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By

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ABSTACT

ANALYSIS OF THE INTERRELATIONSHIP OF NUTRITIONAL AND REPRODUCTIVE FACTORS IN DAIRY CATTLE

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The purpose of this study was to determine interrelationships between nutrient content of feeds, management and feeding practices that could be affecting reproductive performance of dairy cows and to establish basic guidelines for feeding and management practices in two areas of the State of Chihuahua, Mexico.

Data were collected, from eight Mexican farms and nineteen American farms (used as a comparison), using a questionnaire and analyzed by multiple linear regression (least squares method), analysis of variance and Factor Analysis.

Interactions between Protein, Net Energy, Crude Fiber, Calcium and Phosphorus contributed the most to the variation observed in reproductive parameters. The biological interpretation of these interaction proved to be difficult.

Mexican dairy ration was consistently high in Calcium, Protein and Crude Fiber and deficient in Net Energy.

From Factor Analysis, only the alfalfa hay-based ration in Mexico contributed significantly to explain the variation found in reproductive performance.

Some practical recommendations for improvement of the Mexican dairy ration are given.

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INTRODUCTION

The effect of nutrition upon reproductive performance of cattle has been a topic of concern for many years.

With the trends for higher milk-yielding cows, the accuracy of providing an adequate plane of nutrition and the implementation of improved reproductive management schemes becomes more critical.

Mexico has not been able to meet the internal demand of milk, and with a growing population (3.2% per year), the problem will tend to increase in the near future.

Studies of the interrelationship between nutrition and reproduction on Holstein-Friesian cattle in Mexico are very scarce. Pathological alterations and diseases always have been linked to impaired performance in dairy cattle and, in most cases, when nutrient deficiencies have been suggested, the assumption has been based on a very minimum amount of research data.

The Northern states of Mexico are one of the most significant areas for milk production, as well as the area with the most increase in production over the last 20 years. The climatic pattern of this region (low and non-well distributed annual rainfall) has restricted the feeding of dairy cows to hays and grains basically due to limited availability and cost of protein supplements.

As a result of scarce feed stuffs, Mexican dairymen should pay increased attention to the nutritional aspect of dairy cows and its impact on reproduction performance and milk production.

For these reasons, veterinarians, animal scientiest, dairymen and feed suppliers in Mexico need to increase the efficiency of dairy husbandry factors and take into account differences in management and climate from populations previously studied.

Since dairy technology in Mexico is in the stage of development, most technology is imported from the USA. In this study American herds were used as models for comparisons with the goal to study the differences in management and further to incorporate those practices that can be beneficial to the Mexican dairy industry.

The specific objectives of this study include the following:

- To establish interrelationships among the nutrient content of feeds and reproductive performance of dairy cattle in various areas of the state of Chihuahua, Mexico.

- To detect possible interactions between management and feeding practices that could be affecting reproduction of dairy cows in the two areas of study.
- To establish basic guidelines for feeding and management practices in the two selected areas and make projections that may be useful for other Mexican areas.

LITERATURE REVIEW

EFFECT OF PROTEIN ON REPRODUCTION

Amino acids absorbed from the small intestine of ruminant animals are supplied from microbial protein synthesized in the rumen, undergraded or protected food protein, amino acids which bypass the rumen, and endogenous secretions (Chalupa, 1975).

The massive intervention of microorganisms at the start of the digestive process in ruminants has a profound influence on the amino acids supplied to the small intestine of ruminants (Satter and Roffler, 1975). Therefore, the extent of dietary protein breakdown and the synthesis of mircobial protein result in marked alterations in the quantity and pattern of amino acids absorbed from the gut of ruminants, compared to the amino acid composition of the diet (Clark, 1975).

As a result of the complexity of ruminant amino acid nutrition, dairy cows can at times suffer an amino acid imbalance which affects body maintenance, milk synthesis and reproductive performance.

Chandler _et al_. (1976) conducted an experiment adding methionine hydroxy analog to diets of 12.5% and 15% crude protein. It reduced services per conception from 2.54 to 1.90 and decreased days open from 149 to 116. The authors suggested that this indirectly make available to the animal increased quantities of energy in the form of acetate and propionate. It also increased quantities of microbial protein for postruminal utilization by stimulating rumen fermentation.

A protein-deficient ration in heifers prolongs the onset of puberty (Palmer _et al_., 1941, Wiltbank _et al_., 1965), has detrimental effects on estrous behavior (Guilbert, 1942, Bedrak _et al_., 1964), increases the length of the estrous cycles and reduced fertility rate (Durrell, 1951, Hill _et al_., 1970).

Protein deficient diets (.32 kg. per day) prior and after parturition are associated with clinically severe uterine infections in primiparous beef heifers (Ruder _et al_., 1981). The authors suggested that a reduced crude protein intake had a negative effect on utèrine antibody production.

Israeli researchers (Davidson _et al_., 1978, Mayer _et al_., 1978 and Francos _et al_., 1978) found significant differences between low and high fertility herds with respect to the amount of digestible protein in the daily ration. In low fertility herds, protein requirements were will below recommended levels.

Julien et al. (1976) obtained evidence that defficiencies of protein along with Selenium could be involved in the etiology of retained placenta in dairy cows.

Excess of crude protein has been suggested as a cause of increased anestrus, lowered peak milk production (Gould, 1969), lengthened interval between parturition and first service (Sonderegger and Schurch, 1977), as well as decreased conception rate and more services per conception (Maree, 1981). Gibson (1969) noted that although excess protein intake may be related to these problems, such excess is only relative to low energy. Energy for microbial growth is derived from the fermentation of dietary carbohydrate since the nitrogenous constituents provide the nitrogen requirements of the micro organisms, nitrogen-carbohydrate interrelationships occurring within the rumen are of considerable importance to overall rumen metabolism (McMeniman et al., 1976). Hewitt (1971), using data from Swedish farms, reported that the fertility of herds, were not higher when the highest levels of protein were fed. However, the higher the level of protein of energy for a cow milking 25 liters or more, the better was the herd's fertility.

Huber and Kung, Jr. (1981) summarized the effects of protein on reproduction of dairy cattle and they pointed out that excess protein might impair reproductive performance in cows.

Physiologically, one would suspect that overfeeding of protein to ruminants was more likely to cause metabolic stresses. A possible toxic effect is the liberation of large quantities of ammonia from an easily soluble protein (Huntgate, 1966). This condition may cause cellular damage throughout the body, resulting in a suboptimal, uterine or ovarian environment and thereby reducing reproductive efficiency (Jordan and Swanson, 1979).

Feeding excess protein appears to be wasteful in that it is expensive and also reproductive parameters tend to increase as protein concentration increases without significant milk yield increment (Jordan and Swanson, 1979, Edwards et al., 1980).

Bond and Wiltbank (1970), working with 54 beef heifers, pointed out that there was no effect on estrus cycle and conception rate when the animals were fed different levels of protein ranging from 4.1 to 28.1%. Wohlt and Clark (1978) also found no significant differences in reproductive performance in cows fed rations containing 9.2, 13.5 or 18.1% crude protein.

Treacher et al., (1976) concluded that feeding 75% of protein requirements to dairy cows during the first 14 weeks of lactation does not have an adverse effect on fertility.

Reproductive performance is not impaired when urea is added to rations of lactating dairy cows (Holter et al., 1968, Ryder et al., 1972, Erb et al., 1976a and 1976b and Treacher et al., 1979). The maximum dietary protein at which NPN additions benefit dairy cattle is probably not over 15% of the ration dry matter even at high energy concentrations (Huber and Kung, Jr., 1981).

Low protein consumption results in ovarian atrophy in adults and to a failure of maturation of the reproduction organs in young animals (Leathem, 1966). Pituitary LH and the response of the uterus to estrogen and progesterone are reduced in protein-deficient animals (Herbert, 1977). Rowlands et al. (1977) found an inverse relationship between albumin levels in blood and a direct relationship between globulin levels in blood when compared to number of services per conception.

Calcium and Reproductive Function

Considerable evidence has been accumulated indicating that mineral deficiencies may have an effect on reproduction.

However, the interrelationships in the absorption and utilization of minerals makes it difficult to identify relationships between a specific mineral and reproduction (Jacobson et al., 1972).

It has been suggested that the excess of Calcium can reduce fertility (Hignett, 1950, Hignett and Hignett, 1951, King, 1971). However, Ward et al., (1971) fed high levels of Ca (200 g. daily) and found that first ovulation occurred earlier in this group compared to low levels of Ca (100 g. daily) but there was no significant difference between treatments in services per conception.

Ward and Call (1979) suggested that adequate calcium intake promotes rapid uterine involution and early ovulation in dairy cows.

Breeding efficiency was not reduced when different levels of Ca (.12, .18, .32 and .64% of ration D.M.) were fed to dairy cows (Fitch et al., 1932, Palmer et al., 1935). These cows ranged in milk production from 2925 to 3351 kgs. per lactation.

The majority of the research relating Ca levels to reproduction functions has centered on the effect of the Calcium-Phosphorus Ratio. Hignett (1959) showed that with a low Manganese consumption (40 mg. per 100 lb. body weight), fertility is high when Ca and P are in the correct proportions. However, when Ca is in excessive relative to P or vice versa and Mn low, fertility is depressed. Littlejohn and Lewis (1960) obtained results that showed quite clearly that fertility was not affected by the Ca and P content of the experimental diet, regardless of the general level of fertility in the herd (Steevens et al., 1971)

Carson, Caudle and Riddle (1978) examined a herd with a high incidence of dystocia, retained placenta and metritis. The milking herd's ration was .6% Ca and .5% P, at the same time mean serum Calcium was 8.98 mg% and mean serum phosphorus 8.25 mg%. After supplementation with steamed bone meal, reproductive disorders decreased and serum concentrations were 10.26 mg% and 6.72 mg% for Ca and P respectively. They suggested that a narrow serum Ca:P ratio is one of many causes of reproductive problems which must be considered when dealing with problem herds.

The suggested calcium levels for cows in milk should contain 0.7% Ca on a dry matter basis in the ration (NRC, 1978). A high ratio of Ca to P in the diet is not critical for Ruminants (Smith et al., 1966), except for pre-partum rations (Jorgensen, 1974).

Phosphorus and Reproductive Function

Phosphorus is the mineral most commonly associated with reproductive disorders in dairy cows.

It has been noted that a low phosphorus ration was accompanied by a temporary disturbance or an entire cessation of the estrous cycle (Jordan *et al*., 1906, Eckles *et al*., 1935, Palmer *et al*., 1941, Alderman, 1963).

Morrow (1969) reported a case in which infertility in 26 dairy heifers were attributed to phosphorus deficiency. Presence of this deficiency was verified when low blood P levels were found (3.9 mg./100 ml.), other blood metabolites were normal. The conception problem in this herd decreased from 3.7 services per conception before P supplementation to 1.3 services after P supplementation, and blood phosphorus levels returned to normal range (6.6 mg./100 ml.).

Steevens *et al*. (1971) tested the effects of varying amounts of Ca and P in rations for dairy cows. In the lowest P group (.4% P of Ration D.M.) with a Ca:P ratio of 3:1, they found a higher incidence of ovarian dysfunctions and a larger number of services per conception were required. They also reported lower average blood serum inorganic phosphorus in this group. P supplementation of range cows grazing in areas deficient in phosphorus improved fertility in lactating cows over the controls (Theiler and Green, 1931, Hart and Mitchell, 1965). Availability of minerals in soils depends upon their concentration in soil solution and it has been indicated that a general association exists between available soil P and P concentrations in forage, cereal and vegetable crops, (Reid and Horvath, 1980). Edye _et al_. (1971) used superphosphate as pasture fertilizer. Cows grazing in these pastures had a better conception rate, calving rate and weight increment than controls (no fertilizer). It is important to point out the fact that stocking rate also has a significant effect on conception rate.

In a trial conducted by Hecht _et al_. (1977), no differences were found between 76 heifers fed low levels of P (0.13 - 0.22% of Ration D.M.), and those heifers fed supplemental P (0.40% P of Ration D.M.). The variables measured were estrus exhibition, services per conception and pregnancies. Noller _et al_. (1977), in a one-year study, failed to show a significant effect on conception rate when 56 Holstein heifers were given complete mixed rations containing all phosphorus from natural feedstuffs (.22%) or a .10% increase in P content of the ration (.32%). Call _et al_. (1978) reported no differences in reproductive performance and age to puberty in 96 Hersford heifers fed either 66% or 174% of NRC-recommended levels of P during two years.

Carstairs _et al_. (1980) suggested that phosphorus status did not influence reproduction in dairy cows fed rations with 98% or 138% of the P levels recommended by NRC. Phosphorus should be fed according to recommendations and excess phosphorus may be detrimental in post partum dairy cows (Carstairs _et al_., 1981).

Effect of Roughage Level in the Ration and Reproductive Performance

Literature reports a definite relationship between dietary fiber, expressed as a roughage-to-concentrate ratio, crude fiber level and type, and percentage of fat in the milk produced (Van Soest, 1963).

It has been suggested that a diet low in fiber adversely affects fertility because of the low production of acetic acid (Francos, 1968). Acetic acid is involved in the formation of steroid hormones, such as estradiol and progesterone (Francos, 1969). Restricted roughage with high grain rations have been shown to promote: changes in Lipoprotein lipase activity, stearic acid and cholesterol linoleate concentration, which are associated with an increased flux of fatty acids toward adipose tissues (Benson _et al_., 1972). A negative relationship exists between serum insulin and milk fat production and rumen acetate: propionate ratios (Walker and Elliot, 1973).

A highly significant correlation between the milk butter-fat percentage of a herd and its conception rate has been reported (Bar-Anan, 1968, Ayalon et al., 1971).

Refsdal in 1977 (quoted by Engvall, 1980) demonstrated a delayed start in the ovarian function of cows after parturition when the animals had been experimentally fed so that the milk-fat percentage was reduced.

Several researchers have found significant differences in the amount of roughage (32.2 to 34.1%) in the dry matter intake in the high fertility herds compared to the intake (20.3 to 23.3%) in the low fertility herds. (Francos et al., 1977, Mayer et al., 1978, Davidson et al., 1978, Tong et al., 1979).

Trimberger et al. (1972) concluded that feeding liberal amounts of grain to compensate restricted forage is not a satisfactory procedure under normal economic conditions. They found that cows fed a liberal concentrate ration has significantly longer calving intervals and required more services per conception than the controls.

Buchanan-Smith et al. (1964) fed beef heifers either an all-concentrate ration ad libitum or a roughage ration composed by corn silage. The data suggested that the all-concentrate ration has a triggering effect on the onset of estous compared to the roughage ration.

Engvall (1980) found no significant difference in fertility in low milk-fat cows ($\leq$ 3.0% B.F., 2.14 services per conception and 105 days open) when compared to controls cows (> 3.2% B.F., 2.25 services per conception and 112 days open).

A 60:40 forage-to-grain ratio fed to Holstein cows showed a delay to postpartum estrus, due to body weight loss and energy stress, when compared to 50:50, 65:35 and 85:15 ratios during early lactation. However, the average number of services per conception was not different among groups (Everson et al., 1976), Markusfeld (1970).

Kali and Amir (1970) found that at the time of first insemination after parturition milk yield, butter fat percentage and butter fat production were higher in cows considered repeat breeders.

Zamet et al. (1979), fed hay, hay crop silage and corn silage to postpartum Holstein cows in a 60%-40% forage concentrate mixture. Significant results showed that calving interval was shorter, more cows conceived and lower services per conception were achieved in cows fed hay compared to cows fed either hay crop silage or corn silage.

Energy and Reproductive Performance

The relationships between energy intake and energy metabolism must be taken into account when considering the influence of nutrition, body condition and milk production on reproductive performance in the lactating cow.

