaning weight of calves sired by A. I. bulls is 21 pounds heavier than the weaning weight of calves resulting from natural mating (pre-synchronization weaning weight). The calves sired by A. I. bulls are also considered to receive an increase in price of one cent a pound over that of calves sired naturally.

The death loss of calves born to cows conceiving within the 26-day breeding period, whether the result of artificial insemination or natural service, is considered to be 66 percent of the pre-synchronization calf death loss. The pre-synchronization calf death loss is used for calves born to cows conceiving from natural service during the 45-day post-synchronization period.

Using the data in this model in conjunction with specific data from an example ranch, a partial budget follows (Table 8) which indicates the results of the synchronization of estrus on that example ranch. The calculations of many of the items in the partial budgets are contained in the appendix.

Table 8. Example pre-synchronization data and synchronization partial budget corresponding to three assumed synchronized conception rates.

Example Ranch

Number of cows[a/]	233	Number replacement heifers	35
Number of bulls	11	Percent calf death loss[a/]	5.80
Percent conception rate[a/]	96.14	Number calves weaned	st. 105 he. 105
Percent cow death loss[a/]	0.43	Sale weight (lbs)	st. 475 he. 423
Percent non-breeders[a/]	3.43	Marketing cost per head (dollars)	1.00

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 794.15	$ 705.69	$ 590.02
b) Increase due No. calves " "	1,187.18	1,052.66	815.22
c) Increase due sale price " "	671.80	596.60	498.16
sub total	$2,653.13	$2,354.95	$1,903.40
Reduced Costs:			
a) Bull depreciation (App. G)	$ 336.00	$ 294.00	$ 252.00
b) Interest on working capital (App. G)	134.40	117.60	100.80
sub total	$ 470.40	$ 411.60	$ 352.80
Total Credits:	$3,123.53	$2,766.55	$2,256.20
Additional Costs:			
a) Feed (App. C)	$ 809.76	$ 806.40	$ 803.04
b) Hormone " "	1,084.50	1,080.00	1,075.50
c) Semen " "	975.00	1,020.00	1,065.00
d) Supplies " "	32.50	34.00	35.50
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	10.00	9.00	7.00
g) Dep. & repair on extra facilities (App. F)	185.61	185.43	185.24
h) Int. on oper. cost & fixed capital " "	220.00	221.23	222.42
Total Debits:	$3,382.37	$3,421.06	$3,458.70
Difference per ranch:	-$ 258.84	-$ 654.51	-$1,202.50
Difference per cow treated:	-$ 1.07	-$ 2.72	-$ 5.03

[a/] See Appendix K for definitions.

V. RESULTS

Synchronization partial budgets (one for each of three assumed synchronized conception rates) were developed for each of 15 ranches (Appendix H).[12/] The debits were subtracted from the credits in each budget, the difference indicating a profit or loss resulting from estrous synchronization. A positive difference implies a profitable adoption of estrous synchronization and a negative difference implies a loss. The difference (profit or loss) per cow for each ranch is shown in Table 9A. The partial budgets indicate that the difference per cow increases as the SCR (synchronized conception rate) increases. They also indicate that as the SCR decreases from 76.5 to 60.75 percent the percentage of ranches having a positive difference decreases from 47 to 7. [13/]

The average cost to synchronize estrus is between $13.30 and $14.52 per cow. As shown in Table 9B synchronization cost is not significantly affected by size or type of ranch. Only a slight variation in cost occurs when the SCR is varied. Approximately

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12/ The synchronized conception rate, which is defined as the sum of the percentage of treated cows conceiving from artificial insemination during the first and second synchronization period, is denoted by SCR.

13/ The sample ranches do not necessarily represent a cross-section of all Oregon beef ranches; therefore, inference cannot be made as to what percent of Oregon beef ranchers could expect to profitably adopt estrous synchronization.

Table 9A. Per cow profit or loss resulting from the adoption of estrous synchronization as related to three assumed synchronized conception rates (SCR).[a/]

SCR[e/]	Ranch Number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
76.50%	+16.61	+5.20	+2.41	+2.13	+1.03	+0.79	+0.73	-0.11	-0.15	-1.07	-2.11	-2.55	-2.72	-5.05	-5.20[b/]
69.04%	+13.29	+4.45	+0.14	-0.31	-1.32	-1.37	-1.29	-2.44	-2.39	-2.72	-3.92	-4.66	-4.45	-6.02	-6.12[c/]
60.75%	+ 9.29	-0.28	-2.55	-2.93	-3.71	-3.72	-4.02	-4.71	-4.69	-5.03	-5.82	-6.79	-7.12	-8.16	-8.27[d/]

[a/] This table should be read as follows: For ranch No. 11 and assumed SCR of 76.50 percent the loss per cow resulting from adopting estrous synchronization is -$2.11.

[b/] Corresponding to the 76.50 percent SCR seven (47%) of the ranches had a positive per cow difference.

[c/] Corresponding to the 69.04 percent SCR three (20%) of the ranches had a positive per cow difference.

[d/] Corresponding to the 60.75 percent SCR one (7%) of the ranches had a positive per cow difference.

[e/] See Appendix K for definition.

Table 9B. Per cow cost resulting from the adoption of estrous synchronization as related to three assumed synchronized conception rates.[a/]

SCR[b/]	Ranch Number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	(dollars)														
76.50%	13.96	13.76	14.06	13.91	14.06	13.68	14.09	14.01	14.02	14.03	13.87	14.02	14.01	13.60	13.30
69.04%	14.17	13.99	14.28	14.13	14.33	13.89	14.30	14.22	14.24	14.25	14.09	14.23	14.23	13.84	13.52
60.75%	14.39	14.18	14.49	14.36	14.48	14.11	14.52	14.42	14.45	14.47	14.31	14.45	14.45	14.00	13.74

[a/] This table should be read as follows: For ranch No. 11 and assumed SCR of 76.5 percent the per cow cost resulting from adopting synchronization is $13.87.

[b/] See Appendix K for definition.

33 percent of the cost is for the synchronization hormone. Thus a less expensive hormone would significantly affect the economic feasibility of estrous synchronization.

The overall conception rate resulting from adopting estrous synchronization was generally greater than the pre-synchronization conception rate (Table 9C).[14/] The increase was greater for those ranches have a low pre-synchronization conception rate. Furthermore, in most cases, the difference per cow increased as the pre-synchronization conception rate decreased.

In Chapter I it was hypothesized that pre-synchronization conception rate, weaning weight, cow-bull ratio, and number of cows would significantly affect the profitability of estrous synchronization. Stepwise regression was used to test this hypothesis and to determine the relative effect of the above independent variables on the profitability (difference per cow).

Equation 1 shows the general form of the regression equation.

$$\text{Eq. 1: } y_i^j = b_o^j + b_1^j X_{1i} + b_2^j X_{2i} + b_3^j X_{3i} + b_4^j X_{4i}$$

where:

y_i^j = difference per cow for the j^{th} SCR and i^{th} ranch

b_o^j, b_1^j, b_2^j, b_3^j, and b_4^j = parameters corresponding to the j^{th} SCR

X_{1i} = pre-synchronization conception rate for the i^{th} ranch

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14/ The overall conception rate is defined as the total conception rate resulting from the adoption of estrous synchronization. It is the sum of the percentage of treated cows conceiving from artificial insemination and the percentage of treated cows conceiving from natural service.

Table 9C. Pre-synchronization conception rates and overall synchronized conception rates resulting from the adoption of estrous synchronization as related to three assumed synchronized conception rates[a/]

SCR[b/]	Ranch Number														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Pre-synchronization Conception Rate[b/]														
	.72	.84	.84	.91	.92	.91	.90	.94	.94	.96	.95	.93	.94	.96	.98
	Overall Synchronized Conception Rate[b/]														
76.50%	.91	.93	.92	.94	.93	.94	.93	.94	.94	.95	.94	.93	.94	.95	.97
69.04%	.89	.93	.91	.93	.93	.93	.92	.93	.93	.95	.94	.92	.94	.95	.97
60.75%	.86	.92	.90	.92	.92	.92	.91	.93	.93	.95	.94	.92	.93	.95	.97

[a/] This table should be read as follows: For ranch No. 6 the pre-synchronization conception rate is 91 percent and for the assumed SCR of 76.50 percent its overall synchronized conception rate resulting from the adoption of estrous synchronization is 94 percent.

[b/] See Appendix K for definitions.

X_{2i} = pre-synchronization average weaning weight for the i^{th} ranch

X_{3i} = pre-synchronization cow-bull ratio for the i^{th} ranch

X_{4i} = pre-synchronization number of cows for the i^{th} ranch

Stepwise regressions were run for each of the three assumed SCR's. The pre-synchronization conception rate, weaning weight, cow-bull ratio, and number of cows were regressed first on the difference per cow associated with the 76.5 percent SCR, second on the difference per cow associated with 69.04 percent SCR, and third on the difference per cow associated with the 60.75 percent SCR (Appendix I). Equations 2, 3, and 4 are the resulting regression equations, with respect to the 76.5, 69.04, and 60.75 percent SCR's.

$$\text{Eq. 2:} \quad y^{76.5} = 63.00908 - 76.54076X_1 + .02487X_2 - .11394X_3$$

$$\text{Eq. 3:} \quad y^{69.04} = 57.91819 - 71.74565X_1 + .01933X_2 - .07222X_3$$

$$\text{Eq. 4:} \quad y^{60.75} = 46.98097 - 62.92256X_1 + .02031X_2 - .07639X_3$$

The independent variable X_4 (number of cows) is not included in the above equations, since it did not have a significant effect on the dependent variable y (difference per cow). However, the independent variables X_1, X_2, and X_3 (conception rate, weaning weight, and cow-bull ratio) have a significant effect on the dependent variable y (per cow difference) (Table 10). The cow-bull

Table 10. Conception rate, weaning weight, and cow-bull ratio significance levels on per cow difference for three assumed SCR's. a/

SCR	Significance level of		
	Conception rate (X_1)	Weaning weight (X_2)	Cow-bull ratio (X_3)
	Percent		
76.50	.1	2	5
69.04	.1	10	20
60.75	.1	5	10

a/ This table should be read as follows: For the 76.50 percent SCR the pre-synchronized conception rate was significant at the .1 percent level.

ratio is maintained in all equations since it is highly significant in two of the equations. As indicated by the degree of significance, the conception rate has the greatest effect and the cow-bull ratio the least effect on the per-cow difference.