In heifers, onset of puberty and subsequent reproductive efficiency can be affected by energy intake. Reid et al. (1957) fed 65, 100 and 145% of the recommended TDN levels to Holstein heifers and feeding levels did not affect the average number of services per conception, however, increasing levels of nutrient intake tended to reduce the percentage of heifers conceiving at the first service. Onset of puberty occurred at 20, 11 and 9 months of age respectively for the low, medium and high TDN intake groups. The authors pointed out that although the age at the time of the first heat is affected markedly by feeding level, all heifers experience the first heat at about the same size and height. These data suggest that body weight, rather than age, is more important for onset of the first estrus to occur. Similar results were reported by Gardner et al. (1977).

Low energy diets for heifers delay onset of puberty and onset of estrus, decrease pregnancy rates, first service conception and alter reproductive performance

(Wiltbank et al., 1965, Dunn et al., 1969, Short and Bellows, 1971, Lemenager et al., 1980).

Arnett et al. (1977) used 12 sets of twin beef females to compare normal and obese females postweaning through three lactations. Normal females were produced by feeding one twin a ration adequate in minerals, vitamins and protein according to NRC recommendations but containing only sufficient energy to gain approximately 1/3 kg. per day and to maintain a healthy, thrifty condition. Obese females were produced by feeding the other twin additional energy to induce and maintain a high degree of body fatness by varying the proportion of corn and cottonseed hulls. They found that normal heifers required fewer services per conception, less assistance at calving, weaned more calves and produced more milk.

Leaver (1977) reported that heifers fed levels of nutrition above maintenance, the effects on fertility was small, using pregnancy rate to first service and total calving rate as reproductive performance measures. On the contrary, Pendlum et al. (1977) fed beef heifers different levels of supplemental energy as shelled corn (0.3 or 6 lbs. per head daily) plus corn silage and protein supplement. They reported that energy intake of all treatment groups was adequate for conception.

It is known that the high milk production dairy cows, during early lactation, are in negative energy balance because of the inability to consume sufficient feed to meet the requirements of the increased level of production. Butler _et_ _al_. (1981) suggested that energy balance during the first 20 days of lactation is important in determining the onset of ovarian activity following parturition. They concluded that this activity was inversely related to average energy balance during the first 20 days of lactation: the greater the average deficit incurred, the longer the delay to ovulation. The same conclusions were reported previously by Ayalon _et_ _al_. (1971) and Sonderegger and Schruch (1977).

Carstairs et al. (1981) reported that excess energy should be avoided for the first month of lactation and then gradually increased in primiparous Holstein cows, in this study high energy fed groups had almost twice as much incidence of disease and cows did not begin to yield more milk than low energy groups until week five after parturition. The authors suggested that primiparous cows should be fed rations moderate in energy immediately after calving and gradually building up their energy intake to a high by four to five weeks of lactation.

In another study, Carstairs et al. (1980) fed either high (135% NRC) or low (85% NRC) energy to Holstein cows and the data suggested that energy, within the ranges studied, did not influence reproduction of dairy cows.

Animals fed on a high plane of nutrition prior to calving had a shorter interval to first estrus than cows fed on a low level of nutrition prior to calving, regardless of the post calving level of nutrition. The postpartum level of nutrition had a marked effect on cows fed below requirements before parturition, delaying estrus to 90 days postpartum but it had almost no effect on reproductive performance of cows in good body condition at calving (Wiltbank et al., 1962, Wiltbank et al. 1964, Davis et al., 1977, Tong et al., 1979.

Morrow et al. (1969) concluded that cows fed a liberal concentrate ration had significantly longer calving intervals and required more services per conception than the controls. The authors found that the interval from parturition to first estrus, the subsequent estrus interval and the occurrence of standing estrus and ovulation were not affected by liberal concentrate feeding.

Large deviations from the desirable levels of energy in the ration may result in declining fertility performance. Francos (1970) suggested that excessive feeding in the second half of pregnancy contributes to a state of postpartum stress, which in turn predisposes the uterus to faulty involution and to metritis. He noted this situation in two herds in which cows and heifers received 200 to 400 Scandinavian feeding units above normal requirements, including two to three times the standard amounts of protein. When the rations were reduced to conventional norms, metritis percent was reduced from 20% to 7% in one herd and from 35% to 14% in the other herd.

Francos (1974) suggested that the "repeat breader" syndrome is associated with feeding a ration deficient in energy during any stage of lactation and the final stages of pregnancy. The same results have been reported by Francos et al. (1977).

During the 4-year study conducted by Armstrong et al. (1966), 170 cows were fed different levels of concentrates ranging from a low of 464 kg. per lactation to 4790 kg. per lactation and the data suggested that high levels of concentrate feeding are not related to conception rate.

Hodgson et al. (1980), in a study using crossbreed cows, obtained limited evidence that conception rate using artificial insemination following estrus synchronization was not affected by plane of nutrition in early lactation.

Changes in body weight prior to and during the mating period have been suggested as causes of impaired reproductive function in cows. Leaver (1977) concluded that there appeared to be an interaction between body condition and level of nutrition in relation to pregnancy rate in British Friesian heifers.

In the dairy cows, there appears to be an association between the rate of body weight change and fertility over a long term (McClure, 1970a and 1970b, Youdan and King, 1977). The results indicate that improvements in fertility are possible if cows are managed so that they are gaining in body weight at the time of service (Schilling and England, 1968, King, 1968, Moller and Shannon, 1972, Sommerville et al., 1979).

Carstairs et al. (1980) fed two levels of energy and phosphorus (100 and 75% of NRC requirements) to primiparous Holstein heifers and although the high energy group gained weight and the low energy group lost weight, there was little difference between groups in time to first ovulation.

Holness et al. (1978) working with 160 Africander and Mashona cows, found a significant negative correlation

($P < .05$) between liveweight postpartum and time between calving and first estrus. This indicates that postpartum anestrus was significantly shorter in cows that lost weight than in those that gained weight postpartum. Broster (1973) reviewed liveweight change and fertility in the lactating dairy cow and pointed out the lack of agreement in investigations between liveweight change and fertility in dairy cattle is due to the interaction between long and short term effects of nutrition on fertility. Other researchers have failed to find a relationship between body weight changes and fertility (Oxenreider and Wagner, 1971, Folman _et al_., 1973, Gardner, 1969, Boyd, 1972, Downie and Gelman, 1976).

Another possible cause of infertility mentioned in the literature is the concentration of glucose in blood. McClure (1968) suggested that acute energy deficiency rapidly causes hypoglycaemia and this effect could lead to a hypothalamic failure.

Increasing blood glucose concentrations appears to be associated with improved fertility (Hunger, 1977, McClure and Payne, 1978).

A significant rise in plasma glucose levels before service in fertile cows has been demonstrated (Downie and Gelman, 1976).

In a recent work conducted by Carstairs et al. (1980), the only indication that glucose might be involved in a reproductive dysfunction, was a negative correlation between blood glucose and days to reach 3 ng./ml. serum progesterone which in this study may be involved in conception.

Oxenreider and Wagner (1971) studied the effect of three levels of energy (66,100 and 133% of NRC requirements) upon postpartum reproductive function. They found that energy intake had a significant effect on plasma glucose levels during the first eight weeks postpartum and there was a significant negative correlation between plasma glucose level and postpartum interval to occurrence of a 10 mm. follicle and ovulation. In extensive studies conducted in England and Sweden, Blowey et al. (1973) and Hewett (1974) failed to find a relationship between fertility and glucose concentrations in blood. Herdt et al. (1981) found that high concentrate diets (60% of dry matter) compared with low concentrate diets (40% of dry matter) increased mean plasma glucose values and reduced mean blood β-hydroxybutyrate concentration. However, they concluded that plasma glucose and blood β-hydroxybutyrate concentrations cannot be used as valid indicators of energy balance. Blood β-hydroxybutyrate might be used as an

indicator of the relative glucogenic potential of dairy rations and blood concentrations of this metabolite could potentially be used to adjust factors in the ration which influence glucose availability to the cow.

Russel et al. (1979) also reported that plasma 3-hydroxybutyrate concentrations in late pregnancy were closely and inversely related to energy intake.

Several experiments have dealt with the effect of different energy levels upon hormones. Changes in hormone concentration of animals in a low plane of nutrition suggest that energy may alter endocrine function. Hill et al. (1970) reported that undernutrition in heifers (85% of NRC requirements of energy and protein) reduced plasma levels of progesterone within five days. It also altered the length of the estrus cycle and reduced the proportion of animals with normally fertilized ova. They reported no change in plasma LH. Folman et al. (1973) pointed out that cows that conceived after one insemination has significantly higher progesterone levels during the estrus cycle preceding insemination than did cows that failed to conceive. At the same time cows maintained on a high level of nutrition required fewer inseminations per conception, conceived earlier and had a high plasma progesterone level 23 days earlier than cows maintained on a standard level of nutrition. In cows that conceived after one insemination, level of nutrition had no effect on progesterone concentration, but it had a profound effect in cows that needed more inseminations for conception.

It has been suggested that restricted energy intake reduces the response to LH by the corpus luteum, synthesizing and releasing less progesterone (Gombe and Hansel, 1973 and Apgar et al., 1975). Supporting these data, Beal et al. (1978) concluded that dietary energy restriction may influence the LH release directly at the pituitary level as well as indirectly through effects on ovarian steroid production. Lishman et al. (1979) found that the pattern of release of LH was altered by plane of nutrition (maximum rise occurred 30 minutes earlier in high plane of feeding than in underfed animals) and estradiol did not vary with plane of nutrition.

Spitzer et al. (1978) reported the same results for progesterone and LH in heifers fed either 100% or 30% of NRC recommendations for energy. Corah et al. (1974) concluded that there was no signficant effect of energy on preipheral levels of progesterone or estradiol either prior to or following parturition. Carstaires et al. (1980) conducted an experiment in which progesterone secretion was not changed by either energy of phosphorus status of the ration. However; they reported that no cow with peak serum progesterone below 2.7 ng./ml. before insemination conceived to that insemination.

MATERIALS AND METHODS

The state of Chihuahua is located in the Northern Plateau of Mexico between $25^{o}37'$, $31^{o}46'$ north latitude and $103^{o}39'$, $109^{o}07'$ west longitude with an area of 247,087 Km^2 (24,708 700 million hectares) that accounts for 12% of the national territory.

The State is divided in three geographical areas:

- Mountain Region (Sierra Tarahumara) - located in the western part, accounts for 30% of the total area, climate is classified as Cfwb according to Koppen's climatic classification, with an annual rainfall of 700-1200 mm. and snow during the winter, and elevations up to 4000 m.
- Semi-Desertic and Desertic Area - located to the northeast and east, it accounts for 52% of the total area, climate is classified as BWHw according to Koppen's climatic classification with an annual rainfall of 200-300 mm.
- Central Plains - located between the two later regions, it accounts for 18% of the total area, climate is classified as BSkw according to Koppen's climatic classification, with an annual rainfall of 300-400 mm.

The study areas are the counties of Chihuahua and Delicias, which are located in the Central Plains region. Average temperatures during the year for Chihuahua and Delicias are 16.9°C and 19.6°C respectively.

Most dairy herds in the area are composed of Holstein-Friesian cattle (approximately 13,500 head), in which all cows are kept in large, outdoor drylots or corrals with high shades provided as a protection agains the sun. Feed bunks are located along one side of the lot to facilitate forage distribution.

Double - 4 to 12 herringbone milking parlors are the most popular depending upon the size of herds.

Alfalfa hay and commercial concentrate mixes are the main feeds offered to the cows throughout the year. Feedstuffs are located in centralized feed storage and processing units and a high percentage of roughages and concentrates, if not all, are purchased.

Use of artificial insemination is common in sampled herds, and good herd husbandry and disease-prevention practices are observed.

Sampling Procedure

In this study, Mexican farms were chosen on the basis of: availability of records such as DHI (Provo, Utah) or the Computerized Dairy Record System of the

Department of Agriculture of Mexico, willingness to provide the data and since most of the dairy cattle in Northern Mexico are of the Holstein breed, only eight Holstein herds were selected. No other factors were considered for selecting the farms.

The Mexican herds were matched with herds in the Michigan DHI with similar size, breed, production level and reproductive parameters such as days open and services per conception.

Design of the Questionnaire

In the implementation of the questionnaire the guidelines for design and structure suggested by Kucker (1970) and Erickson (1972) were followed.

The questionnaire was divided in three sections: Breeding, Reproduction, Herd Health and Nutrition. Preliminary drafts were analyzed by faculty members and graduate students of the Department and the final document consists of 74 questions. A copy of the questionnaire is included in Appendix.

Mexican farmers were interviewed during the Summer of 1980. During the interview, they used either all the records available for more accurate answers or provided a copy of the records for later analysis.

Originally, sixty Michigan farmers were selected and after December 1, 1981, only nineteen answered the questionnaire sufficiently accurate for inclusion in the data set.

Data

Alfalfa hay and commercial concentrate mix samples were carried from Mexico and analyzed in the Research-Extension Analytical Laboratory (Wooster, OH) for Dry Matter, Crude Protein, Crude Fiber, P, Ca, Mg, S, estimated Net Energy, and estimated TDN.

The composition of the Mexican commercial concentrate mix basically is: rolled sorghum grain, cottonseed meal and/or soybean meal, dehydrated alfalfa meal, molasses, rock phophate, salt, limestone, cobalt sulphate, iron sulphate, copper sulphate, manganese sulphate, zinc oxide and potassium iodine, and Vitamins A, D and E.

The data from the questionnaire interviews and ration analysis were transferred to 80-column computer cards. Variables and card format are listed in Appendix.

Answers to the questionnaire were encoded either as numeric answers with a specific key for each one, yes or no type answers (0 = No, 1 = Yes) or a rank-type answer. Reproduction, Herd Health and Breeding data were collected in an attempt to identify management practices which could be affecting herd reproductive performance. Nutrition data were utilized to evaluate different types of rations fed to the cows according to level of milk production.

Nutrient data were provided either by laboratory analysis as in the case of the Mexican herds or by information provided by farmers through the questionnaires or by the NRC 1978 Feed Analysis Tables in the case that farmers data were missing or incomplete.

Ration evaluation was performed using the Tel Cal 56:3 Dairy Ration Evaluation program developed by Hlubik and Thomas (1979). This Tel-Cal program accomplishes several tasks. First, it calculates the amount of D.M. and seven nutrients needed by milking cows (N.E. for lactation, Protein, C.F., Ca, P, Mg and S). Then, it compares these totals to amounts furnished in a ration composed of up to eight feeds. The program also converts feeds entered from an as-fed basis to a D.M. basis, calculates total lbs. of D.M. Percent D.M. of the ration, estimates pounds of feed that the cows would consume and enters nutrient densities per lb. of D.M. The program has the flexibility to allow for changes of any nutrient density for any feed, to estimate lbs. of nutrient required as well as the minimum concentration of crude protein and net energy that should be contained per pound of ration dry matter. The program calculates the amount of each of the seven nutrients provided by the ration, excess or deficiency of every nutrient and nutrient densities per lb. of dry matter in the ration.

Method of Analysis

The dependent variables selected for analysis were: Days Open, Average Days from Calving to First Service, Services per Conception and First Service Conception. The 20 independent variables selected are defined in the regression model description.

One of the objectives of this study was to determine if interrelationships exist among the nutrient content of feeds and reproductive performance of dairy cattle. The statistical methods chosen were the multiple linear regression by lease squares analysis and analysis of variance.

The procedure of least squares ascertains which combination of variables is the most accurate predictor of the dependent variable under study.

The regression equation is described below:

$$Y_i = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_1^2$$
$$+ b_7x_2^2 + b_8x_3^2 + b_9x_4^2 + b_{10}x_5^2 \div b_{11}x_1x_2 + b_{12}x_1x_3$$
$$+ b_{13}x_1x_4 + b_{14}x_1x_5 + b_{15}x^2{}_2x_3 + b_{16}x_2x_4$$
$$+ b_{17}x_2x_5 + b_{18}x_3x_4 + b_{19}x_3x_5 + b_{20}x_4x_5 + e_i$$

where:

Y_i = Dependent Variable

b_0 = Intercept

x_1 = Crude Protein (AVPROT)

x_2 = Net Energy (AVNE)

x_3 = Calcium (AVCA)

x_4 = Phosphorus (AVFO)

x_5 = Crude Fiber (AVFI)

x_1^2 = Quadratic Effect of Crude Protein (AVPROT2)

x_2^2 = Quadratic Effect of Net Energy (AVNE2)

x_3^2 = Quadratic Effect of Calcium (AVCA2)

x_4^2 = Quadratic Effect of Phosphorus (AVFO2)

x_5^2 = Quadratic Effect of Crude Fiber (AVFI2)

x_1x_2 = Cross Product Crude Protein and Net Energy (PRONE)

x_1x_3 = Cross Product Crude Protein and Calcium (PROCA)

x_1x_4 = Cross Product Crude Protein and Phosphorus (PROFO)

x_1x_5 = Cross Product Crude Protein and Crude Fiber (PROFI)

x_2x_3 = Cross Product Net Energy and Calcium (NECA)

x_2x_4 = Cross Product Net Energy and Phosphorus (NEFO)

x_2x_5 = Cross Product Net Energy and Crude Fiber (NEFI)

x_3x_4 = Cross Product Calcium and Phosphorus (CAFO)

x_3x_5 = Cross Product Calcium and Crude Fiber (CAFI)

x_5x_5 = Cross Product Phosphorus and Crude Fiber (FIFO)

e_i = Residual Random Error Associated with Y_i

b_1, b_2, ... b_{20} = Regression Coefficients of Y_i on all the effects considered.

With a stepwise backward elimination procedure, variables can be removed one at a time, starting with the variable that contributes the least to the total variation (Nie et al., 1975). In this fashion, each independent variable eliminated generates a different model and these will be discussed further.

Because the dependent variables (days open, first breeding after calving, first service conception, first heat after parturition and total number of services per conception) were herd averages, and the nutrition data were provided for cows according to production levels (namely high, average and low production), new variables were created.

In order to compute these variables, a weighted average was obtained for the analysis. Where data for the three production groups were available, the total was divided by three to obtain an average; otherwise, in most cases only two groups (high and low) were taken into consideration. List of new variables is included in Appendix Table 36 (variables 203-207).

In order to avoid the high correlation between the linear and quadratic terms and to build a more accurate model, the linear effects of the variables were centered. The approach used for centering was to substract the variable from the overall mean value. The quadratic and cross-products were calculated using the centered variables.

A dummy variable (Country) was fitted into the model for interpreting its significance as a difference between Mexican and Michigan herds.

The second objective of this study was to detect possible interaction between management and feeding practices that could be affecting reproduction of dairy cows and since the factors included in the survey were essentially multivariate, many of them are highly interrelated and sevaral may covary greatly, Factor Analysis was the statistical method chosen.

Factor Analysis is a procedure that allows to identify the best linear combinations of variables that would account for more of the variance in the data as a whole than any other combinations (Nie et al., 1975).

Factor Analysis attempts to account for the correlations among many observed variables in terms of a small number of more general variables called factors and the correlations are regrouped into patterns (Gill, 1978).

After the interpretation of the analysis, data were regrouped, according to the factors, in new general variables (Appendix, variables 208-210) Table 36, the hypotheses concerning association between feeding and management procedures and reproductive parameters was tested using the method of least squares and the following model:

$$Y_i = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + e_i$$

where:

Y_i = Dependent Variable

x_1 = Reproductive Management (RMGT)

x_2 = Nutrition Factors (NUT1)

x_3 = Nutrition Management (NMGT)

b_0 = Intercept

e_i = Residual Random Error Associated with Y_i

b_1, b_2, b_3 = Regression Coefficient of Y_i on all the effects considered.

These new general variables were composed of several of the original variables, grouped together.

For fitting the new general variables in the regression model, Composite Indices or Factor Scores were built from the original variable. The method used for this approach was to standardize values as follows:

General Variable (Correlation Coefficient of Original Variable 1) x (Original Variable 1 Value - Mean of Var. 1)/(Standard Deviation of O. V. 1) + ... + (Correlation Coefficient of O. V. n) x (O. V. n Value - Mean of O. V. n)/(Standard Deviation of O. V. n).

In addition to this regression model a dummy variable for COUNTRY was also included to test the variation between regions and in farms within region.

The Statistical Package for the Social Sciences or SPSS (Nie _et_ _al_., 1975) was utilized for the computer processing of the data.

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RESULTS AND DISCUSSION

Table 1 shows means and standard errors for the dependent variables under study. Differences between regions will be discussed further in the regression models when the variable COUNTRY is fitted into the model.

Tables 2 and 3 shows the nutrient concentrations in the ration of dairy cows in Mexico and Michigan, as well as an analysis of variance performed to detect differences between regions in nutrient concentration.

Table 4 shows the stepwise backward elimination procedure used with the dependent variable Days Open. Deleted variables were: Phosphorus, Quadratic Effect of Phosphorus, Quadratic Effect of Calcium, Fiber and Phosphorus, Protein and Phosphorus, and Net Energy and Phosphorus interactions. Overall significance for the model was .071, the percentage of variation explained by this model as indicated by R^2 = .73457 and adjusted R^2 = .4249, which for small samples it is a more valid estimate of the proportion of the variablity of the dependent variable, which can be explained by the set of independent variables.

TABLE 1. Means and Standard Errors for First Service Conception, Average Days from Calving to First Breeding, Days Open and Services per Conception.

VARIABLE	OVERALL		MEXICO		MICHIGAN	
	MEAN	S.E.	MEAN	S.E.	MEAN	S.E.
First Service Conception	59.03	3.851	56.00	4.17	60.31	5.22
Average days from Calving to 1st Breeding	69.88	2.83	83.50	3.60	64.15	2.85
Days Open	161.33	8.78	148.75	18.57	166.63	9.83
Services per Conception	1.99	0.092	2.14	0.111	1.93	0.12

TABLE 2. Ration Nutrient Concentration

VARIABLE	OVERALL		MEXICO		MICHIGAN	
	MEAN	S.E.	MEAN	S.E.	MEAN	S.E.
Average Protein %	14.920	0.410	16.660	0.827	14.190	0.363
Average Net E (M Cal/1b)	66.720	1.590	56.870	2.900	70.860	0.804
Average Crude Fiber %	20.680	1.010	25.430	2.460	18.680	0.613
Average Calcium %	0.825	0.071	1.200	0.112	0.666	0.060
Average Phosphorus %	0.279	0.015	0.235	0.014	0.298	0.020

TABLE 3. Analysis of Variance for Protein, Net Energy, Calcium, Phosphorus and Fiber.

VARIABLE	SOURCES OF VARIATION	SUMS OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARES	TYPE I ERROR
Average Protein	Region of Country	34.356	1	34.356	.004
	Farm w/Region	83.475	25	3.339	
Average Net Energy	Region or Country	1102.370	1	1102.370	<.001
	Farm w/Region	692.296	25	27.691	
Average Calcium	Region or Country	1.633	1	1.633	<.001
	Farm w/Region	1.927	25	0.0771	
Average Phos-phorus	Region or Country	0.0220	1	0.0220	.063
	Farm w/Region	0.1459	25	0.0050	
Average Fiber	Region or Country	256.750	1	256.750	.001
	Farm w/Region	467.824	25	18.712	

Significant linear effects ($P < .05$) that contributed to explain the variation were Fiber, Net Energy and Calcium. Significant ($P < .05$) quadratic effects were Net Energy and Fiber. In this model, interactions which showed to be highly significant ($P < .01$) were: Net Energy and Fiber, Calcium and Phosphorus, Protein and Net Energy, Net Energy and Calcium, Protein and Fiber and Fiber and Calcium.

Since days open was one of the variables used for matching the Mexican herds with Michigan herds, no significant differences ($P > .05$) were found when the variable COUNTRY was fitted into the model (Table 5).

In this study, ration protein content (AVPROT) seems to have no significant effect ($P > .05$) on days open; although, a highly significant difference in protein content among regions was observed ($P < .01$) in Table 3.

These findings are in agreement with those of Edwards _et al_. (1980), in which no relationship exists between days open and protein content of the ration.

Fiber content of the ration had a significant effect ($P < .05$) on days open (Table 4), and Table 3 shows a highly significant difference ($P < .01$) between Mexican farms (25.4%) and Michigan farms (18.6%).

Apparently a higher roughage content in the ration is fed to cows in Mexico and it seems to have a positive effect on days open. This effect has been reported by Francos et al. (1977), Mayer et al. (1978) and Tong et al. (1979).

It is important to point out that the main roughage fed to dairy cows in Mexico is alfalfa hay compared to corn or alfalfa silage in Michigan. Zamet et al. (1979) found a shorter days open interval in cows fed alfalfa hay compared to the interval in cows fed either corn or alfalfa silage.

Net Energy content of the ration also had a significant effect on days open ($P < .05$). And in Table 3 a highly significant difference between Mexican (56.8 Mcal/lb) and Michigan farms (70.86) was found ($P < .01$).

According to NRC Nutrient Requirements of Dairy Cattle (1978), the recommended levels of Net Energy for lactation range from 64 to 78 Mcal/lb for cows producing 18 to 78 lbs of milk daily, Net Energy concentration for Mexican cows is lower than the recommended levels. Evidence of the effect of Net Energy on days open is contradictory. Morrow et al. (1969) reported that longer days open intervals were found in high energy diets, and Carstairs et al. (1980) concluded that energy seemed not to influence reproductive performance in dairy cows. In this study, lower levels of net energy seems to be favorable for shorter days open intervals.

Calcium content is significantly affecting days open intervsl ($P < .05$), and in Table 3, differences between Mexico (1.2%) and Michigan (0.66%) are highly significant ($P < .01$). These results do not agree with Hignet (1950) and King (1971). However, in this case Ca appears to be influencing the days open interval and maybe due to earlier ovulation as suggested by Ward et al. (1971).

In Table 6, the regression model for average days from calving to first service is shown. Also, a deletion procedure was used and the variables excluded were: Protein, Quadratic Effects of Protein and Calcium, Net Energy and Fiber, and Protein and Net Energy interactions. Overall significance of this model was .001 and the model helps to explain 91% of the variation of average days from calving to first service ($R^2 = .91481$ and adjusted $R^2 = .79863$). In this case, only Calcium as a linear effect was significant ($P < .05$). Highly signficant ($P < .01$) quadratic effects were Net Energy, Fiber and Phosphorus.

TABLE 4. Model for Days Open with the Variables Left After the Stepwise Backward Elimination Procedure.

Model:

R^2 = .73457

Adj. R^2 = .42490

Degrees of Freedom Regression = 14

Mean Squares Regression = 2843.73273

Degrees of Freedom Residual = 12

Mean Squares Residual = 1198.81181

F Significance = .071

Variables[a]:

	Slope	Standard Error of Slope	Type I Error
AVPROT	28.8111	15.8386	.094
AVNE2	-2.3357	.6259	.003
NEFI	-3.8752	.9419	.001
CAFO	3309.8008	921.0457	.004
AVPROT2	-3.7335	3.1746	.262
PRONE	8.7811	2.5942	.005
AVFI2	5.8224	1.7583	.006
AVFI	17.0987	5.8777	.013
NECA	-86.7407	21.6637	.002
AVCA	-520.5686	192.5526	.019
PROFI	24.4123	7.7604	.008
AVNE	-17.9710	6.1962	.013
PROCA	44.1193	36.7559	.253
FICA	-244.0356	68.2102	.007

[a]For description of variables, see Table 35

TABLE 5. Days Open with the Variables Left After the Stepwise Backward Elimination Procedure Including COUNTRY as a Variable.

Model:

R^2 = .73463

Adj. R^2 = .37276

Degrees of Freedom Regression = 15

Mean Squares Regression = 2654.36631

Degrees of Freedom Residual = 11

Mean Squares Residual = 1307.50048

F Significance = .12

Variables[a]:

	Slope	Standard Error of Slope	Type I Error
COUNTRY	1.7355	34.8845	.961
PRONE	8.8465	3.0110	.013
CAFO	3327.1951	1023.4597	.008
AVPROT2	-3.6959	3.4005	.300
AVFI2	5.8514	1.9263	.011
NEFI	-3.8958	1.0670	.004
AVPROT	28.9791	16.8825	.114
NECA	-87.2215	24.6022	.005
AVFI	17.2574	6.9175	.030
AVNE2	-2.3524	.7355	.008
PROFI	24.6182	9.1003	.020
AVCA	-524.0784	213.1066	.032
PROCA	43.7229	39.2041	.289
AVNE	-17.9117	6.5798	.020
FICA	-225.7766	79.3667	.016

[a]For description of variables, see Table 35

Highly significant (P < .01) interactions were Calcium and Phosphorus, Fiber and Calcium, Net Energy and Phosphorus. Signficant (P < .05) interactions were Net Energy and Calcium, Protein and Calcium and Protein and Fiber.

Table 7 shows that differences of average days from calving the first service were not significant (P > .05) between regions. In this model, overall significance is .002 and R^2 = .91481 an adjusted R^2 = .78846. No linear effects showed to be significant (P > .05). Highly significant (P < .01) quadratic effects were Phosphorus, Fiber and Net Energy.

Interaction effects that showed to be highly significant (P < .01) were Calcium and Phosphorus, Fiber and Calcium and Net Energy and Phosphorus. Net Energy and Calcium, and Protein and Calcium Interactions were significant (P < .05).

In Table 3, the difference in ration Calcium content between regions is highly significant (P < .01). It was hypothesized that Calcium content of the ration had a significant effect on Days Open, but in this case Calcium content of the ration did not have a significant (P > .05) effect on average days from calving to first service.

TABLE 6. Model for Average Days from Calving to First Service with the Variables Left After the Stepwise Backward Elimination Procedure

Model:

R^2 = .91481

Adj. R^2 = .79863

Degress of Freedom Regression = 15

Mean Squares Regression = 343.15373

Degrees of Freedom Residual = 11

Mean Squares Residual = 43.57824

F Significance = .001

Variables[a]:

	Slope	Standard Error of Slope	Type I Error
AVNE2	.4566	.1009	.001
AVFI	-.0737	1.0600	.946
AVFO2	6156.9123	1206.3444	.0001
PROFO	-86.7381	47.2611	.094
NECA	9.7708	3.2083	.011
PROCA	17.5725	6.2259	.017
AVFI2	-1.1625	.1949	.0001
FIFO	-27.1768	26.2885	.323
AVCA	32.7045	12.8844	.028
PROFI	-1.6801	.7530	.047
AVFO	-135.7896	66.8410	.067
AVNE	.1855	.9205	.844
NEFO	-131.2926	28.7648	.001
FICA	26.8222	6.4387	.002
CAFO	-2439.4617	488.9348	.0001

[a]For description of variables, see Table 36

TABLE 7. Model for Average Days from Calving to First Service with the Variables Left After the Stepwise Backward Elimination Procedure Including COUNTRY as a Variable.