The parameters of conception rate (b_1) and cow-bull ratio (b_3) are negative, while the constant parameter (b_o) and the

parameter for weaning weight (b_2) are positive. The negative conception rate (or cow-bull ratio) parameter reflects that the difference per cow will be larger for a ranch having a low conception rate (or cow-bull ratio) than for the same ranch with a higher conception rate (or cow-bull ratio). The positive weaning weight parameter means that the difference per cow will be larger if the ranch has a high weaning weight rather than a low weaning weight, other things constant.

Regression equations were calculated for only three assumed SCR's, 76.5, 69.04, and 60.75 percent (eq. 2, 3, and 4). Equations to estimate parameters corresponding to the other SCR's were calculated. Since the three previously estimated values for each of the parameters exhibited a linear relationship (Figure 4), a simple linear regression was used to calculate these equations.[15/]

The three values of b_0 were regressed on the three SCR's, the three values of b_1 were regressed on the three SCR's, the three values of b_2 were regressed on the three SCR's, and finally the three values of b_3 were regressed on the three SCR's. Equations 5, 6, 7, and 8 are the resulting equations for b_0, b_1, b_2, and b_3, respectively.

15/ The relationships are not exactly linear; however, it was thought that if an adequate number of observations were available then an estimate by least squares would give a linear equation, at least within the 60.75-76.5 percent SCR range.

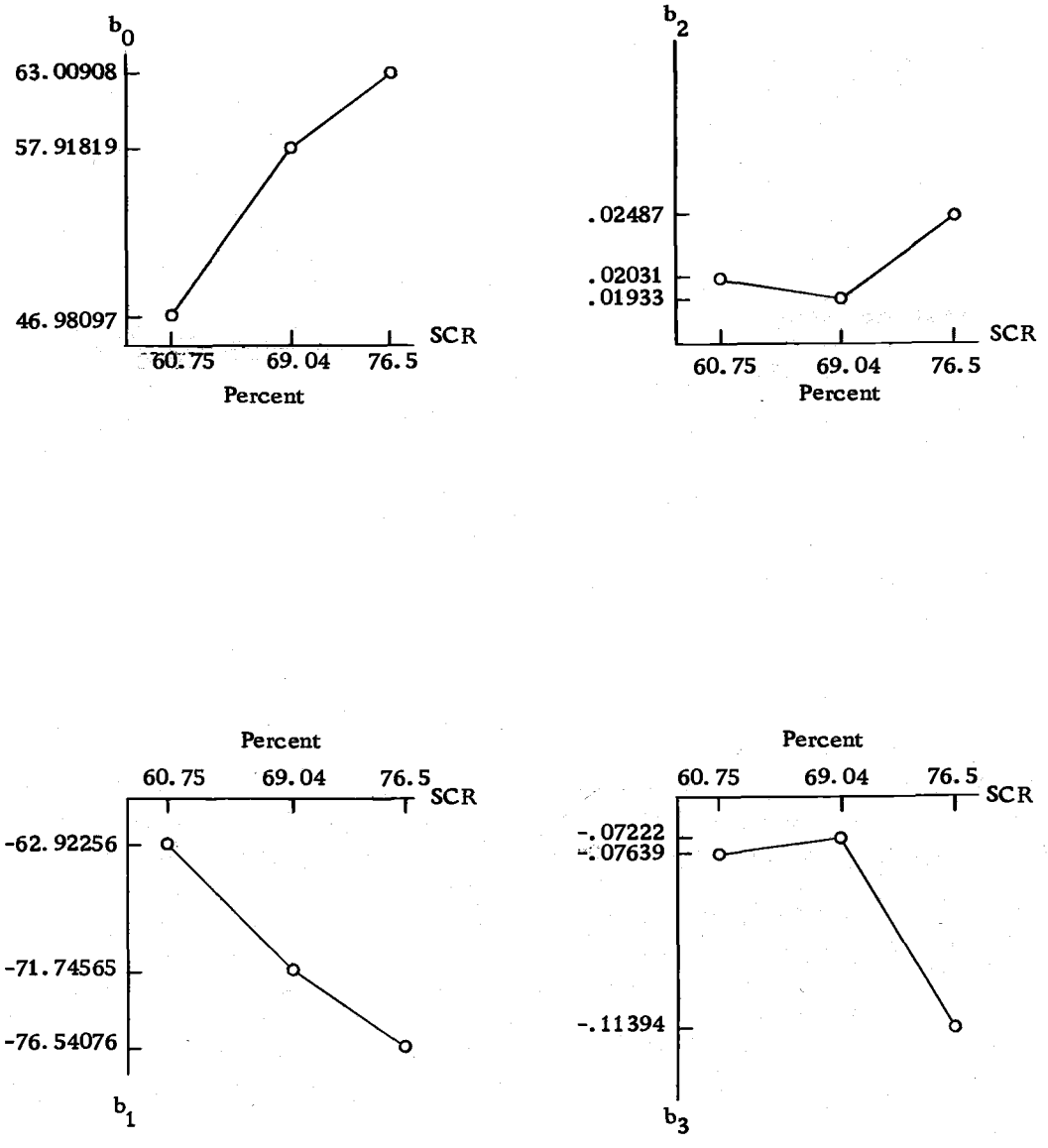

Figure 4. Graphs showing the linear relationship between the parameter and corresponding SCR's.

Eq. 5: $b_0 = -14.3914 + 1.0232\ (SCR)$

Eq. 6: $b_1 = -10.6933 - 0.8683\ (SCR)$

Eq. 7: $b_2 = -0.0021 + 0.0003\ (SCR)$

Eq. 8: $b_3 = 0.0728 - 0.0023\ (SCR)$

The parameters for various SCR's were calculated by substituting the value of the expected SCR's into these equations and solving for each of the parameters (Table 11). The estimated parameters corresponding to SCR's within the original range (60.75% - 76.5%) should be reliable. Parameters associated with SCR's outside of this range can also be estimated; however, it should be realized that the reliability of such estimates depends upon the parameters exhibiting a linear relation outside of this range.[16/]

The parameter for a regression equation associated with a particular SCR can be obtained from Table 11.[17/] For example, the regression equation associated with a 70 percent SCR is

$$y^{70} = 57.2326 - 71.4743X_1 + 0.0189X_2 - 0.0882X_3 .$$

16/ Reliance on such a prediction is dangerous and becomes more dangerous the further the expected SCR lies outside the original range, unless some additional knowledge is available that indicates that the regression equation is valid outside of the original range.

17/ If the parameter for the desired SCR is not available in Table 11, then the parameter can be calculated from equations 5, 6, 7, and 8.

Table 11. Parameters corresponding to various SCR's.

Parameter \ SCR	62%	64%	66%	68%	70%	72%	74%
Constant (b_0)	49.0470	51.0934	53.1398	55.1862	57.2326	59.2790	61.3254
Conception rate (b_1)	-64.5279	-66.2645	-68.0011	-69.7377	-71.4743	-73.2109	-74.9475
Weaning weight (b_2)	0.0165	0.0171	0.0177	0.0183	0.0189	0.0195	0.0201
Cow-bull ratio (b_3)	- 0.0698	- 0.0744	- 0.0790	- 0.0836	- 0.0882	- 0.0928	- 0.0974

The regression equations (equations 2, 3, 4, and equations calculated for other SCR's) can be used to predict the profit or loss (difference) per cow that a rancher could expect from the adoption of estrous synchronization. This difference is calculated by substituting the ranch values for conception rate (X_1), weaning weight (X_2), and cow-bull ratio (X_3) into the desired prediction equation and solving for y (difference per cow). For example, using equation 2 and a ranch with X_1, X_2, and X_3 equal to 89.65 percent, 390 pounds, and 25, respectively, the difference per cow is $1.25. Each prediction equation is associated with a particular SCR. This means that a rancher should use that prediction equation which corresponds to his expected SCR.

The steps which a rancher needs to follow in predicting his possible profit or loss per cow from estrous synchronization are summarized below.

1. Estimate the expected SCR of the ranch.
2. Find the prediction equation corresponding to that SCR.
3. Substitute the ranch values of conception rate, weaning weight, and cow-bull ratio into this equation and solve for y.

The y represents the predicted profit or loss per cow resulting from the adoption of estrous synchronization.

VI. DISCUSSION AND SUMMARY

Discussion

The nature of this study was different from most cost studies in that it considered a technological innovation which was not yet generally practiced. The major contribution of the study was to develop information useful to those ranchers considering adopting this technological innovation.

Certain pre-synchronization ranch characteristics (conception rate, weaning weight, and cow-bull ratio) significantly affected the economic feasibility of estrous synchronization. Conception rate had the greatest effect and cow-bull ratio the least effect on the difference per cow resulting from the adoption of estrous synchronization. Conception rate and cow-bull ratio parameters are negative, while the weaning weight parameter is positive. This means that, other things constant, a ranch having a low conception rate will have a larger difference per cow than for the same ranch having a higher conception rate (Figure 5A). Also, the difference per cow will be larger if the ranch has a low cow-bull ratio rather than a high cow-bull ratio, other things constant (Figure 5B). The positive weaning weight parameter means that the difference per cow will be larger if the ranch has