Model:

R^2 = .91864

Adj. R^2 = .78846

Degress of Freedom Regression = 16

Mean Squares Regression = 323.0551

Degrees of Freedom Residual = 10

Mean Squares Residual = 45.7784

F Significance = .002

Variables[a]:

	Slope	Standard Error of Slope	Type I Error
COUNTRY	7.1397	10.3999	.508
AVFO2	5623.4962	1460.2919	.003
FIFO	-38.7700	31.7986	.251
AVFI2	-1.1503	.2005	.0001
AVNE2	.4610	.1036	.001
NECA	9.2183	3.3854	.021
PROFO	-91.0729	48.8493	.092
PROCA	16.2375	6.6709	.035
AVFI	.1240	1.1245	.914
AVCA	28.8987	14.3220	.071
PROFI	-1.5433	.7971	.082
AVFO	-68.4050	119.6977	.580
AVNE	.2881	.9552	.769
NEFO	-138.1904	31.1471	.001
FICA	25.0152	7.1048	.006
CAFO	-2203.5664	607.6148	.005

[a]For description of variables, see Table 35

Since average days from calving to first service, there is no consistency in the hypothesis.

The regression model for the variable services per conception is shown in Table 8. Variables deleted were: Phosphorus, Quadratic Effects of Phosphorus, Calcium and Protein, Interactions between Protein and Energy, Calcium and Protein. Overall significance for the model was .406, R^2 = .53344 and adjusted R^2 = .06689.

When COUNTRY was used as a dummy variable in the model, no significant differences ($P > .05$) existed between region (Table 9) as expected because this variable was used to match the herds. Only Calcium, Quadratic Effects of Net Energy and Fiber and the interaction between Net Energy and Phosphorus showed to be significant ($P < .05$) in this model.

Regression model for First Service Conception is shown in Table 10. Overall significance for the model is .117, and the variation explained by R^2 = .58621 and adjusted R^2 = .28277. Variables deleted from the model were: Net Energy, Fiber, Quadratic Effects of Net Energy and Fiber and the interactions between Net Energy and Fiber, Calcium and Fiber, Protein and Fiber, Protein and Phosphorus and Net Energy and Phosphorus.

Variables which shown to be significant ($P < .05$) were: quadratic effect of protein, and the interactions

TABLE 8. Model for Services per Conception with the Variables Left After the Stepwise Backward Elimination Procedure.

Model:

R^2 = .53344

Adj. R^2 = .06689

Degrees of Freedom Regression = 13

Mean Squares Regression = .24156

Degrees of Freedom Residual = 13

Mean Squares Residual = .21127

F Significance = .406

Variables[a]:

	Slope	Standard Error of Slope	Type I Error
AVNE	.0826	.0419	.071
PROFI	-.0681	.0426	.135
FIFO	-3.5331	1.7642	.067
NEFI	.0081	.0054	.158
AVPROT	-.2119	.1320	.133
NECA	.1436	.1284	.284
NEFO	-2.9220	1.0813	.018
AVNE2	.0138	.0048	.013
PROFO	-5.7525	3.7874	.153
AVCA	3.7706	1.5087	.027
AVFI	.0792	.0625	.227
AVFI2	-.0424	.0159	.020
FICA	.8746	.4400	.068

[a]For description of variables, see Table 35

TABLE 9. Model for Services per Conception with the Variables Left After the Stepwise Backward Elimination Procedure Including COUNTRY as a Variable.

Model:

R^2 = .53726

Adj. R^2 = 0

Degrees of Freedom Regression = 14

Mean Squares Regression = .22591

Degrees of Freedom Residual = 12

Mean Squares Residual = .22700

F Significance = .509

Variables[a]:

	Slope	Standard Error of Slope	Type I Error
COUNTRY	-.1212	.3853	.758
NEFI	.0077	.0058	.208
NECA	.1314	.1386	.362
FIFO	-3.4435	1.8507	.087
NEFO	-2.8801	1.1288	.025
AVPROT	-.2078	.1375	.157
PROFI	-.0680	.0442	.150
AVNE2	.0136	.0050	.019
PROFO	-5.8507	3.9383	.163
AVCA	3.7878	1.5648	.032
AVFI	.0760	.0656	.270
AVNE	.0718	.0554	.219
AVFI2	-.0414	-.0168	.030
FICA	.8781	.4563	.078

[a]For description of variables, see Table 35

between Calcium and Phosphorus, Fiber and Phosphorus and Net Energy and Calcium.

When COUNTRY was used in the model, the overall significance is lowered to .091 and this variable has a significance of .152 (Table 11). Significant ($P < .05$) variables for this model were: Protein, Quadratic Effect of Protein, and Net Energy and Calcium interaction.

The highly significant ($P < .01$) difference in protein content of the ration between Mexican herds (16.6%) and Michigan herds (14.1%) seems to indicate the difference in first service conception (56% and 60.3%, respectively).

The variability of the factors studied ranged from size of herd to amount of time spent detecting estrus as well as amount of number of times concentrate and hay were fed to the cows.

Factor analysis was applied to determine if some pattern of relationship among the different measurements existed and if the data could be reduced or rearranged into subsets of factors or variables that account for sources of variation. The patterns defined in Factor Analysis can be visualized through a geometric interpretation. Each of the variables included in the analysis could be considered as an axis of a geometric space, in this way, the space would have a total of 49 dimensions, one

TABLE 10. Model for First Service Conception with the Variables Left After the Stepwise Backward Elimination Procedure.

Model:

R^2 = .58621

Adj. R^2 = .28277

Degrees of Freedom Regression = 11

Mean Squares Regression = 554.92929

Degrees of Freedom Residual = 15

Mean Squares Residual = 287.24938

F Significance = .117

Variables[a]:

	Slope	Standard Error of Slope	Type I Error
AVPROT	-9.2104	4.9733	.084
CAFO	-2097.3982	851.9888	.026
FIFO	125.8073	58.3743	.048
PRONE	-.9740	.6524	.156
AVPROT2	3.2112	1.3685	.033
NECA	12.0149	5.3350	.040
AVCA	-14.0044	41.9565	.743
AVCA2	213.3930	115.8053	.085
AVFO	-43.8821	146.6152	.769
PROCA	-41.3610	28.9462	.174
AVFO2	3526.7925	2002.6318	.099

[a]For description of variables, see Table 35

TABLE 11. Model for First Service Conception with the Variables Left After the Stepwise Backward Elimination Procedure Including COUNTRY as a Variable.

Model:

R^2 = .64443

Adj. R^2 = .33966

Degrees of Freedom Regression = 12

Mean Squares Regression = 559.2040

Degrees of Freedom Residual = 14

Mean Squares Residual = 264.4653

F Significance = .091

Variables[a]:

	Slope	Standard Error of Slope	Type I Error
COUNTRY	19.9503	13.1770	.152
PRONE	-1.4328	.6955	.058
AVFO2	1279.1290	2428.2398	.607
FIFO	119.9637	56.1443	.051
NECA	12.5362	5.1306	.028
AVPROT2	3.1495	1.3137	.031
AVPROT	-12.7875	5.3248	.031
AVCA2	253.4099	114.2179	.044
AVCA	-11.6116	40.2892	.777
AVFO	198.7656	213.2520	.367
PROCA	-58.5050	29.9941	.071
CAFO	-1375.6616	946.3363	.168

[a]For description of variables, see Table 35

for each of the variables under consideration. In the space defined by the dimensions, every variable is represented by a point depending on its value. A line can be drawn from the point to the origin for a vector representation and the angle between any two of these vectors is a measure of the relationship between the two characteristics. If the angle approximates 90 degrees of relationship is less, if the angle approximates 0 degrees the relationship is stronger, if the angle between the two vectors is 180 degrees an inverse relationship exists, therefore variables that are highly interrelated will be grouped together in a pattern.

The initial analysis was performed using SPSS (Nie *et al*., 1975).

The first analysis is for exploring the data-reduction possibilities by constructing a set of new variables on the basis of the interrelation of variables in the data.

This approach, which uses defined factors, is called principal-component analysis.

Factors are shown in Table 12. Variation in Factor 1 is characterized by the grouping of variables related to nutrient concentration in each feedstuff, nutrient concentration (%) in total ration and total amount of nutrient in the ration.

Variability of Factor 2 is related to daily amount of feed materials fed to the animals.

In Factor 3, a combination of variables related to general management and nutrient concentration in each feedstuff was included.

The fourth factor included variables related to reproductive management such as: daily time for observing estrus of % of retained placenta.

Included in Factor 5 are a small grouping of variables without relationships, for that reason, this factor was not considered.

Eigenvalue is a measure of the relative importance of the function and the sum of eigenvalues is a measure of the total variance existing in the variables. In Table 13, the factors are ordered in terms of decreasing variation.

New general variables were created and the criteria used was to select the two highest correlations (independently of the sign) and regroup them under a single factor.

In this way, the new variables created were:

Nutrition (NUT1) characterized by Factor 1, Nutrition Management (NMGT) characterized by Factor 2, Reproductive Management (RMGT) characterized by Factor 4.

Factor 3 and Factor 5 were discarded due to the low number of variables grouped in them.

It is important to point out that the analysis grouped the variables in a very defined way. Related variables were clustered under the same factor and unrelated variables were excluded as was the case for Factor 5.

Subsequently, the data were fitted into three well defined newly generated variables to facilitate testing a general hypothesis.

Hypothesis to be tested is that some feeding and reproductive management procedures could be affecting specific reproductive parameters.

Before the new variables were tested for prediction in multiple regression analysis, they were standardized using the procedure described in Methods of Analysis. The goal was to develop a more accurate prediction model.

The models are included in Tables 14-17. Using Days Open as dependent variable and COUNTRY as dummy variable (Table 14), the regression showed that the variables RMGT, NMGT and NUT1 did not account for a significant difference between farms in Mexico and Michigan ($P > .2$).

In Table 15, there was a highly significant difference between countries ($P < .01$) using first service after parturition as a dependent variable.

However, the variables under consideration did not account for the difference between the regions ($P > .25$).

No significance between countries or variables was found for first service conception or services per conception (Tables 16 and 17).

According to this analysis, no significant differences between Mexico and Michigan existed in relation to reproductive management, as shown in Appendix Tables 1, 37, 48, 51, 52.

The differences among farms could be due to managerial decisions such as: policy for first service after parturition, use of heat detection aids, uterine infusion of antibiotics after calving, technical assistance, record keeping system or operator's level of competency as stated by Erickson (1972).

During the analysis, management differences related to Nutrition were found.

Most Michigan farms use complete rations for feeding dairy cows and operator utilized one or two production level groups for supplementing concentrates individually in the parlor, or only 1 group regardless or production.

Due to larger herd size, all Mexican farms used three production level groups and allowed milking cows to consume their entire ration, with concentrate placed on the roughage, apart from the milking operation.

These differences between feeding practices were not significant and the results agreed with those of Wilk et al. (1978) and Clark et al. (1980).

Cows fed a constant amount of concentrate (7.3 Kg/cow) during the entire lactation regardless of yield were compared to cows alloted to high and low subgroups on production of fat-corrected milk (1 Kg of concentrate per 2.25 Kg fat-corrected milk) (Wilk et al., 1978). The groups did not differ significantly in reproductive performance.

Clark et al. (1980) assigned cows randomly to either a herd with high, medium and low production groups or a one-group control herd. Also, the groups did not differe significantly in reproductive performance.

We expected to find differences that accounted for the variation in reproductive performance of dairy cows in two different region; thus, the complete analysis showed that the effect of management practices on reproductive performance in a dairy herd is not easily measured because of the complexity of the process. Also, it showed that although statistical data were obtained, cause and effect relationships between herd management and reproductive performance could not be established.

TABLE 12. Factor Matrix Using Principal Factor (Correlation Coefficients).

Variables	Nutrition	Nutrition Mgt.	Factor 3	Reprod. Mgt.	Factor 5
WDHO	-0.50714	-0.16938	-0.40476	-0.53553	-0.07383
SDHO	-0.34362	-0.26549	-0.19185	0.58825	0.27365
DTHO	0.26548	-0.21472	0.18411	0.38401	0.41315
MHAI	0.64640	0.09085	0.34684	0.19512	0.16172
EHAI	0.48312	0.17121	0.11275	-0.57303	-0.33972
PREGT	0.08965	-0.69827	0.11495	0.34896	0.23030
FTSER	0.28075	-0.30646	0.12620	0.03503	0.36099
RGPD	0.11524	0.25616	0.09098	0.50832	-0.55694
CGPD	-0.14629	0.41216	-0.15900	0.44989	-0.60964
PPC	0.56920	-0.22423	-0.05561	-0.27148	0.05333
NEC	-0.03748	0.24000	0.74979	-0.39844	0.08463
CAC	0.71732	0.41194	-0.23675	0.21951	0.19126
PHC	0.69046	0.26305	-0.20156	-0.19791	0.38574
CFC	0.37403	-0.79162	0.11303	0.03812	0.09311
CSPP	-0.42383	-0.10599	-0.29418	-0.54511	0.11818
CSNE	0.28564	0.35842	0.49448	-0.26559	-0.53065
CSCA	-0.70450	-0.39142	0.42038	-0.11180	0.40420
CSPH	-0.82687	-0.49398	0.13811	0.29400	-0.01107
CSCF	0.28853	-0.05444	-0.34727	-0.58179	-0.16319
AHPP	-0.17821	-0.09157	-0.67078	0.37495	0.12317
AHNE	0.49283	0.27932	-0.60245	0.40220	-0.33908
AHCA	0.78545	0.40212	-0.38033	-0.00115	-0.23673
AHPH	-0.59588	-0.59159	-0.06969	0.31310	-0.23475
AHCF	0.77546	-0.16483	-0.19111	0.09484	-0.40426
HPP	-0.28851	0.42622	-0.73303	0.03376	0.04353

TABLE 12 (con't)

Variables	Nutrition	Nutrition Mgt.	Factor 3	Reprod. Mgt.	Factor 5
HNE	0.11530	0.70137	0.18073	-0.01103	-0.01230
HCA	-0.25959	0.66460	0.32041	0.19613	0.19839
HPH	-0.47984	0.50051	0.28258	0.06128	0.08204
HCF	0.44933	-0.39633	-0.47266	-0.05588	-0.53004
FAT	-0.45316	-0.04731	0.08060	-0.14548	-0.12288
BALPR	0.60352	0.17358	-0.06571	0.44476	0.04158
BALNE	0.41746	0.04044	0.58280	0.59865	-0.24831
BALFI	0.67465	-0.45611	0.46689	0.21608	-0.08843
BALCA	0.77425	0.49633	0.14750	0.17213	0.28202
BALFO	0.83033	0.34448	0.10686	0.18077	0.33097
HSIZE	-0.46175	0.74646	0.06943	0.24404	-0.06551
MILK	0.16385	-0.47849	-0.59989	-0.04677	0.20568
DRY	-0.16385	0.47849	0.59989	0.04677	-0.20568
MET	-0.66325	0.42098	-0.18721	0.18259	0.23722
REP	-0.17190	0.49218	0.13072	-0.58899	0.23393
AGR	-0.21364	0.41284	0.20412	0.59162	0.30065
ACSR	0.01490	-0.62139	0.51423	0.00725	-0.11428
AHR	0.44160	-0.55547	0.23983	0.26260	0.14314
AHYR	-0.01386	0.70939	0.25753	0.08692	-0.25177
AVPROT	0.13901	0.40716	-0.66245	-0.21786	0.32027
AVNE	-0.57012	0.70228	-0.14628	0.01438	-0.13388
AVCA	0.71970	0.58950	-0.04663	0.08783	0.34451
AVFO	0.75352	0.41269	-0.11999	0.05024	0.43662
AVFI	0.77516	-0.57217	-0.01265	-0.13868	-0.14231

TABLE 13. Eigenvalues

Factor	Eigenvalue	Percent of Variation	Cumulative Percent
1	12.13997	33.4	33.4
2	9.48608	26.1	59.5
3	6.00982	16.5	76.0
4	4.94622	13.6	89.6
5	3.79399	10.4	100.0

TABLE 14. Regression Model for Days Open with the Variables Derived from Factor Analysis.

Model:

R^2 = .03810

Adj. R^2 = 0

Degrees of Freedom Regression = 3
Mean Squares Regression = 688.2697
Degrees of Freedom Residual = 23
Mean Squares Residual = 2266.6604
F Significance = .822

Variables:

	Slope	Standard Error of Slope	Type I Error
RMGT	-1.5611	5.6934	.786
NMGT	-1.3761	1.7820	.448
NUT1	-.1448	.1658	.392

INCLUDING COUNTRY AS A VARIABLE:

Model:

R^2 = .0856

Adj. R^2 = 0

Degrees of Freedom Regression = 4
Mean Squares Regression = 1160.5141
Degrees of Freedom Residual = 22
Mean Squares Residual = 2252.5428
F Significance = .725

Variables:

	Slope	Standard Error of Slope	Type I Error
COUNTRY	-21.5089	20.1083	.296
RMGT	.3862	5.9605	.949
NMGT	-1.8384	1.8283	.326
NUT1	.0864	.2721	.751

TABLE 15. Regression Model for Average Days from Calving to First Service with the Variables Derived from Factor Analysis.

Model:

R^2 = .1941

Adj. R^2 = .08901

Degrees of Freedom Regression = 3
Mean Squares Regression = 364.0885
Degrees of Freedom Residual = 23
Mean Squares Residual = 197.1478
F Significance = .167

Variables:

	Slope	Standard Error of Slope	Type I Error
RMGT	.9926	1.6790	.56
NMGT	-.2959	.5255	.579
NUT1	.0782	.0489	.123

INCLUDING COUNTRY AS A VARIABLE:

Model:

R^2 = .4127

Adj. R^2 = .3059

Degrees of Freedom Regression = 4
Mean Squares Regression = 580.5845
Degrees of Freedom Residual = 22
Mean Squares Residual = 150.1967
F Significance = .016

Variables:

	Slope	Standard Error of Slope	Type I Error
COUNTRY	14.8595	5.1924	.009
RMGT	-.3526	1.5391	.821
NMGT	.0234	.4721	.961
NUT1	-.0815	.0702	.258

TABLE 16. Regression Model for Services per Conception with the Variables Derived From Factor Analysis.

Model:

R^2 = .2165

Adj. R^2 = .1144

Degrees of Freedom Regression = 3
Mean Squares Regression = .4250
Degrees of Freedom Residual = 23
Mean Squares Residual = .2005
F Significance = .125

Variables

	Slope	Standard Error of Slope	Type I Error
RMGT	.0569	.0535	.298
NMGT	-.0275	.0167	.114
NUT1	.0009	.0015	.49

INCLUDING COUNTRY AS A VARIABLE:

Model:

R^2 = .2731

Adj. R^2 = .1409

Degrees of Freedom Regression = 4
Mean Squares Regression = .4019
Degrees of Freedom Residual = 22
Mean Squares Residual = .1945
F Significance = .12

Variables:

	Slope	Standard Error of Slope	Type I Error
COUNTRY	-.2443	.1868	.204
RMGT	.0790	.0553	.167
NMGT	-.0328	.0169	.067
NUT1	.0035	.0025	.173

TABLE 17. Regression Model for First Service Conception with the Variables Derived from Factor Analysis.

Model:

R^2 = .0300

Adj. R^2 = 0

Degrees of Freedom Regression = 3
Mean Squares Regression = 104.1292
Degrees of Freedom Residual = 23
Mean Squares Residual = 439.1551
F Significance = .87

Variables

	Slope	Standard Error of Slope	Type I Error
RMGT	.9779	2.5060	.70
NMGT	-.3114	.7844	.695
NUT1	-.0481	.0730	.516

INCLUDING COUNTRY AS A VARIABLE:

Model:

R^2 = .0306

Adj. R^2 = 0

Degrees of Freedom Regression = 4
Mean Squares Regression = 79.7541
Degrees of Freedom Residual = 22
Mean Squares Residual = 458.8157
F Significance = .949

Variables:

	Slope	Standard Error of Slope	Type I Error
COUNTRY	-1.090	9.075	.905
RMGT	1.076	2.690	.693
NMGT	-.3349	.8251	.689
NUT1	-.0364	.1228	.77

In an overview of all the models, we observe that the variable which accounted for most variation in the analyses was calcium in Days Open ($P < .05$), average days from calving to first service ($P < .05$) and Services per Conception ($P < .05$). Also interactions of Ca with P, Net Energy, Protein and Fiber showed to be significative in all four models.

Calcium levels for Mexican herds (1.2% of ration D.M.) are well above the NRC recommendations (0.7% of ration D.M.), whereas Michigan herds have a good Ca balance in the ration (.66%).

However, no significant differences among countries were found for the variables days open and services per conception, the results of this study agree with those of Littlejohn and Lewis (1960), and Steevens _et_ _al_. (1971). These authors concluded that fertility was not affected by the Ca content of the diet. Ward _et_ _al_. (1971) reported that high levels of Ca did not affect significantly services per conception.

For the variable average days from calving to first service a highly significant differences was found ($P < .01$) among regions.

The results seem to agree with Ward and Call (1979). These authors suggested that recommended levels of Calcium promote rapid uterine involution and early ovulation in dairy cows. And, this could be the case for Michigan dairy cows which are fed an adequate level of Calcium.

However, the variable average days from calving to first service should be considered related to important management decisions such as: interval for first breeding after parturition, post partum reproductive check and others which are going to influence the average number of days from calving to first service.

Since average days from calving to first service influences greatly days open and to lesser extend services per conception, along with the management decisions described before, the influence of Ca alone seems to be doubtful for explaining the variance for the most part.

It is important to point out that the results observed for phosphorus and protein are in agreement with the reports found in the literature. Phosphorus approaches significance ($P < .06$) only in the variable average days from calving in first service. Differences relative to this variable among regions are not significant ($P > .05$). Also, the results are similar to those reported before by Noller _et al_. (1977). Hecht _et al_. (1977), Call _et al_. (1978) and Carstairs _et al_. (1980) in which phosphorus levels in the ration did not influence reproduction dairy cows.

Protein approaches significance ($P < .08$) only in First Service Conception, the difference relative to this variable between regions is highly significant ($P > .01$).

Since no significant differences among countries were found for the dependent variables, except for average days from calving to first service. The results agree with those of Bond and Wiltbank (1970), Wohlt and Clark (1978) and Edward et al. (1980), in which ration protein levels did not affect reproductive performance.

High protein levels in the ration of Mexican cows could be detrimental for first service conception and services per conception. As Jordan and Swanson (1979) suggested, this condition could create a suboptimal uterine or ovarian environment and reduce reproductive efficiency. Also, the practice of feeding excess protein is wasteful and could impair reproductive efficiency without increasing milk production.

In the regression model for Days Open, Net Energy was significant ($P < .05$) and showed to have a negative effect. The results did not agree with literature reports of Sonderegger and Schurch (1977) and Ayalon et al. (1971). These authors suggested that deficient levels of energy increased the interval from parturition to conception. In this study, although no significant differences among countries were observed for Net Energy, average days open were lower for Mexican farms compared to Michigan farms. The results agree with Tong *et al*. (1979) and Carstairs *et al*. (1980) for showing no influence of energy on first service conception, services per conception and average days from calving to first service.

Crude fiber was another variable attempting to explain the variation observed in Days Open ($P < .05$). The results agree with literature reports of Zamet *et al*. (1979), Francos *et al*. (1977), Mayer *et al*. (1978) and Tong *et al*. (1979).

Table 18 shows a correlation analysis between Protein, Net Energy, Calcium, Phosphorus and Fiber. This approach was used in an attempt to explain the interactions among the nutrients. Highly significant positive ($P < .01$) correlations were: Calcium and Protein, Fiber and Protein and Fiber and Calcium. Significant positive correlation ($P < .05$) was Phosphorus and Net Energy.

Significant negative correlation ($P < .05$) was Calcium and Net Energy. The correlations between variables and their interactions are not consistent through the analyses and they do not help to explain how the interactions are affecting reproductive performance. Another attempt to understand the interaction effects was made by dividing our herds in high and low

TABLE 18. Correlation Coefficients Between Average Protein, Average Net Energy, Average Calcium, Average Phosphorus and Average Fiber.

	Average Protein	Average Net Energy	Average Calcium	Average Phosphorus
Average Net Energy	-.1666			
	P = .203			
Average Calcium	.6762	-.3690		
	P = .001	P = .029		
Average Phosphorus	.0158	.3436	.3009	
	P = .469	P = .040	P = .064	
Average Fiber	.4833	-.3061	.6122	-.0261
	P = .005	P = .060	P = .001	P = .449

nutrient concentration groups using the overall mean of each nutrient as a breaking point. In other words, herds having a nutrient value higher than the overall mean were treated as the high group for that nutrient and so forth for the other nutrients. Means for the dependent variables were calculated for herds falling in higher or lower groups of the two nutrients under consideration.

The significant interactions tested for Days Open are shown in Table 19-24.

For this variable, the higher the nutrient concentrations, the shorter Days Open interval. It seems that this parameter tends to be lower when the ration is approximately balanced.

For average days from calving to first service services, services per conception and first service conception, the results appeared to be somewhat contradictories. In these cases, the interactions did not follow a definite pattern.

For average days from calving to first service, Calcium, and Protein seemed to exert their influence at lower ration concentration, and Crude Fiber and Phosphorus at a higher concentration, whereas Net Energy is indifferent (Tables 25-30).

For services per conception (Table 30) and first service conception (Tables 32-34), the lack of sufficient number of interactions made the interpretation more difficult. Lower concentration of Calcium reduced first service conception.

Further study will be needed in order to elucidate these interactions.

TABLE 19. Effect of the Interaction of Net Energy and Fiber on Days Open Interval.

		Net Energy	
		High[a]	Low[a]
Fiber	High	114[b]	183[b]
	Low	163[b]	143[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of Days Open for herds falling in every category.

TABLES 20. Effect of the Interaction of Calcium and Phosphorus on Days Open Interval.

		Calcium	
		High[a]	Low[a]
Phosphorus	High	142[b]	177[b]
	Low	164[b]	162[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of Days Open for herds falling in every category.

TABLE 21. Effect of the Interaction of Protein and Net Energy on Days Open Interval.

		Protein	
		High[a]	Low[a]
Net Energy	High	137[b]	176[b]
	Low	177[b]	168[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of days open for herds falling in every category.

TABLE 22. Effect of the Interaction of Net Energy and Calcium on Days Open Interval.

		Net Energy	
		High[a]	Low[a]
Calcium	High	139[b]	169[b]
	Low	162[b]	189[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of days open for herds, falling in every category.

TABLE 23. Effect of the Interaction of Protein and Fiber on Days Open Interval.

		Protein	
		High[a]	Low[a]
Fiber	High	155[b]	189[b]
	Low	149[b]	171[b]

[a]High and low nutrient concentration groups, respect to the overall mean.

[b]Average number of days open for herds falling in every category.

TABLE 24. Effect of the Interaction of Fiber and Calcium on Days Open Interval.

		Fiber	
		High[a]	Low[a]
Calcium	High	155[b]	156[b]
	Low	189[b]	162[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of days open for herds falling in every category.

TABLE 25. Effect of the Interaction of Calcium and Phosphorus on Average Days from Calving to First Service.

		Calcium	
		High[a]	Low[a]
Phosphorus	High	62[b]	71
	Low	81	64

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of days from calving to first service for herds falling in every category.

TABLE 26. Effect of the Interaction of Fiber and Calcium on Average Days from Calving to First Service.

		Fiber	
		High[a]	Low[a]
Calcium	High	77[b]	67[b]
	Low	55[b]	68[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of days from calving to first service for herds falling in every category.

TABLE 27. Effect of the Interaction of Net Energy and Phosphorus on Average Days from Calving to First Service.

		Net Energy	
		High[a]	Low[a]
Phosphorus	High	66[b]	No Data
	Low	67[b]	76[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of days from calving to first service for herds falling in every category.

TABLE 28. Effect of the Interaction of Net Energy and Calcium on Average Days from Calving to First Service.

		Net Energy	
		High[a]	Low[a]
Calcium	High	63[b]	82[b]
	Low	68[b]	55[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of days from calving to first service for herds falling in every category.

TABLE 29. Effect of the Interaction of Protein and Calcium on Average Days from Calving to First Service.

		Protein	
		High[a]	Low[a]
Calcium	High	73[b]	82[b]
	Low	69[b]	65[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of days from calving to first service for herds falling in every category.

TABLE 30. Effect of the Interaction of Protein and Fiber on Average Days from Calving to First Service.

		Protein	
		High[a]	Low[a]
Fiber	High	77[b]	55[b]
	Low	66[b]	69[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of days from calving to first service for herds falling in every category.

TABLE 31. Effect of the Interaction of Net Energy and Phosphorus on Services per Conception

		Net Energy	
		High[a]	Low[a]
Phosphorus	High	1.6[b]	No data
	Low	2.1[b]	2.2[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Average number of services per conception for herds falling in every category.

TABLE 32. Effect of the Interaction of Calcium and Phosphorus on First Service Conception

		Calcium	
		High[a]	Low[a]
Phosphorus	High	55[b]	61[b]
	Low	54[b]	63[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Percentage of first service conception for herds falling in every category.

TABLE 33. Effect of the Interaction of Fiber and Phosphorus on First Service Conception.

		Fiber	
		High[a]	Low[a]
Phosphorus	High	70[b]	54[b]
	Low	58[b]	60[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Percentage of first service conception for herds falling in every category.

TABLE 34. Effect of the Interaction of Net Energy and Calcium on First Service Conception

		Net Energy	
		High[a]	Low[a]
Calcium	High	56[b]	54[b]
	Low	60[b]	80[b]

[a]High and low nutrient concentration groups respect to the overall mean.

[b]Percentage of first service conception for herds falling in every category.

CONCLUSIONS

Although, the regression models for days open, services per conception and first service conception did not accurately describe these variables, many of the nutrients were significantly related to the variation found in these models. One of the reasons could be that there are other variables not measured such as milk production that influenced these parameters, also it is possible with more farms participating a better model might have been determined.

Throughout this study, no single nutrient explained variation observed in reproductive performance.

Interactions among Protein, Net Energy, Crude Fiber, Calcium and Phosphorus contributed the most to variation in reproductive parameters. However; the biological interpretation of these interactions proved to be difficult. Further research will be needed in order to examine the effect of the interactions on dairy cows reproduction.

Cows in Mexico are fed primarily alfalfa. Consequently, rations for these cows were consistently high in Calcium, Protein and Crude Fiber and deficient in

Net Energy. And since the interactions of these nutrients explained variation in the models, a practical recommendation would be to review the dairy ration in order to balance these and all other nutrients.

Forage and feed analysis would be used along with reliable sources of information on requirements to provide a feeding program for dairy cows in Mexico. Using this approach, reproductive problems related to nutrition should be minimal and production of milk will be increased.

A continuing, long-term feeding program must be used for the entire herd including replacements and dry cows since reproductive problems may not be apparent in a relatively short period of time.

From the Factor Analysis, only the alfalfa hay-based ration in Mexican herds contributed significantly to variation in reproductive performance. All other variables tested did not account for significant amounts of variation.