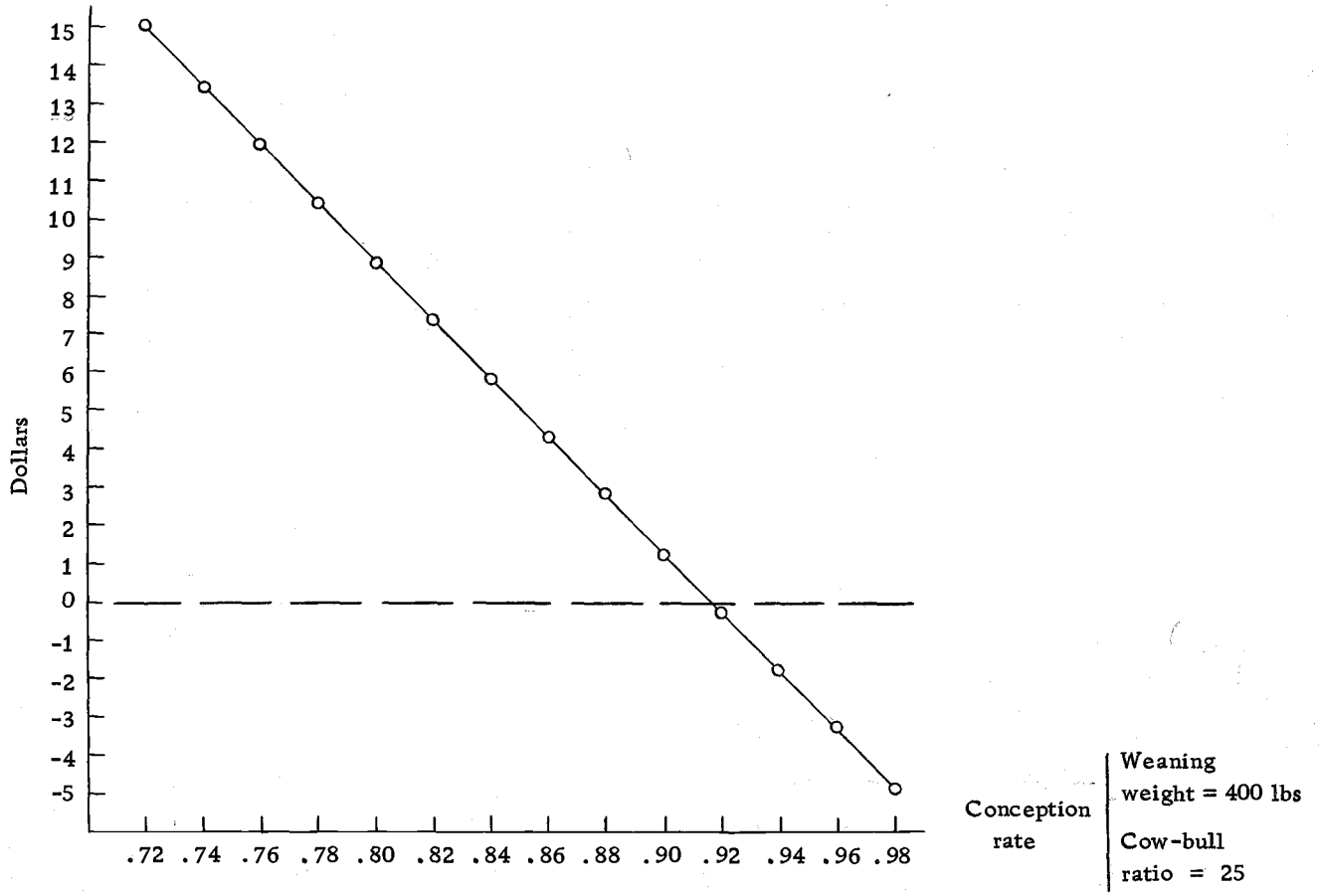

Figure 5A. Difference per cow, corresponding to various pre-synchronization conception rates, resulting from adopting estrous synchronization at 76.5 percent SCR.

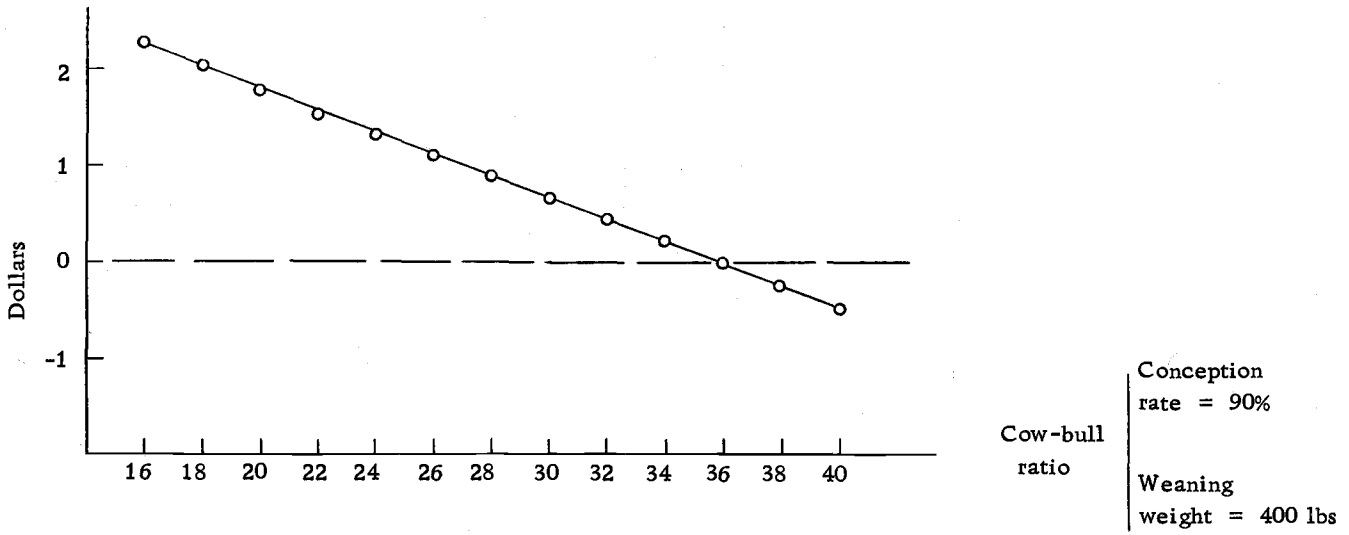

Figure 5B. Difference per cow, corresponding to various pre-synchronization cow-bull ratios, resulting from adopting estrous synchronization at 76.5 percent SCR.

a high weaning weight rather than a low weaning weight, other things constant (Figure 5C). Hence, it would be more profitable for ranchers having a low conception rate and cow-bull ratio, and a high weaning weight to adopt estrous synchronization. This combination does not generally occur together. Most of the ranches located in areas of adverse breeding conditions had a low conception rate, cow-bull ratio, and weaning weight, while ranches located in areas of favorable breeding conditions generally had a higher conception rate, cow-bull ratio, and weaning weight. The synchronization partial budgets (Appendix H) indicated that those ranchers operating under adverse breeding conditions (as indicated by the level of conception rate, weaning weight, and cow-bull ratio) benefited from the adoption of estrous synchronization, while the ranchers operating under favorable breeding conditions did not benefit from adopting estrous synchronization (Figure 6). The reason for this result is that under adverse range conditions the low conception rate and cow-bull ratio effects, which are conducive to adopting estrous synchronization, outweighed the low weaning effect, which is not conducive to adopting estrous synchronization. However, under favorable range conditions the high weaning weight effect, which is conducive to adopting estrous synchronization, was overshadowed by the high conception rate and cow-bull ratio effects, which are not conducive to adopting estrous synchronization.

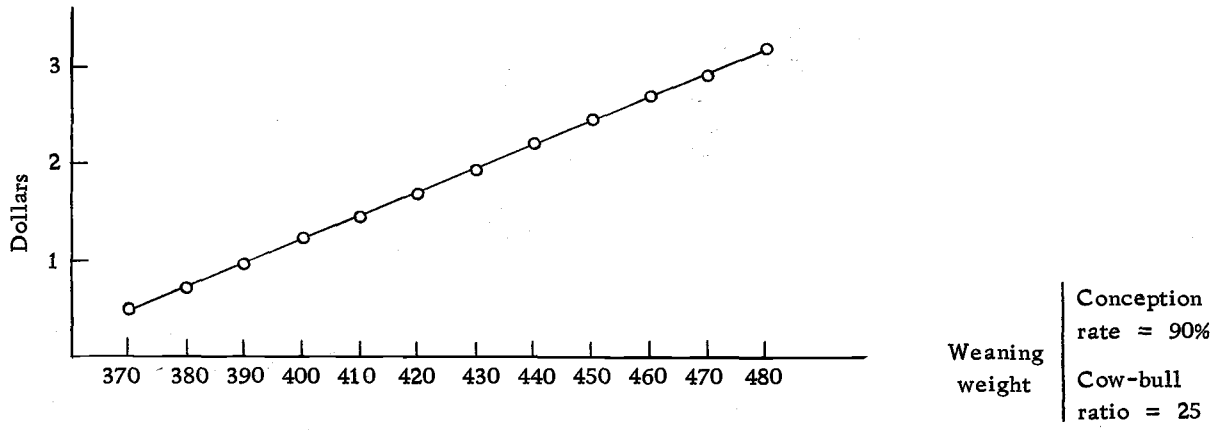

Figure5C. Difference per cow, corresponding to various pre-synchronization weaning weights, resulting from adopting estrous synchronization at 76.5 percent SCR.

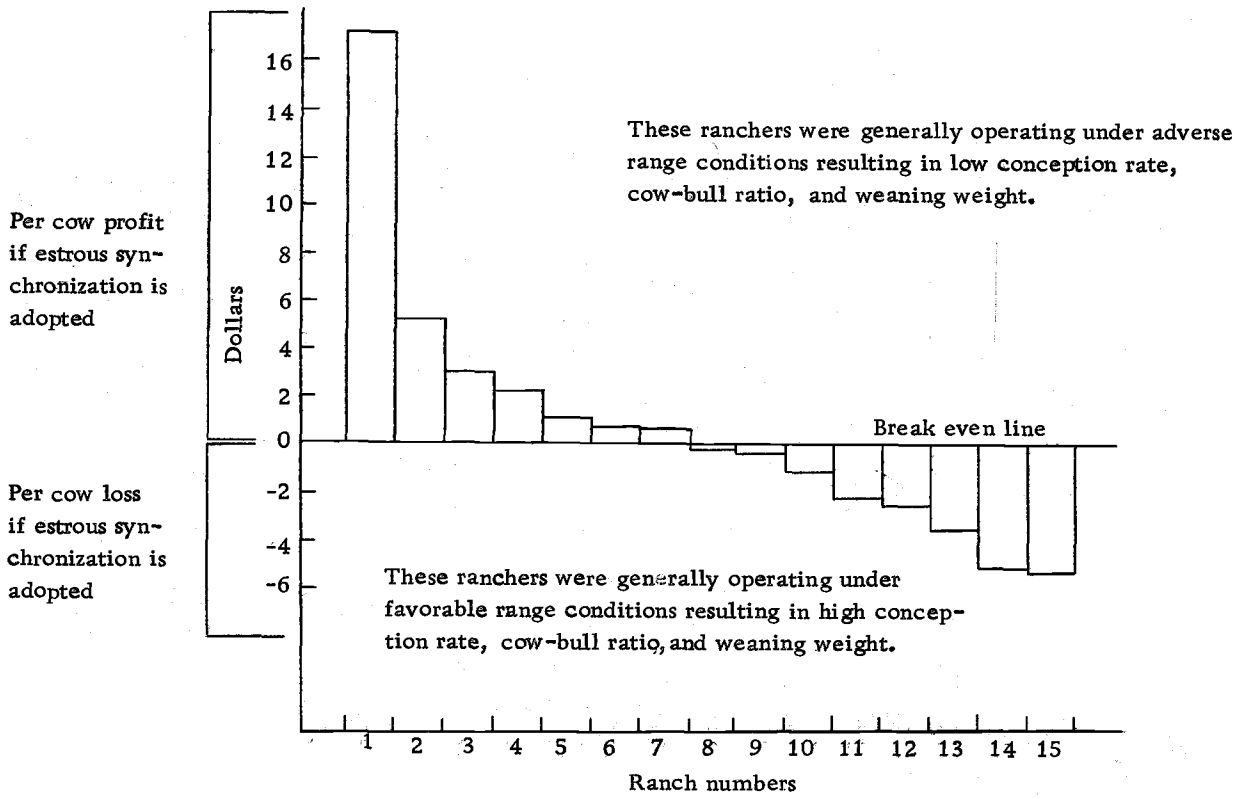

Figure 6. Distribution and degree of feasibility in adopting estrous synchronization at the 76.5 percent SCR. (This figure should be read as follows: Ranch 5 had a per cow profit of $1.03 resulting from the adoption of estrous synchronization at 76.5 percent SCR.)