APPENDIX

APPENDIX

TABLE 35. Alphabetical List of Variables

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
ABI	40	Antibiotic Infusion
ABOR	51	Abortions # of Cows
ACI	33	Avg. Calving Interval Months
ACSR	200	(CSHP + CSLP)/2
ADDC	89	Additive for Corn Silage
ADDT	90	Additive for Corn Silage Type
AGR	199	(GHP + GLP)/2
AHAP	137	Alfalfa Hay-Avg. Prod. Cows
AHCA	119	Alfalfa Hay-Ca %
AHCF	121	Alfalfa Hay-C.F. %
AHDC	101	Lbs Alfalfa Hay:Dry Cow:Day
AHHP	133	Alfalfa Hay-High Prod. Cows
AHLP	141	Alfalfa Hay-Low Prod. Cows
AHNE	118	Alfalfa Hay-N.E. Mcal:Lb
AHPH	120	Alfalfa Hay-P %
AHPP	117	Alfalfa Hay-Prot %
AHR	201	(AHHP = AHLP)/2
AHYR	202	(HHP + HLP)/2

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
AIB	3	A.I. Breeding
AICR	21	A.I. Conception Rate vs. Bull
AVCA	205	(RACH + RACL)/2
AVCA2		Quadratic effect of Calcium
AVFI	207	(RAFH + RAFL)/2
AVFI2		Quadratic effect of Crude Fiber
AVFO	206	(RAWH = RAWL)/2
AVFO2		Quadratic Effect of Phosphorus
AVNE	204	(RAEH + RAEL)/2
AVNE2		Quadratic effect of Net Energy
AVPROT	203	(RAPH + RAPL)/2
AVPROT2		Quadratic Effect of Crude Protein
BCR	34	Better Conception Rate
BRED	44	Avg Days Calving to Breeding
BWA	127	Cows body weight Avg
CAC	109	Ca Cont.-Conc. %
CAFI		Cross Product Calcium and Phosphorus
CAFO		Cross Product P and Crude Fiber
CALA	163	Ca Cont. Avg prod. Group-Lbs
CALAED	162	Ca Cont. Avg prod. Group-Sta

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
CALH	153	Ca Cont. high prod. Group-Lbs
CALHED	152	Ca Cont. high prod. Group-Sta
CALL	173	Ca Cont. Low prod. Group-Lbs
CALLED	172	Ca Cont. Low prod. Group-Sta
CAPL	43	Calving Place
CAPR	80	Calving Prob
CCAH	92	Criteria for Cutting Alfalfa Hay
CFC	111	C.F. Cont.-Conc. %
CGM	85	Changes in Grain Mix
CGPD	95	Times Conc. given per Day
CIOP	130	Cows inseminated by operator
CLUB	38	Use of Clean up Bull
CLUC	39	Clean Up Bull Calvings
CORRAL	147	Area: Cow in Mexico
CSAP	136	Corn Silage-Avg. Prod Cows
CSCA	114	Corn Silage-Ca %
CSCF	116	Corn Silage-C.F. %
CSDC	100	Lbs Corn Silage:Dry Cow:Day
CSHP	132	Corn Silage - High Prod. Cows

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
CSLP	140	Corn Silage-Low Prod. Cows
CSNE	113	Corn Silage-N.E. Mcal:Lb
CSPH	115	Corn Silage-P%
CSPP	112	Corn Silage-Prot. %
CVB	55	Calf Vaccination-Brucellosis
CVLE	57	Calf Vaccination-Leptospirosis
CVPI	59	Calf Vaccination-PI3
CURN	56	Calf Vaccination-IBR
CVSF	60	Calf Vaccinatin-Pasteurella
CVTRI	61	Calf Vaccination-Triple
CVVD	58	Calf Vaccination-BVD
DAID	37	Use of Heat Detection Aids
DAYO	145	Days Open
DCOW	129	Number of Dry Cows
DEDI	76	Culling-disposition
DEFL	72	Culling-Feet and Legs
DEMP	71	Culling-Milk Production
DEMU	73	Culling-Mastitis and Udder Prob.
DEO	77	Culling-Other
DER	74	Culling-Reproduction
DETY	75	Culling-Type

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
DOTF	64	Dairy Operation-Type of Facilities
DRY	196	(DCOW/HSIZE) x 100
DRYL	144	Dry Period Length
DTHO	17	Daily time for heat obst. mins.
ECM	41	Estrus Cows Management
EFFI	54	Efficiency of A.I. against disease
EHAI	19	Evening heat-A.I.
FARM	2	Farm Code
FAT	193	Milk Fat %
FDLS	84	Feeding Dry Lot Summer
FIBA	167	C.F. Cont. Avg. Prod-Lbs
FIBAED	166	C.F. Cont. Avg. Prod Group-Sta
FIBH	157	C.F. Cont. High Prod Group-Lbs
FIBHED	156	C.F. Cont. High Prod Group-Sta
FIBL	177	C.F. Cont. Low Prod Group-Lbs
FIBLED	176	C.F. Cont. Low Prod Group-Sta
FIFO		Cross Product P and Crude Fiber

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
FSC	20	First Service Conception
FTSER	50	First Service After Part-urition
GAP	135	Conc. Avg Prod Cows
GDRC	98	Lbs Conc:Dry Cow:Day
GFEG	103	Grain Feeding Guide
GHP	131	Cont. High Prod Cows
GHPC	105	Lbs Grain High Prod Cow
GLP	139	Conc. Low Prod Cows
GOFT	96	Cows Off Feed-Season
HAP	138	Haylage Avg Prod Cows
HCA	124	Haylage-Ca %
HCF	126	Haylage-C.F. %
HD	6	Heat Detection
HDC	102	Lbs Haylage: Dry Cow Per Day
HEAT	45	Avg Days Calving to Heat
HHP	134	Haylage Hay Prod Cows
HLP	142	Haylage-Low Prod Cows
HNE	123	Haylage-N.E. Mcal:Lb
HOWF	88	How Fed
HPH	125	Haylage-P %
HPKE	68	High Producers-Ketosis

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
HPMF	69	High Producers-Milk Fever
HPMU	67	High Producers-Mastitis and Udder
HPO	70	High Producers-Others
HPOF	65	High Producers-Off Fed
HPP	122	Haylage-Prot %
HPRP	66	High Producers-Reproductive Prob
HSIZE	194	(MCOW + DCOW)
IGDC	99	Increase Conc. to Dry Cows
KETO	53	Ketosis # of Cows
MCE	36	More Cows in Estrus
MCOW	128	Number of Milking Cows
MET	197	(METR/HSIZE) x 100
METR	79	Metritis Inc # of Cows
MGC	106	More Grain per Cow
MHAI	18	Morning Heat-A.I.
MIFE	52	Milk Fever # of Cows
MILK	195	(MCOW/HSIZE) x 100
NCD	63	Number of Cows Dead
NCSO	62	Number of Cows Sold
NEC	108	N.E.-Conc. Mcal:lb

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
NECA		Cross Product Net Energy and Ca
NEFI		Cross Product Net Energy and C.F.
NEFO		Cross Product Net Energy and P
NELA	161	N.E. Avg Prod Group-Mcal:Lb
NELAED	160	N.E. Avg Prod Group-Sta
NELH	151	N.E. High Prod Group-Mcal:Lb
NELHED	150	N.E. High Prod Group-Sta
NELL	171	N.E. Low Prod Group-Mcal:Lb
NELLED	170	N.E. Low Prod Group-Sta
PHC	110	P Cont-Conc. %
PHOSA	165	P Cont. Avg Prod Group-Lbs
PHOSAED	164	P Cont. Avg Prod Group-Sta
PHOSH	155	P Cont. High Prod Group-Lbs
PHOSHED	154	P Cont. High Prod Group-Sta
PHOSL	175	P Cont. Low Prod Group-Lbs
PHOSLED	174	P Cont. Low Prod Group-Sta
PPC	107	Prot-Conc.
PPCK	46	Postpartum Check Before Rebred
PREG	47	Pregnancy Check After Breeding

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
PREGT	48	Days Breeding to Pregnancy Check
PROCA		Cross Product Crude Protein and Ca
PROFI		Cross Product Crude Protein and C.F.
PROFO		Cross Product Crude Protein and P
PRONE		Cross Product Crude Protein and N.E.
PROTA	159	Prot Avg Prod Group-Lbs
PROTAED	158	Prot Avg Prod Group-Sta
PROTH	149	Prot Cont. High Prod Group-Lbs: Cow
PROTHED	148	Prot Cont. High Prod Group-Sta
PROTL	169	Prot Cont. Low Prod Group-Lbs
PROTLED	168	Prot Cont. Low Prod Group-Sta
QUAN	91	Additive-Lbs: Ton
RACA	186	Ca Cont. Ration Avg Prod Cows-%
RACH	181	Ca Cont. Ration High Prod Cows-%
RACL	191	Ca Cont. Ration Low Prod Cows-%

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
RAEA	184	N.E. Ration Avg Prod Cows-Mcal: Cwt
RAEH	179	N.E. Ration High Prod Cows-Mcal: Cwt
RAEL	189	N.E. Ration Low Prod Cows-Mcal: Cwt
RAFA	185	C.F. Ration Avg Prod Cows %
RAFH	180	C.F. Ration High Prod Cows %
RAFL	190	C.F. Ration Low Prod Cows %
RAPA	183	Prot-Ration Avg Prod Cows %
RAPH	178	Prot Cont. Ration High Prod Cows %
RAPL	188	Prot Ration Low Prod Cows %
RAWA	187	P Cont. Ration Avg Prod Cows %
RAWH	182	P Cont. Ration High Prod Cows %
RAWL	192	P Cont. Ration Low Prod Cows %
RBA	23	Rank Bull-Pedigree
RBCR	26	Rank Bull-Conception Rate
RBM	25	Rank Bull-Color Markings
RBMF	22	Rank Bull-Dams Milk and Fat
RBO	32	Rank Bull-Other

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
RBP	27	Rank Bull-Price
RBPD	24	Rank Bull-Predicted Difference
RBRF	28	Rank Bull-Repeatability Factor
RBRP	31	Rank Bull-Recognition
RBS	30	Rank Bull-Summary List
RBT	29	Rank Bull-Daughters Type
REP	198	(REPL/HSIZE) x 100
REPL	78	Retained Placenta Inc # of Cows
RG	1	Region
RGPD	94	Times Roughage Given Per Day
SADR	86	Suppl. Added to Ration
SADHM	87	Suppl. Added-How Much Lbs: Cow
SCB	35	Summer Time cows insemin-ation
SCD	143	Services Per Conception
SDHO	12	Summer Daily Heat Obs.
SEI	97	Selenium Included in Ration
SHADES	146	Shades in Mexico
SHOC	15	Summer Heat Detection-Children

TABLE 35 (con't.)

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
SHOL	16	Summer Heat Detection-H. Labor
SHOO	13	Summer Heat Detection-Operator
SHOW	14	Summer Heat Detection-Wife
TOE	42	Time for Catching Up Cow in Heat
TSMA	93	Trace Mineral Salt Available
TT	5	Technician Training
UTME	81	Uterus Medication
UTMP	82	Uterus Medication %
VET	49	Pregnancy Check Carried Out by
WDHO	7	Winter Daily Heat Obs
WEEG	104	Lbs Grain Winter Feeding
WHOC	10	Winter Heat Detection-Children
WHOL	11	Winter Heat Detection-H. Labor
WHOO	5	Winter Heat Detection-Operator
WHOW	9	Winter Heat Detection-Wife
WORM	83	Deworming Practice
YUAI	4	Years Using A.I.

TABLE 36. Card Format

Variable Name	Variable Number	Variable Description	Card No.	Col.
RG	1	Region	1	1
FARM	2	Farm Code	1	2-3
AIB	3	A.I. Breeding	1	4-6
YUAI	4	Years Using A.I.	1	7-8
TT	5	Technician Training	1	9
HD	6	Heat Detection	1	10
WDHO	7	Winter Daily Heat Obs	1	11
WHOO	8	Winter Head Detection-Operator	1	12
WHOW	9	Winter Heat Detection-Wife	1	13
WHOC	10	Winter Heat Detection-Children	1	14
WHOL	11	Winter Heat Detection-H. Labor	1	15
SDHO	12	Summer Daily Heat Obs.	1	16
SHOO	13	Summer Heat Detection-Operator	1	17
SHOW	14	Summer Heat Detection-Wife	1	18
SHOC	15	Summer Heat Detection-Children	1	19
SHOL	16	Summer Heat Detection-H. Labor	1	20
DTHO	17	Daily Time for Heat Obs. Mins	1	21-22

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
MHAI	18	Morning Heat-A.I.	1	23
EHAI	19	Evening Heat-A.I.	1	24
FSC	20	First Service Conception	1	25-26
AICR	21	A.I. Conception Rate vs. Bull	1	27
RBMF	22	Rank Bull-Dams Milk and Fat	1	28
RBA	23	Rank Bull-Pedigree	1	29
RBPD	24	Rank Bull Predicted Difference	1	30
RBM	25	Rank Bull-Color Markings	1	31
RBCR	26	Rank Bull-Conception Rate	1	32
RBP	27	Rank Bull-Price	1	33
RBRF	28	Rank Bull-Repeatability Factor	1	34
RBT	29	Rank Bull-Daughters Type	1	35
RBS	30	Rank Bull-Summary List	1	36
RBRP	31	Rank Bull-Recognition	1	37
RBO	32	Rank Bull-Other	1	38
ACI	33	Avg Calving Interval Months	1	39-42
BCR	34	Better Conception Rate	1	43

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
SCB	35	Summer Time Cows Insemination	1	44
MCE	36	More Cows in Estrus	1	45
DAID	37	Use of Heat Detection Aids	1	46
CLUB	38	Use of Clean-Up Bull	1	47
CLUC	39	Clean-Up Bull Calvings	1	48-49
ABI	40	Antibiotics Infusion	1	50-51
ECM	41	Estrus Cows Management	1	52
TOE	42	Time for Catching Up Cows in Heat	1	53
CAPL	43	Calving Place	1	54
BRED	44	Avg Days Calving To Breeding	1	55-56
HEAT	45	Avg Days Calving To Heat	1	57-58
PPCK	46	Postpartum Check Before Rebred	1	59
PREG	47	Pregnancy Check After Breeding	1	60
PREGT	48	Days Breeding To Preg. Check	1	61-62
VET	49	Pregnancy Check Carried Out By	1	63
FTSER	50	First Service After Parturition		64-65
ABOR	51	Abortions # of Cows	1	66-67

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
MIFE	56	Milk Fever # of Cows	1	68-69
KETO	53	Ketosis # of Cows	1	70-71
EFFI	54	Efficiency of A.I. Against Disease	1	72
CVB	55	Calf Vaccination-Brucellosis	1	73
CVRN	56	Calf Vaccination-IBR	1	74
CVLE	57	Calf Vaccination-Leptospirosis	1	75
CVVD	58	Calf Vaccination-BVD	1	76
CVPI	59	Calf Vaccination-P13	1	77
CVSF	60	Calf Vaccination-Pasteurella	1	78
CVTRI	61	Calf Vaccination-Triple	1	79
NCSO	62	Number of Cows-Sold	1	4-5
NCD	63	Number of Cows-Dead	1	6-7
DOTF	64	Dairy Operation-Type of Facilities	2	8-9
HPOF	65	High Producers-Off Feed	2	10
HPRP	66	High Producers-Reproductive Prob	2	11
HPMU	67	High Producers-Mastitis and Udder	2	12
HPKE	68	High Producers-Ketosis	2	13
HPMF	69	High Producers-Milk Fever	2	14

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
HPO	70	High Producers-Others	2	15
DEMP	71	Culling-Milk Production	2	16
DEFL	72	Culling-Feed and Legs	2	17
DEMU	73	Culling-Mastitis and Udder Prob	2	18
DER	74	Culling-Reproduction	2	19
DETY	75	Culling-Type	2	20
DEDI	76	Culling-Disposition	2	21
DEO	77	Culling-Other	2	22
REPL	78	Retained Placenta Inc. # of Cows	2	23-24
METR	79	Metritis Inc. # of Cows	2	25-26
CAPR	80	Calving Prob	2	27
UTME	81	Uterus Mecication	2	28
UTMP	82	Uterus Medication %	2	29-30
WORM	83	Deworming Practice	2	31
FDLS	84	Feeding Dry Lot Summer	2	32
CGM	85	Changes in Grain Mix	2	33
SADR	86	Suppl. Added to Ration	2	34
SADHM	87	Suppl. Added-How Much Lbs:Cow	2	35-36
HOWF	88	How Fed	2	37
ADDC	89	Additive For Corn Silage	2	38

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
ADDT	90	Additive for Corn Silage-Type	2	33
QUAN	91	Additive-Lbs:Ton	2	40-41
CCAH	92	Criteria for Cutting Alfalfa Hay	2	42
TSMA	93	Trace Mineral Salt Available	2	43
RGPD	94	Times Roughage Given Per Day	2	44
CGPD	95	Times Conc. Given Per Day	2	45
GOFT	96	Cows Going Off Feed-Season	2	46
SEI	97	Selenium Included in Ration	2	47
GDRC	98	Lbs. Conc.:Dry Cow:Day	2	48-49
IGDC	99	Increase Conc. to Dry Cows	2	50
CSDC	100	Lbs. Corn Silage:Dry Cow:Day	2	51-52
AHDC	101	Lbs. Alfalfa Hay:Dry Cow:Day	2	53-54
HDC	102	Lbs. Haylage:Dry Cow Per Day	2	55-56
GFEG	103	Grain Feeding Guide	2	57
WFEG	104	Lbs. Grain Winter Feeding	2	58-59

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
GHPC	105	Lbs. Grain High Prod Cow	2	60-61
MGC	106	More Grain Per Cow	2	62
PPC	107	Prot.-Conc.	2	63-66
NEC	108	N.E.-Conc. Mcal:Lab	2	67-70
CAC	109	Ca Cont.-Conc. %	2	71-74
PHC	110	P Cont.-Conc. %	2	75-78
CFC	111	C. F. Cont.-Conc. %	3	4-7
CSPP	112	Corn Silage-Prot. %	3	8-11
CSNE	113	Corn Silage-N.E. Mcal:Lb	3	12-15
CSCA	114	Corn Silage-Ca %	3	16-19
CSPH	115	Corn Silage-P %	3	20-23
CSCF	116	Corn Silage - C.F. %	3	24-27
AHPP	117	Alfalfa Hay-Prot. %	3	28-31
AHNE	118	Alfalfa Hay-N.E. Mcal:Lb	3	32-35
AHCA	119	Alfalfa Hay-Ca %	3	36-39
AHPH	120	Alfalfa Hay-P %	3	40-43
AHCF	121	Alfalfa Hay-C.F. %	3	44-47
HPP	122	Haylage-Prot. %	3	48-51
HNE	123	Haylage-N.E. Mcal:Lb	3	52-55
HCA	124	Haylage-Ca %	3	56-59
HPH	125	Haylage-P %	3	60-63

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
HCF	126	Haylage-C.F. 5	3	64-67
BWA	127	Cows Body Weight Avg	3	68-71
MCOW	128	Number of Milking Cows	3	72-74
DCOW	129	Number of Dry Cows	3	75-77
CIOP	130	Cows Inseminated by Operator	3	78
GHP	131	Conc.-High Prod Cows	4	4-5
CSHP	132	Corn Silage-High Prod Cows	4	6-7
AHHP	133	Alfalfa Hay-High Prod Cows	4	8-9
HHP	134	Haylage-High Prod Cows	4	10-11
GAP	135	Conc.-Avg Prod Cows	4	12-13
CSAP	136	Corn Silage-Avg Prod Cows	4	14-15
AHAP	137	Alfalfa Hay-Avg Prod Cows	4	16-17
HAP	138	Haylage-Avg Prod Cows	4	18-19
GLP	139	Conc.-Low Prod Cows	4	20-21
CSLP	140	Corn Silage-Low Prod Cows	4	22-23
AHLP	141	Alfalfa Hay-Low Prod Cows	4	24-25
HLP	142	Haylage-Low Prod Cows	4	26-27
SPC	143	Services Per Conception	4	28-31
DRYL	144	Dry Period Length	4	32-33

TABLE (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
DAYO	145	Days Open	4	34-36
SHADES	146	Shades in Mexico	4	37
CORRAL	147	Area:Cow in Mexico	4	38-39
PROTHED	148	Prot. Cont. High Prod Group-Sta	4	40
PROTH	149	Prot. Cont. High Prod Group-Lbs:Cow	4	41-43
NELHED	150	N.E. High Prod Group-Sta	4	44
NELH	151	N.E. High Prod Group-Mcal:Lb	4	45-47
CALHED	152	Ca Cont. High Prod Group-Sta	4	48
CALH	153	Ca Cont. High Prod Group-Lbs	4	49-51
PHOSHED	154	P Cont. High Prod Group-Sta	4	52
PHOSH	155	P Cont. High Prod Group	4	53-55
FIBHED	156	C.F. Cont. High Prod Group-Sta	4	56
FIBH	157	C.F. Cont. High Prod Group-Lbs	4	57-59
PROTAED	158	Prot. Avg Prod Group-Sta	4	60
PROTA	159	Prot. Avg Prod Group-Lbs	4	61-63
NELAED	160	N.E. Avg Prod Group-Sta	4	64

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
NELA	161	N.E. Avg Prod Group-Mcal:Lb	4	65-67
CALAED	162	Ca Cont. Avg Prod Group-Sta	4	68
CALA	163	Ca Cont. Avg Prod Group-Lbs	4	69-71
PHOSAED	164	P Cont. Avg Prod Group-Sta	4	72
PHOSA	165	P Cont. Avg Prod Group-Lbs	4	73-75
FIBAED	166	C.F. Cont. Avg Prod Group-Sta	4	76
FIBA	167	C.F. Cont Avg Prod Group-Lbs	4	77-79
PROTLED	168	Prot. Cont Low Prod Group-Sta	5	4
PROTL	169	Prot. Low Prod. Group-Lbs	5	5-7
NELLED	170	N.E. Low Prod Cows-Sta	5	8
NELL	171	N.E. Low Prod Group-Mcal:Lb	5	9-11
CALLED	172	Ca Cont. Low Prod Group-Sta	5	12
CALL	173	Ca Cont. Low Prod Group-Lbs	5	13-15
PHOSLED	174	P Cont. Low Prod Group-Sta	5	16
PHOSL	175	P Cont. Low Prod Group-Lbs	5	17-19

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
FIBLED	176	C.F. Cont. Low Prod Grou-Sta	5	20
FIBL	177	C.F. Cont. Low Prod Group-Lbs	5	21-23
RAPH	178	Prot. Cont. Ration High Prod Cows %	5	24-27
RAEH	179	N.E. Ration High Prod Cows-Mcal:Cwt	5	28-29
RAFH	180	C.F. Ration High Prod Cows %	5	30-31
RACH	181	Ca Cont. Ration High Prod Cows %	5	32-34
RAWH	182	P Cont. Ration High Prod Cows %	5	35-37
RAPA	183	Prot. Ration Avg Prod Cows %	5	38-41
RAEA	184	N.E. Ration Avg Prod Cows-Mcal:Cwt	5	42-43
RAFA	185	C.F. Ration Avg Prod Cows %	5	44-45
RACA	186	Ca Cont. Ration Avg Prod Cows %	5	46-48
RAWA	187	P Cont. Ration Avg Prod Cows %	5	49-51
RAPL	188	Prot. Ration Low Prod Cows %	5	52-55
RAEL	189	N.E. Ration Low Prod Cows-Mcal:Cwt		57-57
RAFL	190	C.F. Ration Low Prod Cows %		58-59

TABLE 36 (con't.)

Variable Name	Variable Number	Variable Description	Card No.	Col.
RACL	191	Ca Cont. Ration Low Prod Cows %	5	60-62
RAWL	192	P Cont. Ration Low Prod Cows %	5	63-65
FAT	193	Milk Fat %	5	66-68
HSIZE	194	(MCOW + DCOW)		
MILK	195	(MCOW/HSIZE) x 100		
DRY	196	(DCOW/HSIZE) x 100		
MET	197	(METR/HSIZE) x 100		
REP	198	(REPL/HSIZE) x 100		
AGR	199	(GHP + GLP)/2		
ACSR	200	(CSHP + CSLP)/2		
AHR	201	(AHHP = AHLP)/2		
AHYR	202	(HHP + HLP)/2		
AVPROT	203	(RAPH + RAPL)/2		
AVNE	204	(RAEH + RAEL)/2		
AVCA	205	(RACH + RACL)/2		
AVFO	206	(RAWH = RAWL)/2		
AVFI	207	(RAFH + RAFL)/2		

TABLE 36. Card Format

VARIABLE NAME	VARIABLE NUMBER	VARIABLE DESCRIPTION
RMGT	208	(.5553* (WDHO-3.11)-/1.57) + (.5882*(SDHO-3.25) /1.65) + (.384*(DTHO-30.75)/17.13) - (.573*(EHAI - 1.92)/ .38) + (.3489*(PREGT-58.07)/18.22) + (.5889*(REP-.001)/ .002).
NUT1	209	(.5692*(PPC-15.09)/1.94) + (.7173*(CAC-.415).54) + (.6904*(PHC-.383)/.205) + (.374*(CFC-5.17)/2.09) - (.4238*(CSPP-9.57)/2) - (.7045*(CSCA-.279)/.007) - (.8268*(CSPH-2.52/.002) + (.4928*(AHNE-50.33)/3.85) + (.7854*(AHCA-1.21)/.184) - (.5958*(AHPH-.224)/.039) + (.7754*(AHCF-32.24)/2.8) + (.6035*(BALPR-1.01/.89) + (.6746*(BALFI-2.5)/2.16) + (.7742*(BALCA-.065)/1.55) + (.8303*(BALFO-.022)/.04) - (.5701*(AVNE-66.72).8.3) + (.7197*(AVCA-.825/.37) + (.7535*(AVFO-.279)/.08 + (.7751*(AVFI-20.68)/5.27)
NMGT	210	(.5916*(AGR-17.88)/.486) - (.6213*(ACSR-16.7)/15.71) - (.5554*(AHR-15.11)/10.43) + (.7093*(AHRY-12)/11.82)

TABLE 37. Means and Standard Errors of Reproductive Variables

VARIABLE	Overall		Overall		Overall	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
% of Herd artifically bred	90.29	3.81	95.62	3.71	88.05	5.15
Years Using A.I.	17.14	1.97	15.00	2.68	18.05	2.57
Winter-Daily Heat Observations	3.11	0.304	3.00	0.263	3.15	0.407
Summer-Daily Heat Observations	3.25	0.318	3.00	0.378	3.36	0.427
Daily Time For Heat Observations (mins)	30.74	3.29	34.37	4.76	29.21	4.26
Average Calving Interval	13.8	0.21	14.22	0.598	13.63	0.162
Clean-Up Bull Calvings	15.15	5.05	3.57	1.02	21.91	7.38
Average Days From Calving to First Heat	32.26	2.88	---	---	32.26	2.88
Days From Breeding To Pregnancy Check	58.07	3.57	59.37	5.85	57.50	4.56
First Service After Parturition	54.44	1.96	56.25	2.45	53.68	2.61

TABLE 37 (con't.)

VARIABLE	Overall		Overall		Overall	
	Mean	S.E.	Mean	S.E.	Mean	S.E.
Abortions (# of Cows)	2.44	0.63	3.87	1.71	1.84	0.52
Milk Fever (# of Cows)	2.66	0.698	2.87	1.26	2.57	0.859
Ketosis (# of Cows)	1.59	0.518	1.00	0.756	1.84	0.668
Cows Sold	20.07	4.15	30.50	13.09	15.68	1.91
Cows Dead	3.07	0.722	4.50	2.15	2.47	0.492
Retained Placenta (# of Cows)	8.00	1.98	13.00	6.03	5.89	1.12
Metritis (# of Cows)	10.51	2.84	16.25	6.68	8.10	2.86
Average Body Weight	1308.700	16.830	1262.500	34.060	1328.150	17.900
Number of Cows	151.330	42.450	305.120	130.410	86.570	11.320
Milking Cows	126.770	35.630	260.620	108.550	70.420	9.030
Dry Cows	24.550	7.040	44.500	22.420	16.150	2.510
Dry Period Length	59.77	2.910	72.62	3.540	54.36	3.15

TABLE 38. Means and Standard Errors of Nutrition Variable

VARIABLE	OVERALL		MEXICO		MICHIGAN	
	MEAN	S.E.	MEAN	S.E.	MEAN	S.E.
Hay Dry Cows (lbs)	16.00	1.800	17.87	2.120	14.63	2.710
Haylage Dry Cows (lbs)	20.40	3.890	---	---	20.40	3.890
Protein % Concentrate	15.09	0.374	14.85	0.411	15.19	0.507
Net E Concentrate (Mcal/1b)	83.250	1.240	76.40	0	86.13	1.270
Calcium % Concentrate	0.415	0.104	0.638	0.222	0.321	0.111
Phosphorus % Concentrate	0.383	0.039	0.364	0.032	0.391	0.055
Crude Fiber % Concentrate	5.170	0.403	5.16	0.125	5.17	0.574
Protein % Corn Silage	9.570	0.486	--	--	9.57	0.486
Net E Corn Silage (MCal/1b)	70.000	0.743	--	--	70.00	0.743
Calcium % Corn Silage (MCal/1b)	0.279	0.002	--	--	0.279	0.002
Phosphorus % Corn Silage	0.252	0.005	--	--	0.252	0.005
Crude Fiber % Corn Silage	24.820	0.570	--	--	24.820	0.570

TABLE 38 (con't.)

	OVERALL		OVERALL		OVERALL	
	MEAN	S.E.	MEAN	S.E.	MEAN	S.E.
Protein % Hay	15.590	0.507	16.61	0.564	15.160	0.664
Net E Hay	50.330	0.741	46.62	0.678	51.89	0.772
Calcium % Hay	1.210	0.035	1.38	0.086	1.14	0.020
Pounds of Concentrate fed to Dry Cows	7.27	2.00	5.50	2.5	7.66	2.42
Corn Silage Dry Cows (LB)	19.40	5.60	--	--	19.40	5.60
Phosphorus % Hay	0.224	0.008	0.170	0.009	0.246	0.003
Crude Fiber % Hay	32.240	0.540	32.430	1.890	32.158	0.115
Protein % Haylage	16.330	0.947	--	--	16.330	0.947
Net E Haylage (Mcal/lb)	55.870	0.831	--	--	55.870	0.831
Calcium % Haylage	1.390	0.072	--	--	1.390	0.072
Phosphorus % Haylage	0.261	0.005	--	--	0.261	0.005
Crude Fiber % Haylage	29.120	0.657	--	--	29.120	0.657
Concentrate High Producing Cows	23.590	1.080	19.750	1.010	25.210	1.330

TABLE 38 (con't.)

VARIABLE	OVERALL MEAN	S.E.	OVERALL MEAN	S.E.	OVERALL MEAN	S.E.
Corn Silage High Producing Cows	28.000	2.930	--	--	28.00	2.930
Hay High Producing Cows	16.140	2.180	32.370	0.981	9.310	0.952
Haylage High Producing Cows	21.060	1.980	--	--	21.060	1.980
Concentrate Average Producing Cows	17.08	0.848	15.75	0.84	19.75	1.03
Corn Silage Average Producing Cows	25.75	7.050	--	--	25.75	7.05
Hay Average Producing Cows	23.33	3.030	28.87	2.66	12.25	2.59
Haylage Average Producing Cows	15.25	3.030	--	--	15.25	3.03
Concentrate Low Producing Cows	12.18	1.000	8.37	0.625	13.78	1.23
Corn Silage Low Producing Cows	25.05	2.670	--	--	25.05	2.67

TABLE 38 (con't.)