Hence, it was concluded that ranchers located in areas of adverse breeding conditions (such as the desert areas in southeastern Oregon and rough mountainous areas elsewhere in Oregon) might adopt estrous synchronization as a means of increasing ranch efficiency. Those ranchers located in areas having favorable breeding conditions (such as the Willamette Valley and certain areas around John Day, Oregon) should seek other ways to increase ranch efficiency.

There are several ways of improving the economic feasibility of estrous synchronization. First, the partial budgets revealed that the feasibility increased as the SCR increased. The SCR is largely dependent upon two factors--the technician's ability to successfully artificially inseminate the cows and the degree to which the hormone depresses conception. Hence, both the technician (rancher in this study) and hormone producer can aid in increasing the SCR and subsequently increase the economic feasibility of estrous synchronization. Second, approximately 33 percent of the per cow cost, resulting from the adoption of estrous synchronization, is for the hormone. Thus, a less expensive hormone would significantly affect the economic feasibility of estrous synchronization. By reducing the hormone cost from $4.50 to $1.50 per cow, it would be economically feasible for six additional sample ranchers to adopt estrous

synchronization at the assumed SCR of 76.5 percent (Figure 7). Third, if the weaning weight of calves sired by A. I. was to exceed the pre-sychronization weaning weight by more than 21 pounds or if the calves sired by A. I. were to receive more than one cent a pound above the price of calves sired naturally then the economic feasibility of estrous synchronization would be improved.

There are several limitations to this study. First, it must be emphasized that the values generated in this study should be associated with the short run. This study considered only the first year effect of adopting estrous synchronization. In the long run the replacement heifers from superior A. I. bulls will produce offspring. The increase in weaning weight of their calves should be more than the 21 pounds allowed in this study. Also, they should produce calves of higher quality than the calves sired by A. I. in this study. Thus, the increase in price paid for these calves may be greater than one cent a pound. Second, many ranchers do not presently observe their cows as closely as is necessary when using estrous synchronization. This closer observation in itself may improve management and subsequently increase ranch efficiency. Since it was not possible to accurately estimate the increase in ranch efficiency due to an improvement in management, no allowance was made for managerial effect. Furthermore, if actual ranch data had been available on estrous

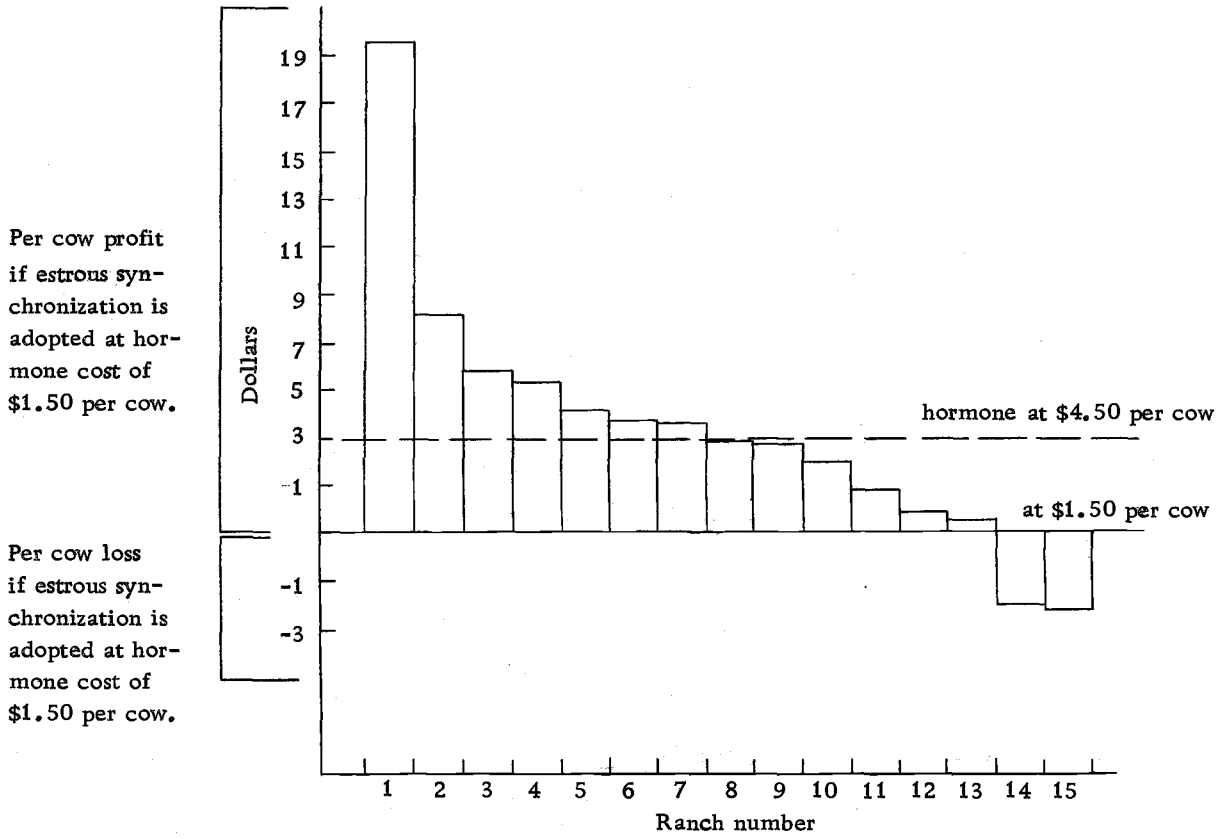

Figure 7. Effect of a reduction in the hormone cost on the distribution and degree of feasibility in adopting estrous synchronization at the 76.5 percent SCR. (This figure should be read as follows: with a 76.5 per cent SCR and with a hormone cost of $4.50 per cow, ranch 13 lost $2.72 per cow, while with a hormone cost of $1.50 the ranch would have a per cow profit of $0.28. ($3.00 -$2.72=$0.28).)

synchronization, it would have been difficult to determine what portion of the change in ranch efficiency was due to adopting estrous synchronization and what portion was due to a change in management. Third, the 21 pounds increase in weaning weight of calves sired by A. I. was entirely genetic. However, when using synchronization of estrus the average age of the calves at weaning is older (due to a larger percent of the cows conceiving early) than prior to estrous synchronization. This should increase the weaning weight. Allowance was not made for this factor.

Summary

The adoption of estrous synchronization, with subsequent artificial insemination, is being considered by beef ranchers as a means of increasing economic efficiency. These ranchers are in need of guidelines to aid them in estimating possible profit or loss on their ranch resulting from the adoption of estrous synchronization.

The present study was designed to test the economic feasibility of adopting estrous synchronization for selected Oregon beef ranches. The specific objectives of the study are as follows:

1. To determine under what conditions it is economically feasible to adopt estrous synchronization.
2. To identify those factors which significantly affect the

profitability of adopting estrous synchronization and to determine the extent of the effect.

3. To identify those factors which are affected as a result of adopting estrous synchronization and to determine the extent of the effect upon such factors.
4. To propose optimum conditions under which estrous synchronization can be profitably adopted.

Though generally applicable to all beef producing counties, the primary data were taken from ranches located in Benton, Grant, Harney, Josephine, Klamath, Morrow, and Wheeler counties.

Livestock Extension personnel of Oregon State University provided a list of beef producers who were familiar with synchronization of estrus. Personal interviews were held with the operators of these ranches. Data on livestock production, sales, equipment, and management practices were obtained for all ranches. Ranch data were used in developing partial budgets representing the adoption of estrous synchronization. Three synchronization partial budgets (one for each of three assumed SCR's) were structured for each ranch. These partial budgets revealed that as the SCR was reduced from 76.5 to 60.75 percent the percentage of sample ranches having a positive difference (profit or loss) per cow decreased from 47 to 7. Also, those ranches exhibiting the positive differences generally had a low pre-synchronization

conception rate and cow-bull ratio. The per cow cost resulting from the adoption of estrous synchronization ranged between $13.30 and $14.52.

The pre-synchronization ranch values of conception rate, weaning weight, cow-bull ratio, and number of cows were regressed first on the difference per cow associated with the 76.5 percent SCR, second on the difference per cow associated with the 69.04 percent SCR, and third on the difference per cow associated with the 60.75 percent SCR. Conception rate, weaning weight, and cow-bull ratio exhibited a significant effect on the difference per cow; however, it was not significantly affected by number of cows. The parameters of conception rate (b_1) and cow-bull ratio (b_3) were negative, while the constant parameter (b_0) and the parameter of weaning weight (b_2) were positive.

Equations to estimate parameters (b_0, b_1, b_2, and b_3) for regression equations associated with other SCR's were calculated. Linear regression was used for these calculations.

The three equations resulting from the stepwise regression and equations corresponding to other SCR's can be used by ranchers to estimate profit resulting from the adoption of estrous synchronization.

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APPENDICES

APPENDIX A

Data From Repromix Field Trials Conducted in 1964

	No. of Animals	% Syn.	Conception Rate[a/] 1st Service	Conception Rate[a/] Total 2 Services	Conceived[b/] Within 26 Day Period
02 - Montana					
Repromix	97	64	50	72	72
Controls	47		68	81	28
03 - Montana					
Repromix	47	100	47	70	79
Controls	47		50	57	53
04 - Montana					
Repromix	50	76	54	78	78
Controls	50		83	90	52
05 - North Dakota					
Repromix	55	91	38	62	62
Controls	55		27	39	20
06 - Colorado					
Repromix	49	86	25	51	39
Controls	45		47	62	49
07 - Wyoming					
Repromix	50	80	12	40	38
Controls	51		27	53	24
08 - Montana					
Repromix	98	60	54	81	66
Controls	47		55	76	43
09 - Oklahoma					
Repromix	150	67	49	78	58
Controls	35		78	78	20
10 - South Dakota					
Repromix	60	56	37	62	47
Controls	66		57	74	42
11 - South Dakota					
Repromix	289	80	31	60	55
Controls	49		32	60	37
12 - Iowa					
Repromix	98	95	35	56	56
Controls	58		53	71	48
13 - Illinois					
Repromix	37	92	27	62	57
Controls	22		60	70	45
14 - North Dakota					
Repromix	47	98	34	64	66
Controls	45		79	79	20
15 - Iowa					
Repromix	44	91	32	64	61
Controls	38		47	59	32

APPENDIX A (continued)

	No. of Animals	% Syn.	Conception Rate[a/] 1st Service	Conception Rate[a/] Total 2 Services	Conceived[b/] Within 26 Day Period
16 - North Dakota					
Repromix	164	73	52	63	55
Controls	47		46	57	45
17 - Iowa					
Repromix	58	66	22	53	59
Controls	56		36	57	39
18 - North Dakota					
Repromix	562	59	38	54	40
Controls	52		48	56	27
01 - Iowa					
Repromix	20	65	11	39	35
Controls	21		33	48	34

Source: The Repromix Story (23)

a/ Proportion of bred diagnosed pregnant.

b/ Proportion of the entire group (whether bred or not) diagnosed pregnant.

APPENDIX B

Construction Cost of Extra Facilities Resulting From the Adoption of Estrous Synchronization

The cost of materials used is based upon current prices. The corrals are square with x dimensions. The construction cost is $0.660875 per linear foot. Based upon 100 square feet per cow and n cows per corral the construction cost per square foot is $0.26435/$\sqrt{n}$. The pastures are rectangular with x by 2x dimensions. The construction cost per linear foot is $0.0783. Based upon eight tenths of an acre per cow and n cows per pasture, the construction cost per acre is $77.5175/$\sqrt{n}$. It is assumed that all ranches previously had a corral, pasture, and water trough adequate for one group of treated cows (approximately 100 cows). Therefore, the formulas for construction cost of those facilities are adjusted downward by $\frac{Q-1}{Q}$ (where Q is the number of sets of facilities used and Q-1 is the number of facilities built).

The cost per cow for these facilities are:

Feed bunk cost per cow = (2 linear ft.) (0.85 per linear ft.)

Corral cost per cow = (100 sq. ft.) $\left(\frac{Q-1}{Q}\right)$ $\left(\frac{\$0.26435}{\sqrt{n} \text{ sq. ft.}}\right)$

Pasture cost per cow = (.8 acre) $\left(\frac{Q-1}{Q}\right)$ $\left(\frac{\$77.5175}{\sqrt{n} \text{ acre}}\right)$

Water trough cost per cow = $\left(\frac{1}{n} \text{ trough}\right)\left(\frac{Q-1}{Q}\right)$ ($100 per trough)

APPENDIX C

Cost of Ration, Hormone, Semen, Refrigerator and Supplies Resulting from the Adoption of Estrous Synchronization

The cost of the materials used in based on current prices. A pelleted ration of 95 percent barley and 5 percent molasses is used in this study. The cost per ton (including pelleting) is $70.00. This ration is fed to the cows for 30 days, then the synchronization hormone is added and it is fed for an additional 18 days.

The cost of the ration and hormone per cow are:

Preliminary ration cost per cow = 2 lbs. per day for 30 days at 3.5¢ per lb. ---------- $ 2.10

Treatment ration cost per cow = 2 lbs. per day for 18 days at 3.5¢ per lb. ----------$ 1.26

Total ration cost per cow ---------- $ 3.36

Hormone cost per cow = 180 mgs. for 18 days at .1388¢ per mg.---------- $ 4.50

Semen refrigerator and nitrogen cost per ranch are based upon a rental fee of $1.00 per day with 45-day minimum. The cost of shipping the refrigerator to and from the ranch is based upon Northwest freight rates.

The refrigerator and freight cost per ranch are:

Refrigerator rental fee (includes nitrogen) per ranch ----------$45.00

Refrigerator freight rates per ranch ----------$20.00

Total cost per ranch ---------- $65.00

The semen and supplies per cow are based upon average prices paid by Northwest ranchers, as obtained from Waddell (26) of American Breeders Service and William (27) of All West breeders. The cost varies as the SCR varies. The cost per cow is shown in Table 1.

Table 1. Semen and supplies cost per cow resulting from the adoption of estrous synchronization as related to three assumed synchronized conception rates (SCR).

SCR (Appendix D)	Number of inseminations per cow (Appendix E)	Cost per cow	
		Semen $3.00 per insemination	Supplies $0.10 per insemination
Percent	Number	Dollars	Dollars
76.50	1.350	4.05	0.1350
69.04	1.418	4.25	0.1418
60.75	1..485	4.46	0.1485

APPENDIX D

Calculations of Various Types of Conception Rates Resulting from the Adoption of Estrous Synchronization

In obtaining the various types of conception rates the survey of supporting data (Chapter 3) was relied upon heavily. The general assumptions are as follows:

1. All cows that exhibit estrus during the first and second synchronization periods are artificially inseminated.
2. Only those cows that do not conceive from the insemination at the first synchronization period exhibit estrus during the second synchronization period.
3. Those cows which do not exhibit estrus during the first synchronization period come into estrus between the 5th and 18th day, and are exposed to bulls during this period.
4. All cows that have not conceived by the 26th day post treatment are exposed to bulls for the following 45 days.

The conception rates are shown in Table 1.

APPENDIX D

Table 1. Assumed synchronization and conception rates resulting from the adoption of estrous synchronization.

Day			(%)	(%)	(%)
		Synchronized conception rate (C+I)[a]	76.50	69.04	60.75
		26 day conception rate (C+F+I)[a]	81.50	74.04	65.75
1	First synchronization period (5 days)	A. Total cows exhibiting estrus	90	90	90
		B. Cows exhibiting estrus that conceive	50	42.5	35
		C. Total cows that conceive (A*B=C)	45	38.25	31.5
6	Bulls with cows (12 days)	D. Total animals exhibiting estrus	10	10	10
		E. Cows exhibiting estrus that conceive	50	50	50
		F. Total cows that conceive (D*E=F)	5	5	5
18	Second synchronization	G. Total cows that exhibit estrus (A-C=G)	45.00	51.75	58.50
		H. Cows exhibiting estrus that conceive	70.00	59.50	50.00
		I. Total cows that conceive (G*H=I)	31.50	30.79	29.25
27	Bulls with cows (45 days)	The post-synchronization conception rate[a] is derived from: [100% - (percent 26 day conception rate + percent non-breeders + percent cow death loss)] [pre-synchronization conception rate][b]			
72					

[a] See Appendix K for definitions.

[b] The percent non-breeders and percent cow death loss varies over ranches; thus, no values are given.

APPENDIX E

Number of Inseminations per Cow

It is assumed that all cows exhibiting estrus during the first and second synchronization periods are inseminated. Therefore, the inseminations per cow is the sum of the percent of cows exhibiting estrus in the first period and percent exhibiting estrus during the second period. The percent of cows exhibiting estrus during the second period varies as the SCR varies. Table 1 shows the number of inseminations per cow.

Table 1. Number of inseminations per cow resulting from the adoption of estrous synchronization as related to three assumed SCR's.

SCR	Cows in estrus first period[a/]	+	Cows in estrus second period[a/]	=	Inseminations per cow
Percent	Percent		Percent		Number
76.50	.90	+	.4500	=	1.350
69.04	.90	+	.5175	=	1.418
60.75	.90	+	.5850	=	1.485

a/ Appendix D.

APPENDIX F

Rates Charged for Interest, Depreciation, and Repairs

Interest on operating capital was computed at seven percent of one half of the operating expenses, i.e., three and a half percent of the total operating expenses. The interest on working capital (cattle) and fixed capital (extra facilities) is computed at five and one quarter percent. The interest on the cattle is based on the following values: cows, $180; yearling replacements, $160; weanling replacements, $123; coming yearling steers, $137; bulls according to purchase price on concerned ranch.

The depreciation of a bull is the purchase value minus salvage value divided by number of years on the ranch. The depreciation of extra facilities is constructed on straight line method with life expectancy of pastures at 20 years and corrals, bunks, and water troughs at 10 years.

The annual repairs of the extra facilities is computed at one percent of original value.

APPENDIX G

Calculation of Additional Receipts and Reduced Cost Resulting from the Adoption of Estrous Synchronization

The additional receipts resulting from the adoption of estrous synchronization are due to three factors--increase in weaning weight of A. I. calves (calves sired by A. I.), increase in sale price of A. I. calves, and increase in number of calves sold. The weaning weight of each A. I. calf is increased by 21 pounds over the pre-synchronization weaning weight. The sale price of these A. I. calves is increased over the sale price of natural calves (calves sired naturally) by $1.00 per cwt. Also, in most cases the adoption of estrous synchronization resulted in an increase in the number of calves sold. Refer to Appendix J to find number of calves weaned. Also, reference should be made to Appendix K for definition of terms.

The additional receipts due to increase in weaning weights of steers and heifers are:

Increase steer receipts = (No. A. I. steer weaned) (21 lbs.) ($0.2832/lb.)

Increase heifer receipts = [(No. A. I. heifers weaned) - (replacement heifers)] [21 lbs.] [$0.2433/lb.]

The additional receipts due to increase in the number of

steers and heifers are:

Increase steer receipts = [(A. I. steers weaned + natural steers weaned) - (Pre-synchronization steers weaned)] [Pre-synchronization steer sale weight] [$0.2832/lb.]

Increase heifer receipts = [(A. I. heifers weaned + natural heifers weaned) - (Pre-synchronization heifers weaned)] [Pre-synchronization heifer sale weight] [$0.2433/lb.]

The additional receipts due to increase in sale price of steers and heifers are:

Increase steer receipts = [A. I. Steers weaned] [Pre-synchronization steer sale weight + 21 pounds] [$0.01/lb.]

Increase heifer receipts = [A. I. heifers weaned - replacement heifers] [Pre-synchronization sale weight + 21 pounds] [$0.01/lb.]

The reduced costs resulting from the adoption of estrous synchronization are due to two factors--a decrease in bull depreciation and a decrease in interest on working capital (cattle). The decrease in bull depreciation results from fewer bulls being needed when using artificial insemination.

The reduced cost of bull depreciation and interest on working capital are:

Reduced bull depreciation = (No. bulls) (depreciation per bull)

Reduced interest on working capital = [(No. bulls removed) (bull inventory value)] - [(No. cows added) (cow inventory value)] [5.25%]

APPENDIX H

Pre-synchronization Data and Synchronization Partial Budgets
Corresponding to Three Assumed Synchronized Conception Rates

Ranch 1

Number of cows[a/]	560	Number replacement heifers	40
Number of bulls	34	Percent calf death loss[a/]	9.20
Percent conception rate[a/]	71.78	Number calves weaned	st. 182 he. 183
Percent cow death loss[a/]	0.36	Sale weight (lbs)	st. 395 he. 359
Percent non-breeders[a/]	5.00	Marketing cost per head (dollars)	0.00

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 2,123.44	$ 1,891.25	$ 1,625.90
b) Increase due No. calves " "	13,259.64	11,865.18	10,159.64
c) Increase due sale price " "	1,523.76	1,356.60	1,165.56
sub total	$16,906.84	$15,113.03	$12,951.10
Reduced Costs:			
a) Bull depreciation (App. G)	$ 687.50	632.50	550.00
b) Interest on working capital (App. G)	288.75	265.65	231.00
sub total	$ 976.25	$ 898.15	$ 781.00
Total Credits:	$17,883.09	$16,011.18	$13,732.10
Additional Costs:			
a) Feed (App. C)	$ 1,965.60	$ 1,958.88	$ 1,948.80
b) Hormone " "	2,632.50	2,623.50	2,610.00
c) Semen " "	2,370.00	2,481.00	2,583.00
d) Supplies " "	79.00	82.70	86.10
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	0.00	0.00	0.00
g) Dep. & repair on extra facilities (App. F)	492.41	490.36	489.80
h) Int. on oper. cost & fixed capital	559.21	561.30	563.91
Total Debits:	$ 8,163.72	$ 8,262.74	$ 8,346.61
Difference per ranch:	$ 9,719.37	$ 7,748.44	$ 5,385.49
Difference per cow treated:	$ 16.61	$ 13.29	$ 9.29

[a/] See Appendix K for definitions.

Ranch 2

Number of cows[a/]	70	Number replacement heifers	19
Number of bulls	3	Percent calf death loss[a/]	11.86
Percent conception rate[a/]	84.29	Number calves weaned	st. 26 he. 26
Percent cow death loss[a/]	0.00	Sail weight (lbs)	st. 410 he. 331
Percent non-breeders[a/]	5.00	Marketing cost per head (dollars)	0.74

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 179.34	$ 157.22	$ 118.11
b) Increase due No. calves " "	902.69	902.70	706.04
c) Increase due sale price " "	128.87	113.21	85.41
sub total	$1,210.90	$1,173.13	$ 909.56
Reduced Costs:			
a) Bull depreciation (App. G)	$ 120.66	$ 120.66	$ 60.33
b) Interest on working capital (App. G)	33.60	33.60	16.80
sub total	$ 154.26	$ 154.26	$ 77.13
Total Credits:	$1,365.16	$1,327.39	$ 986.69
Additional Costs:			
a) Feed (App. C)	$ 241.92	$ 241.92	$ 238.56
b) Hormone " "	324.00	324.00	319.50
c) Semen " "	291.00	306.00	315.00
d) Supplies " "	9.70	10.20	10.50
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	6.62	6.62	5.15
g) Dep. & repair on extra facilities (App. F)	13.46	13.46	13.28
h) Int. on oper. cost & fixed capital " "	39.31	39.85	39.76
Total Debits:	$ 991.01	$1,007.05	$1,006.75
Difference per ranch	$ 374.15	$ 320.34	-$ 20.06
Difference per cow treated:	$ 5.20	$ 4.45	-$ 0.28

[a/] See Appendix K for definitions.

Ranch 3

Number of cows[a/]	1,000	Number replacement heifers	285
Number of bulls	48	Percent calf death loss[a/]	8.57
Percent conception rate[a/]	83.92	Number calves weaned	st. 383 he. 384
Percent cow death loss[a/]	0.71	Sale weight (lbs)	st. 340 he. 290
Percent non-breeders[a/]	5.00	Marketing cost per head (dollars)	0.30

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 2,678.98	$ 2,258.83	$ 1,799.57
b) Increase due No. calves " "	10,941.21	9,606.45	7,938.00
c) Increase due sale price " "	1,626.93	1,371.57	1,092.44
sub total	$15,247.12	$13,236.85	$10,830.01
Reduced Costs:			
a) Bull depreciation (App. G)	$ 1,303.20	$ 1,194.60	$ 1.049.80
b) Interest on working capital (App. G)	510.30	467.78	411.08
sub total	$ 1,813.50	$ 1,662.38	$ 1,460.88
Total Credits:	$17,060.62	$14,899.23	$12,290.89
Additional Costs:			
a) Feed (App. C)	$ 3,480.96	$ 3,470.88	$ 3,457.44
b) Hormone " "	4,662.00	4,648.50	4,630.50
c) Semen " "	4,197.00	4,395.00	4,584.00
d) Supplies " "	139.90	146.50	152.80
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	39.30	34.50	28.50
g) Dep. & repair on extra facilities (App. F)	946.24	945.68	944.93
h) Int. on oper. cost & fixed capital " "	1,039.43	1,045.33	1,050.50
Total Debits:	$14,569.83	$14,751.39	$14,913.67
Difference per ranch:	$ 2,490.79	$ 147.84	-$ 2,622.78
Difference per cow treated:	$ 2.41	$ 0.14	-$ 2.55

[a/] See Appendix K for definitions.

Ranch 4

Number of cows[a/]	368	Number replacement heifers	35
Number of bulls	20	Percent calf death loss[a/]	3.90
Percent conception rate[a/]	90.50	Number calves weaned	st. 160 he. 160
Percent cow death loss[a/]	0.00	Sale weight (lbs)	st. 400 he. 364
Percent non-breeders[a/]	5.00	Marketing cost per head (dollars)	0.00

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 1,396.31	$ 1,236.41	$ 1,059.50
b) Increase due No. calves " "	2,914.34	2,422.09	1,905.13
c) Increase due sale price " "	1,013.62	896.93	767.97
sub total	$ 5,324.27	$ 4,555.43	$ 3,732.60
Reduced Costs:			
a) Bull depreciation (App. G)	$ 567.00	$ 491.40	$ 415.80
b) Interest on working capital (App. G)	252.00	218.40	184.80
sub total	$ 819.00	$ 709.80	$ 600.60
Total Credits:	$ 6,143.27	$ 5,265.23	$ 4,333.20
Additional Costs:			
a) Feed (App. C)	$ 1,286.88	$ 1,280.16	$ 1,273.44
b) Hormone " "	1,723.50	1,714.50	1,705.50
c) Semen " "	1,551.00	1,620.00	1,689.00
d) Supplies " "	51.70	54.00	56.30
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	0.00	0.00	0.00
g) Dep. & repair on extra facilities (App. F)	299.41	298.02	297.65
h) Int. on oper. cost & fixed capital " "	351.36	352.40	354.17
Total Debits:	$ 5,328.85	$ 5,384.08	$ 5,441.06
Difference per ranch:	$ 814.42	-$ 118.85	-$ 1,107.86
Difference per cow treated:	$ 2.13	-$ 0.31	-$ 2.93

[a/] See Appendix K for definitions.

Ranch 5

Number of cows[a]	1029	Number replacement heifers	125
Number of bulls	63	Percent calf death loss[a]	4.84
Percent conception rate[a]	92.42	Number calves weaned	st. 453 he. 452
Percent cow death loss[a]	0.49	Sale weight (lbs)	st. 400 he. 350
Percent non-breeders[a]	5.00	Marketing cost per head (dollars)	1.00

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 3,767.78	$ 3,314.46	$ 2,828.97
b) Increase due No. calves " "	6,633.51	5,442.90	4,167.14
c) Increase due sale price " "	2,692.62	2,367.90	2,019.42
sub total	$13,093.91	$11,125.26	$ 9,014.53
Reduced Costs:			
a) Bull depreciation (App. G)	$ 2,350.00	$ 2,100.00	$ 1,850.00
b) Interest on working capital (App. G)	789.60	705.60	621.60
sub total	$ 3,139.60	$ 2,805.60	$ 2,471.60
Total Credits:	$16,233.51	$13,930.86	$11,486.13
Additional Costs:			
a) Feed (App. C)	$ 3,615.36	$ 3,598.56	$ 3,581.76
b) Hormone " "	4,842.00	4,819.50	4,797.00
c) Semen " "	4,359.00	4,557.00	4,749.00
d) Supplies " "	145.30	151.90	158.30
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	67.00	55.00	42.00
g) Dep. & repair on extra facilities (App. F)	967.24	972.96	962.02
h) Int. on oper. cost & fixed capital " "	1,070.40	1,125.80	1,077.61
Total Debits:	$15,131.30	$15,345.72	$15,432.69
Difference per ranch:	$ 1,102.21	-$ 1,414.86	-$ 3,946.56
Difference per cow treated:	$ 1.03	-$ 1.32	-$ 3.71

[a] See Appendix K for definitions.

Ranch 6

Number of cows[a/]	219	Number replacement heifers	0
Number of bulls	6	Percent calf death loss[a/]	1.50
Percent conception rate[a/]	91.32	Number calves weaned	st. 99 he 98
Percent cow death loss[a/]	0.00	Sale weight (lbs)	st. 490 he 470
Percent non-breeders[a/]	5.00	Marketing cost per head (dollars)	0.50

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 934.69	$ 840.29	$ 740.79
b) Increase due No. calves " "	1,265.60	1,012.48	759.36
c) Increase due sale price " "	846.79	761.52	671.34
sub total	$3,047.08	$2,614.29	$2,171.49
Reduced Costs:			
a) Bull depreciation (App. G)	$ 143.00	$ 143.00	$ 107.25
b) Interest on working capital (App. G)	35.70	35.70	26.78
sub total	$ 178.70	178.70	134.03
Total Credits:	$3,225.78	$2,792.99	$2,305.52
Additional Costs:			
a) Feed (App. C)	$ 749.28	$ 749.28	$ 745.92
b) Hormone " "	1,003.50	1,003.50	999.00
c) Semen " "	903.00	948.00	990.00
d) Supplies " "	30.10	31.60	33.00
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	5.00	4.00	3.00
g) Dep. & repair on extra facilities (App. F)	122.83	122.84	123.04
h) Int. on oper. cost & fixed capital " "	171.23	172.82	173.72
Total Debits:	$3,049.94	$3,097.04	$3,132.68
Difference per ranch:	$ 175.84	-$ 304.05	-$ 827.16
Difference per cow treated:	$ 0.79	-$ 1.37	-$ 3.72

[a/] See Appendix K for definitions.

Ranch 7

Number of cows[a/]	396	Number replacement heifers	40
Number of bulls	16	Percent calf death loss[a/]	3.66
Percent conception rate[a/]	89.65	Number calves weaned	st. 171 he 171
Percent cow death loss[a/]	0.51	Sale weight (lbs)	st. 415 he 365
Percent non-breeders[a/]	5.00	Marketing cost per head (dollars)	0.30

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$1,476.22	$1,310.37	$1,122.41
b) Increase due No. calves " "	2,888.66	2,475.99	1,856.99
c) Increase due sale price " "	1,095.04	971.74	832.00
sub total	$5,459.92	$4,758.10	$3,811.40
Reduced Costs:			
a) Bull depreciation (App. G)	$ 417.00	$ 382.25	$ 312.75
b) Interest on working capital (App. G)	170.10	155.93	127.58
sub total	$ 587.10	$ 538.18	$ 440.33
Total Credits:	$6,047.02	$5,296.28	$4,251.73
Additional Costs:			
a) Feed (App. C)	$1,370.88	$1,367.52	$1,360.80
b) Hormone " "	1,836.00	1,831.50	1,822.50
c) Semen " "	1,653.00	1,731.00	1,803.00
d) Supplies " "	55.10	57.70	60.10
e) Refrig., nitrigen & freight (App. C)	65.00	65.00	65.00
f) Marketing	8.40	7.20	5.40
g) Dep. & repair on extra facilities (App. F)	360.33	358.68	358.31
h) Int. on oper. cost & fixed capital " "	401.65	403.03	404.84
Total Debits	$5,750.36	$5,821.63	$5,879.95
Difference per ranch:	$ 296.66	-$ 525.35	-$1,628.22
Difference per cow treated:	$ 0.73	-$ 1.29	-$ 4.02

[a/] See Appendix K for definitions.

Ranch 8

Number of cows[a/]	460	Number replacement heifers	68
Number of bulls	20	Percent calf death loss[a/]	3.94
Percent conception rate[a/]	93.70	Number calves weaned	st. 207 he. 207
Percent cow death loss[a/]	0.43	Sale weight (lbs)	st. 500 he. 453
Percent non-breeders[a/]	5.00	Marketing cost per head (dollars)	1.50

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$1,609.57	$1,415.66	$1,200.48
b) Increase due No. calves " "	2,376.55	1,872.92	1,369.29
c) Increase due sale price " "	1,438.83	1,264.47	1,070.68
sub total	$5,424.95	$4,553.05	$3,640.45
Reduced Costs:			
a) Bull depreciation (App. G)	$ 885.00	$ 767.00	$ 708.00
b) Interest on working capital (App. G)	291.38	252.53	233.10
sub total	$1,176.38	$1,019.53	$ 941.10
Total Credits:	$6,601.33	$5,572.58	$4,581.55
Additional Costs:			
a) Feed (App. C)	$1,596.00	$1,589.28	$1,585.92
b) Hormone " "	2,137.50	2,128.50	2,124.00
c) Semen " "	1,923.00	2,013.00	2,103.00
d) Supplies " "	64.10	67.10	70.10
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	28.50	22.50	16.50
g) Dep. & repair on extra facilities (App. F)	391.19	390.81	389.26
h) Int. on oper. cost & fixed capital " "	449.49	451.81	453.53
Total Debits:	$6,654.78	$6,728.00	$6,807.31
Difference per ranch:	-$ 53.45	-$1,155.42	-$2,225.76
Difference per cow treated:	-$ 0.11	-$ 2.44	-$ 4.71

[a/] See Appendix K for definitions.

Ranch 9

Number of cows[a]	1032	Number replacement heifers	100
Number of bulls	50	Percent calf death loss[a]	4.23
Percent conception rate[a]	93.99	Number calves weaned	st. 465 he. 464
Percent cow death loss[a]	0.48	Sale weight (lbs)	st. 425 he. 384
Percent non-breeders[a]	5.00	Marketing cost per head (dollars)	0.51

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$3,889.56	$3,442.19	$2,955.70
b) Increase due No. calves " "	4,703.32	3,634.38	2,565.45
c) Increase due sale price " "	2,981.98	2,637.53	2,263.09
sub total	$11,574.86	$9,714.10	$7,784.24
Reduced Costs:			
a) Bull depreciation (App. G)	$2,225.66	$1,991.38	$1,757.10
b) Interest on working capital (App. G)	1,037.40	928.20	819.00
sub total	$3,263.06	$2,919.58	$2,576.10
Total Credits:	$14,837.92	$12,633.68	$10,360.34
Additional Costs:			
a) Feed (App. C)	$3,595.20	$3,581.76	$3,568.32
b) Hormone " "	4,815.00	4,797.00	4,779.00
c) Semen " "	4,335.00	4,536.00	4.731.00
d) Supplies " "	144.50	151.20	157.70
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	22.51	17.34	12.24
g) Dep. & repair on extra facilities (App. F)	962.76	962.02	961.28
h) Int. on oper. cost & fixed capital " "	1,063.42	1,069.04	1,074.46
Total Debits:	$15,003.39	$15,179.36	$15,349.00
Difference per ranch:	-$ 165.47	-$2,545.68	-$4,988.66
Difference per cow treated:	-$ 0.15	-$ 2.39	-$ 4.69

[a] See Appendix K for definitions.

Ranch 10

Number of cows[a/]	233	Number replacement heifers	35
Number of bulls	11	Percent calf death loss[a/]	5.80
Percent conception rate[a/]	96.14	Number calves weaned	st. 105 he. 105
Percent cow death loss[a/]	0.43	Sale weight (lbs)	st. 475 he. 423
Percent non-breeders[a/]	3.43	Marketing cost per head (dollars)	1.00

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 794.15	$ 705.69	$ 590.02
b) Increase due No. calves " "	1,187.18	1,052.66	815.22
c) Increase due sale price " "	671.80	596.60	498.16
sub total	$2,653.13	$2,354.95	$1,903.40
Reduced Costs:			
a) Bull depreciation (App. G)	$ 336.00	$ 294.00	$ 252.00
b) Interest on working capital (App. G)	134.40	117.60	100.80
sub total	$ 470.40	$ 411.60	$ 352.80
Total Credits:	$3,123.53	$2,766.55	$2,256.20
Additional Costs:			
a) Feed (App. C)	$ 809.76	$ 806.40	$ 803.04
b) Hormone " "	1,084.50	1,080.00	1,075.50
c) Semen " "	975.00	1,020.00	1,065.00
d) Supplies " "	32.50	34.00	35.50
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	10.00	9.00	7.00
g) Dep. & repair on extra facilities (App. F)	185.61	185.43	185.24
h) Int. on oper. cost & fixed capital " "	220.00	221.23	222.42
Total Debits:	$3,382.37	$3,421.06	$3,458.70
Difference per ranch:	-$ 258.84	-$ 654.51	-$1,202.50
Difference per cow treated:	-$ 1.07	-$ 2.72	-$ 5.03

[a/] See Appendix K for definitions.

Ranch 11

Number of cows[a/]	273	Number replacement heifers	30
Number of bulls	14	Percent calf death loss[a/]	5.41
Percent conception rate[a/]	94.87	Number calves weaned	st. 122 he. 123
Percent cow death loss[a/]	0.73	Sale weight (lbs)	st. 440 he. 405
Percent non-breeders[a/]	4.40	Marketing cost per head (dollars)	0.00

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$1,001.71	$ 886.03	$ 758.46
b) Increase due No. calves " "	1,240.33	1,017.19	794.04
c) Increase due sale price " "	798.94	705.98	603.80
sub total	$3,040.98	$2,609.20	$2,156.30
Reduced Costs:			
a) Bull depreciation (App. G)	$ 172.50	$ 155.25	$ 138.00
b) Interest on working capital (App. G)	115.50	103.95	92.40
sub total	$1,288.00	$ 259.20	$ 230.40
Total Credits:	$3,328.98	$2,868.40	$2,386.70
Additional Costs:			
a) Feed (App. C)	$ 950.88	$ 947.52	$ 944.16
b) Hormone " "	1,273.50	1,269.00	1,264.50
c) Semen " "	1,146.00	1,200.00	1,251.00
d) Supplies " "	38.20	40.00	41.70
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	0.00	0.00	0.00
g) Dep. & repair on extra facilities (App. F)	203.43	203.24	203.05
h) Int. on oper. cost & fixed capital " "	248.18	249.77	251.25
Total Debits:	$3,925.19	$3,974.53	$4,020.66
Difference per ranch:	-$ 596.21	-$1,106.13	-$1,633.96
Difference per cow treated:	-$ 2.11	-$ 3.92	-$ 5.82

[a/] See Appendix K for definitions.

Ranch 12

Number of cows[a/]	1040	Number replacement heifers	100
Number of bulls	40	Percent calf death loss[a/]	4.14
Percent conception rate[a/]	92.88	Number calves weaned	st. 463 he. 463
Percent cow death loss[a/]	1.15	Sale weight (lbs)	st. 450 he. 384
Percent non-breeders[a/]	5.00	Marketing cost per head (dollars)	0.50

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$3,889.56	$3,452.41	$2,960.81
b) Increase due No. calves " "	4,510.77	3,313.01	2,208.67
c) Increase due sale price " "	3,081.48	2,735.13	2,345.64
sub total	$11,481.81	$9,500.55	$7,515.12
Reduced Costs:			
a) Bull depreciation (App. G)	$ 444.90	$ 400.41	$ 355.92
b) Interest on working capital (App. G)	346.50	311.85	277.20
sub total	$ 791.40	$ 712.26	$ 633.12
Total Credits:	$12,273.21	$10,212.81	$8,148.24
Additional Costs:			
a) Feed (App. C)	$3,595.20	$3,585.12	$3,575.04
b) Hormone " "	4,815.00	4,801.50	4,788.00
c) Semen " "	4,335.00	4,539.00	4,740.00
d) Supplies " "	144.50	151.30	158.00
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	20.50	15.00	10.00
g) Dep. & repair on extra facilities (App. F)	962.76	962.21	961.65
h) Int. on oper. cost & fixed capital " "	1,063.35	1,069.43	1,075.44
Total Debits:	$15,001.31	$15,188.56	$15,373.13
Difference per ranch:	-$2,728.10	-$4,975.75	-$7,224.89
Difference per cow treated:	-$ 2.55	-$ 4.66	-$ 6.79

[a/] See Appendix K for definitions.

Ranch 13

Number of cows[a/]	234	Number replacement heifers	42
Number of bulls	10	Percent calf death loss[a/]	3.62
Percent conception rate[a/]	94.44	Number calves weaned	st. 106 he. 107
Percent cow death loss[a/]	0.43	Sale weight (lbs)	st. 450 he. 370
Percent non-breeders[a/]	5.00	Marketing cost per head (dollars)	0.50

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 774.55	$ 680.99	$ 564.47
b) Increase due No. calves " "	779.82	652.38	344.90
c) Increase due sale price " "	606.87	534.00	443.09
sub total	$2,161.24	$1,867.37	$1,352.46
Reduced Costs:			
a) Bull depreciation (App. G)	$ 441.00	$ 378.00	$ 315.00
b) Interest on working capital (App. G)	117.60	100.80	84.00
sub total	$ 558.60	$ 478.80	$ 399.00
Total Credits:	$2,719.84	$2,346.17	$1,751.46
Additional Costs:			
a) Feed (App. C)	$ 804.76	$ 806.40	$ 803.04
b) Hormone " "	1,084.50	1,080.00	1,075.50
c) Semen " "	975.00	1,020.00	1,065.00
d) Supplies " "	32.50	34.00	35.50
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	3.50	3.00	1.50
g) Dep. & repair on extra facilities (App. F)	185.61	185.43	185.24
h) Int. on oper. cost & fixed capital " "	219.78	221.02	222.23
Total Debits:	$3,375.65	$3,414.85	$3,453.01
Difference per ranch:	-$ 655.81	-$1,068.68	-$1,701.55
Difference per cow treated:	-$ 2.72	-$ 4.45	-$ 7.12

[a/] See Appendix K for definitions.

Ranch 14

Number of cows[a/]	80	Number replacement heifers	11
Number of bulls	2	Percent calf death loss[a/]	2.60
Percent conception rate[a/]	96.25	Number calves weaned	st. 38 he. 37
Percent cow death loss[a/]	0.00	Sale weight (lbs)	st. 425 he. 377
Percent non-breeders[a/]	3.75	Marketing cost per head (dollars)	3.50

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 281.44	$ 248.27	$ 209.15
b) Increase due No. calves " "	91.72	91.72	0.00
c) Increase due sale price " "	213.88	188.56	158.78
sub total	$ 587.04	$ 528.55	$ 367.93
Reduced Costs:			
a) Bull depreciation (App. G)	$ 89.50	$ 89.50	$ 89.50
b) Interest on working capital (App. G)	15.70	15.70	15.70
sub total	$ 105.20	$ 105.20	$ 105.20
Total Credits:	$ 692.24	$ 633.75	$ 473.13
Additional Costs:			
a) Feed (App. C)	$ 272.16	$ 272.16	$ 272.16
b) Hormone " "	364.50	364.50	364.50
c) Semen " "	327.00	345.00	360.00
d) Supplies " "	10.90	11.50	12.00
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	3.50	3.50	0.00
g) Dep. & repair on extra facilities (App. F)	15.15	15.15	15.15
h) Int. on oper. cost & fixed capital " "	43.79	44.44	44.86
Total Debits:	$1,102.00	$1,121.25	$1,133.67
Difference per ranch:	-$ 409.76	-$ 487.50	-$ 660.54
Difference per cow treated:	-$ 5.05	-$ 6.02	-$ 8.16

[a/] See Appendix K for definitions.

Ranch 15

Number of cows[a/]	120	Number replacement heifers	18
Number of bulls	3	Percent calf death loss[a/]	4.27
Percent conception rate[a/]	97.50	Number calves weaned	st. 56 he. 56
Percent cow death loss[a/]	0.00	Sale weight (lbs)	st. 400 he. 377
Percent non-breeders[a/]	2.50	Marketing cost per head (dollars)	0.25

Synchronized Conception Rates:	76.50%	69.04%	60.75%
Additional Receipts:			
a) Increase due weaning wt. (App. G)	$ 405.58	$ 356.24	$ 306.07
b) Increase due No. calves " "	205.00	205.00	91.72
c) Increase due sale price " "	296.91	260.17	223.20
sub total	$ 907.49	$ 821.41	$ 620.99
Reduced costs:			
a) Bull depreciation (App. G)	$ 47.26	$ 47.26	$ 23.63
b) Interest on working capital (App. G)	33.60	33.60	16.80
sub total	$ 80.86	$ 80.86	$ 40.43
Total Credits:	$ 988.35	$ 902.27	$ 661.42
Additional Costs:			
a) Feed (App. C)	$ 409.92	$ 409.92	$ 406.56
b) Hormone " "	549.00	549.00	544.50
c) Semen " "	495.00	519.00	540.00
d) Supplies " "	16.00	17.30	18.00
e) Refrig., nitrogen & freight (App. C)	65.00	65.00	65.00
f) Marketing	0.50	0.50	0.25
g) Dep. & repair on extra facilities (App. F)	22.81	22.81	22.62
h) Int. on oper. cost & fixed capital " "	64.70	65.59	65.97
Total debits:	$1,622.93	$1,649.12	$1,662.90
Difference per ranch:	-$ 634.58	-$ 746.85	-$1,001.48
Difference per cow treated:	-$ 5.20	-$ 6.12	-$ 8.27

[a/] See Appendix K for definitions.

APPENDIX I

Stepwise Regression Data Showing Pre-synchronization Conception Rate, Weaning Weight, Cow-bull Ratio, and Number of Cows, and Profit or Loss Resulting from the Adoption of Estrous Synchronization.

Variables		Ranch Number														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Dependent	y_1	+16.61	+5.20	+2.41	+2.13	+1.03	+0.79	+0.73	-0.11	-0.15	-1.07	-2.11	-2.55	-2.72	-5.05	-5.20
	y_2	+13.29	+4.45	+0.14	-0.31	-1.32	-1.37	-1.29	-2.44	-2.39	-2.72	-3.92	-4.66	-4.45	-6.02	-6.12
	y_3	+ 9.29	-0.28	-2.55	-2.93	-3.71	-3.72	-4.02	-4.71	-4.69	-5.03	-5.82	-6.79	-7.12	-8.16	-8.27
Independent	x_1	.7178	.8429	.8392	.9050	.9242	.9132	.8965	.9370	.9399	.9614	.9487	.9288	.9444	.9625	.9750
	x_2	377	371	315	382	375	480	390	477	405	449	423	417	410	401	389
	x_3	16	23	21	18	16	37	25	23	21	21	20	26	23	40	40
	x_4	503	70	1000	354	1005	218	395	449	1016	232	265	1000	224	74	114

y_1, y_2, and y_3 = profit or loss per cow resulting from adopting estrous synchronization, as related to the 76.5, 69.04, and 60.75 percent SCRs, respectively.

x_1 = conception rate prior to adoption of estrous synchronization.

x_2 = weaning weight prior to adoption of estrous synchronization.

x_3 = cow-bull ratio prior to adoption of estrous synchronization.

x_4 = number of cows prior to adoption of estrous synchronization.

APPENDIX J

Calculations of the Number of Calves Born, Died, and Weaned Resulting from the Adoption of Estrous Synchronization

Both A. I. (calves sired by A. I.) and natural (calves sired naturally) calves result from the adoption of estrous synchronization. The number of A. I. calves is found by multiplying the number of treated cows times the assumed SCR. Since there are three assumed SCR's this will need to be done for each. The death loss of A. I. calves is 66 percent of the pre-synchronization calf death loss. Reference should be made to Appendix K for definitions of unknown terms.

The number of A. I. calves born, died, and weaned are:

A. I. calves born = (cows treated) (synchronized conception rate)

A. I. calves died = (A. I. calves born) (66%) (percent pre-synchronization calf death loss)

A. I. calves weaned = difference between calves born and died

The natural calves, resulting from the adoption of estrous synchronization, are the result of natural service between the two synchronization periods (within 26-day breeding period) and during the 45-day post-synchronization period. The percent calf death loss of those calves, resulting from natural service between the synchronization periods, is 66 percent of the pre-synchronization

calf death loss. However, the pre-synchronization calf death loss is used for those calves resulting from natural service during the 45-day post-synchronization period.

The number of natural calves (resulting from service between the two synchronization periods) born, died, and weaned are:

Natural calves born = (cows treated) (5 %)

Natural calves died = (calves born) (66%) (percent pre-synchronization calf death loss)

Natural calves weaned = difference between calves born and died

The number of natural calves (resulting from service during the 45-day post-synchronization period) born, died, and weaned are:

Natural calves born = [cows treated] [100% - (26-day conception rate + percent non-breeders + percent cow death loss)] [pre-synchronization conception rate]

Natural calves died = [calves born] [percent pre-synchronization calf death loss]

Natural calves weaned = difference between calves born and died

APPENDIX K

Glossary of Terms

Conception rate - percent of cows exposed to bulls and/or A. I. that conceive. A cow is considered to conceive if it carries the calf close to the full term.

Pre-synchronized conception rate - the conception rate prior to adopting estrus synchronization.

First synchronized conception rate - percent of cows treated with synchronization hormone that conceived from A. I. during the first synchronization period.

Second synchronized conception rate - percent of cows treated with synchronization hormone that conceived from A. I. during the second synchronization period.

Synchronized conception rate (SCR) - sum of the percentage of synchronization hormone treated cows that conceived from A. I. during the first and second synchronization periods. It is the sum of the first and second synchronized conception rates.

Twenty-six day conception rate - percent of cows treated with synchronization hormone that conceive as a result of A. I. during the first and second synchronization periods and natural service between the two synchronization periods.

Post-synchronized conception rate - percent of cows treated with synchronization hormone that conceive as a result of natural service during a 45-day period following the second synchronization period.

Overall synchronized conception rate - percent of cows treated with synchronization hormone that conceive from either artificial insemination or natural service. It is the sum of the 26-day conception rate and post-synchronized conception rate.

Artificial insemination (A. I.) - the process of manually placing bull semen in the female's reproductive tract.

A. I. stud - business organization which, as one of its services, provides bull semen to interested persons.

A. I. bull - semen from bull in an A. I. stud.

A. I. calves - calves sired by A. I. bulls.

Natural calves - calves sired by natural service.

Percent nonbreeders - percent of total cows exposed to bulls and/or A. I. that are not capable of conceiving. This does not change when adopting estrous synchronization.

Percent cow death loss - percent of total cows exposed to bulls and/or A. I. that are lost between exposure and due calving date. This does not change when adopting estrous synchronization.

Pre-synchronization calf death loss - ratio of the number of calves that died at birth plus number of calves that died between birth and weaning divided by the number of calves carried full term.

Cow-bull ratio - number of cows to be exposed to bulls divided by number of bulls.

Number of cows - cows that are exposed to bulls and/or artificial insemination.

APPENDIX L

Suggestion for Future Research

This study considered only the first year or short-run aspect of adopting estrous synchronization. Thus, the long-run cumulative improvement in the genetic quality of the herds was not considered. This cumulative effect should increase the weaning weight and sale price more than allowed in this study. Some attempt should be made to establish the feasibility of adopting estrous synchronization when the cumulative effect is considered. For instance, consideration should be given to those ranchers which could expect to receive a negative profit the first few years and then begin to receive a positive profit. This would aid the ranchers in making long-run decisions.