VARIABLE	OVERALL MEAN	S.E.	OVERALL MEAN	S.E.	OVERALL MEAN	S.E.
Hay Low Producing Cows	14.07	1.890	26.62	2.260	8.78	1.13
Haylage Low Producing Cows	19.43	2.110	--	--	19.43	2.11
Protein % Ration High Producing Cows	14.88	0.384	16.48	0.743	14.21	0.357
Net E Ration High Producing Cows (MCal/1b)	68.25	1.78	58.25	3.92	72.47	0.821
Crude Fiber % Ration High Producing Cows	19.290	0.923	23.87	2.03	17.36	0.608
Calcium % Ration High Producing Cows	0.799	0.077	1.18	0.13	0.635	0.065
Phosphorus % Ration High Producing Cows	0.290	0.018	0.249	0.019	0.307	0.024
Protein % Ration Average Producing Cows	15.950	0.648	16.960	0.631	13.920	0.844
Net E Ration Average Prod. Cows (Mcal/1b)	62.580	2.120	59.250	2.330	69.250	1.370

TABLE 38 (con't.)

VARIABLE	OVERALL MEAN	OVERALL S.E.	OVERALL MEAN	OVERALL S.E.	OVERALL MEAN	OVERALL S.E.
Crude Fiber % Ration Avg. Prod. Cows	23.500	1.730	25.000	2.430	20.500	1.041
Calcium % Ration Avg. Prod. Cows	1.087	0.115	1.200	0.119	0.855	0.229
Phosphorus % Ration Avg. Prod. Cows	0.292	0.035	0.245	0.016	0.385	0.090
Protein % Ration Low Prod. Cows	14.960	0.503	16.830	1.240	14.170	0.384
Net E Ration Low Prod. Cows (MCal/lb)	65.180	1.720	55.500	3.750	69.260	0.830
Crude Fiber % Ration Low Prod. Cows	22.070	1.150	27.000	3.000	20.000	0.662
Calcium % Ration Low Producing Cows	0.851	0.068	1.220	0.107	0.696	0.056
Phosphorus % Ration Low Prod. Cows	0.269	0.013	0.221	0.015	0.228	0.016
Milk Fat %	3.670	0.050	3.500	--	3.740	0.065

TABLE 39. Criteria Used For Selection of Sires[a]

VARIABLE	OVERALL				MEXICO				MICHIGAN			
	1	2	3	4	1	2	3	4	1	2	3	4
Dam's Milk and Fat Prod.	2	2	2	1	0	0	0	0	2	2	2	1
Pedigree	1	0	1	1	0	0	0	0	1	0	1	1
USDA Predicted Difference	12	9	3	0	2	5	1	0	10	4	2	0
Color Markings	0	0	0	0	0	0	0	0	0	0	0	0
Conception Rate	2	6	3	5	2	1	0	3	0	5	3	2
Price	3	2	4	4	2	0	0	0	1	2	4	4
Repeatability Factor	3	6	7	7	0	2	4	2	3	4	3	5
Type Traits	3	1	5	5	2	0	2	2	1	1	3	3
A.I. Summary Lists	0	1	0	0	0	0	0	0	0	1	0	0
Recognition Programs	0	0	0	0	0	0	0	0	0	0	0	0
Other (Mastitis Resistance)	1	0	1	0	0	0	1	0	1	0	0	0

[a]Number of Respondents Ranking the Criteria for Sire Selection.

[b]Highest Ranking=1

TABLE 40. Most Common Disorders Cited in High Producing Cows[a]

VARIABLE	OVERALL		MEXICO		MICHIGAN	
	Yes	No	Yes	No	Yes	No
Going Off Feed	8	19	3	5	5	14
Reproduction	17	10	7	1	10	9
Mastitis & Udder	14	13	5	3	9	10
Ketosis	1	26	0	8	1	18
Milk Fever	3	24	1	7	2	17

[a]Data are expressed as a percent of the total number of response for a region: Mexico = 8, Michigan = 19 and Combined = 27.

TABLE 41. Rank for Culling Cows[a]

VARIABLE	OVERALL				MEXICO				MICHIGAN			
	1	2	3	4[b]	1	2	3	4[b]	1	2	3	4[b]
Milk Production	10	4	8	3	3	1	3	0	7	3	5	3
Feet & Legs	0	2	5	6	0	0	0	2	0	2	5	4
Mastitis & Udder	5	10	8	3	0	4	2	1	5	6	6	2
Reproduction	12	8	4	2	5	1	2	0	7	7	2	2
Type	0	1	0	2	0	0	0	1	0	1	0	1
Disposition	0	0	1	7	0	0	0	2	0	0	1	5

[a]Data are expressed as a percent of the total number of responses for a region: Mexico = 8, Michigan = 19 and Combined = 27.

[b]Highest Ranking = 1

TABLE 42. Comparison of A.I. and Bull In Terms of Conception Rate

VARIABLE	OVERALL	MEXICO	MICHIGAN
Much More Convenient	7[a] (25.9)[b]	4 (50.0)	3 (15.8)
More Convenient	8 (29.6)	4 (50.0)	4 (21.1)
Same	6 (22.2)	0	6 (31.6)
Less Convenient	5 (18.5)	0	5 (26.3)
Much Less Convenient	1 (3.7)	0	1 (5.3)

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents

TABLE 43. Percentage of Respondents That Use Grain Feeding Guide

VARIABLE	OVERALL	MEXICO	MICHIGAN
Milk Production	18[a] (66.6)[b]	6 (75.0)	12 (63.3)
Fat Production	1 (3.7)	0	1 (5.3)
Cows Condition	1 (3.7)	1 (12.5)	0
Same For All Cows	7 (25.9)	1 (12.5)	6 (31.3)

[a]Number of Respondents

[b]Number of Parenthesis are Percentage of Respondents

TABLE 44. Uterine Medication After Parturition

VARIABLE	OVERALL	MEXICO	MICHIGAN
Yes	6[a] (22.2)[b]	2 (25.0)	4 (21.1)
No	21 (77.8)	6 (75.0)	15 (78.9)
% of Cows			
0	22 (81.5)	6 (75.0)	16 (84.2)
25 - 79	1 (3.7)	0	1 (5.3)
80 - 89	1 (3.7)	0	1 (5.3)
90 - 99	3 (11.1)	2 (25.0)	1 (5.3)

[a]Number of Respondents

[b]Number in Parenthesis are Percentage of Respondents

TABLE 45. Criteria For Cutting Alfalfa Hay

VARIABLE	OVERALL	MEXICO	MICHIGAN
Pre-Bloom	6[a] (22.2)[b]	1 (12.5)	5 (26.3)
1/10 Bloom	14 (51.9)	7 (87.5)	7 (36.8)
Half Bloom	7 (25.9)	0	7 (36.8)
Mature	0	0	0

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents

TABLE 46. Availability of Trace Mineral Salt

VARIABLE	OVERALL	MEXICO	MICHIGAN
Free Choice	10[a] (37.0)[b]	4 (50.0)	6 (31.6)
Mixed in Ration	6 (22.3)	0	6 (31.6)
Both Methods	11 (40.7)	4 (50.0)	7 (36.8)

[a]Number of Respondents

[b]Numbers in Parentheses are Percentage of Respondents

TABLE 47. Management of Cows in Estrus

VARIABLE	OVERALL	MEXICO	MICHIGAN
Separated	6[a] (22.2)[b]	3 (37.5)	3 (15.8)
Leave the Cow with the Herd	21 (77.8)	5 (62.5)	16 (84.2)

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents

TABLE 48. Schedule for Observing Cows for Estrus

VARIABLE	OVERALL	MEXICO	MICHIGAN
Before Feeding	7[a] (25.9)[b]	3 (37.5)	4 (21.1)
During Feeding	6 (22.2)	1 (12.5)	5 (26.3)
After Feeding	6 (22.2)	1 (12.5)	5 (26.3)
Other (Milking, Barn Cleaning)	8 (29.6)	3 (37.5)	5 (26.3)

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents

TABLE 49. Season to Which Better Conception Rate is Obtained (% of Respondents)

VARIABLE	OVERALL	MEXICO	MICHIGAN
Summer	8[a] (29.6)[b]	1 (12.5)	7 (36.8)
Winter	14 (51.9)	5 (62.5)	9 (47.4)
Same All Year	5 (18.5)	2 (25.0)	3 (15.8)

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents

TABLE 50. Use of Clean-Up Bull on the Farm

VARIABLE	OVERALL	MEXICO	MICHIGAN
Number of Services with A.I. Before Using Bull:			
Never	6[a] (22.2)[b]	1 (12.5)	5 (26.3)
1	2 (7.4)	0	2 (10.5)
2	3 (11.1)	0	3 (15.8)
3	7 (25.9)	2 (25.0)	5 (26.3)
4	6 (22.2)	4 (50.0)	2 (10.5)
>4	3 (11.1)	1 (12.5)	2 (10.5)
% of Calvings From Bull	15.15	3.57	21.91

[a]Number of Respondents

[b]Numbers of Parenthesis are Percentage of Respondents.

TABLE 51. Artificial Insemination Variables

VARIABLE	OVERALL	MEXICO	MICHIGAN
% of Herd Artificially Inseminated:			
5 to 70	3[a] (11.1)[b]	0 (0)	3 (15.7)
71 to 80	3 (11.1)	1 (12.5)	2 (10.6)
81 to 100	21 (77.8)	7 (87.5)	14 (73.6)
Years Using A.I.			
3 to 10	9 (33.3)	2 (25.0)	7 (37.0)
11 to 20	8 (29.6)	5 (62.5)	3 (21.0)
21 to 35	10 (37.0)	1 (12.5)	9 (42.0)
Heat Detected A.M. A.I. Carried Out:			
Immediately	2 (7.4)	0	2 (10.5)
Same Day, P.M.	23 (85.2)	8 (100.0)	15 (75.9)
Next Day	2 (7.4)	0	2 (10.5)
Heat Detected P.M. A.I. Carried Out:			
Immediately	3 (11.1)	0	3 (15.8)
Next Day, A.M.	23 (85.2)	8 (100.0)	15 (78.9)
Next Day, P.M.	1 (3.7)	0	1 (5.3)

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents

TABLE 51 (con't.)

VARIABLE	OVERALL	MEXICO	MICHIGAN
Cows Detected in Estrus:			
Early A.M.	16 (59.3)	5 (62.5)	11 (57.9)
Late A.M.	2 (7.4)	0	2 (10.5)
Noon	3 (11.1)	1 (12.5)	2 (10.5)
Evening	6[a] (22.2)[b]	2 (25.0)	4 (21.1)
Breeding Time During Summer			
Early A.M.	10 (37.0)	7 (87.5)	3 (15.8)
Late A.M.	6 (22.0)	0	6 (37.6)
Noon	0	0	0
Evening	11 (40.9)	1 (12.5)	10 (52.6)

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents

TABLE 52. Heat Detection Variables

VARIABLE	OVERALL	MEXICO	MICHIGAN
Very Difficult	2[a] (7.4)[b]	0 (0)	2 (10.5)
Difficult	10 (37.0)	4 (50.0)	6 (31.6)
Easy	13 (48.0)	3 (37.5)	10 (52.6)
Very Easy	2 (7.4)	1 (12.5)	1 (5.3)
Winter Heat Obs. Frequency per Day			
1	1 (3.7)	0 (0)	1 (5.3)
2	10 (37.0)	3 (37.5)	7 (36.8)
3	9 (33.3)	3 (37.5)	6 (31.6)
≥ 3	7 (25.9)	2 (25.0)	5 (26.3)
Observer:			
Operator or Owner	21 (77.8)	2 (25.0)	19 (100.0)
Wife	4 (14.8)	0 (0)	4 (21.1)
Children	4 (14.8)	0 (0)	4 (21.1)
Hired Labor	17 (63.0)	8 (100.0)	9 (47.4)

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents.

TABLE 52 (con't.)

VARIABLE	OVERALL	MEXICO	MICHIGAN
Summer Heat Obs. Frequency per Day:			
1	0 (0)	0 (0)	0 (0)
2	12 (44.4)	3 (37.5)	9 (47.4)
3	6 (22.2)	3 (37.5)	3 (15.8)
3	9 (33.3)	2 (25.0)	7 (36.9)
Operator or Owner	21 (77.8)	2 (25.0)	19 (100.0)
Wife	6 (22.2)	0 (0)	6 (31.6)
Children	5 (18.5)	0 (0)	5 (26.3)
Hired Labor	18[a] (66.7)[b]	8 (100.0)	10 (52.6)
Time for Heat Detection (Mins.):			
5 to 20	10 (37.0)	2 (25.0)	8 (42.1)
21 to 40	11 (40.7)	4 (50.0)	7 (36.9)
>41	6 (22.3)	2 (25.0)	8 (24.0)

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents

TABLE 53. Reproductive Management of Cows After Calving

VARIABLE	OVERALL	MEXICO	MICHIGAN
Post Partum Check Before Breeding:			
No	8[a] (29.6)[b]	1 (12.5)	7 (36.8)
Yes	19 (70.4)	7 (87.5)	12 (63.2)
Pregnancy Check After Breeding:			
No	2 (7.4)	0	2 (10.5)
Yes	25 (92.6)	8 (100)	17 (89.5)
Post Partum Check Carried Out By:			
Veterinarian	23 (92.0)	6 (75.0)	17 (100)
Other (Technician, Operator)	2 (8.0)	2 (25.0)	0
Pregnancy Check (days):			
30 to 50	13 (52.0)	5 (62.5)	8 (47.0)
51 to 70	10 (40.0)	1 (12.5)	9 (52.9)
> 71	2 (8.0)	2 (25.0)	0

[a]Number of Respondents

[b]Numbers in Parenthesis are Percentage of Respondents

TABLE 53 (con't.)

VARIABLE	OVERALL	MEXICO	MICHIGAN
Interval from Calving to Breeding (days):			
40 - 50	9 (33.3)	2 (25.0)	7 (36.8)
51 - 60	17 (62.9)	6 (75.0)	11 (57.9)
> 61	1 (3.7)	0	1 (5.3)

TABLE 54. Use of Heat Detection Aids

VARIABLE	OVERALL	MEXICO	MICHIGAN
Yes	10[a] (37.0)[b]	0	10 (52.6)
No	17 (63.0)	8 (100.0)	9 (17.4)

[a]Number of Respondents

[b]Numbers of Parenthesis are Percentage of Respondents

BREEDING

1. What percent of your herd is bred artificially? ________%

2. How long have you been using A.I.? _________years

3. Do you inseminate any of your own cows? (If yes, all, skip to question 5).

    _____ yes, all
    _____ yes, some
    _____ no

4. How well do you feel your inseminator is trained for this job:

    _____ adequately
    _____ partially
    _____ inadequately

5. Heat detection is difficult for some people. In your case, it is:

    _____ very difficult
    _____ difficult
    _____ easy
    _____ very easy

6. How many times a day are your cows observed for heat in the winter? _____

    By whom? Operator _____ Wife _____
    Children _____ Hired Labor _____

7. How many times a day are your cows observed for heat in the summer? _____

    By whom? Operator _____ Wife _____
    Children _____ Hired Labor _____

8. How long a time each day are the cows observed for heat? ___________

9. If standing to be mounted is used as a symptom of heat, and your cow shows symptoms in the morning, A.I. is carried out:

    _____ Immediately
    _____ The same day, in the evening
    _____ The next day

10. If your cow stands to be mounted in the evening, she will be bred:

    _____ Immediately
    _____ Next day in the morning
    _____ Next day in the evening

11. What percent of your cows settle with one breeding? ________%

12. In terms of conception rate - that is getting a cow to settle - would you say AI, compared to a bull is?

_____ Much more convenient
_____ More convenient
_____ Same
_____ Less convenient
_____ Much less convenient

13. How do you rank (in order or importance) the following in making your decision about what bull to use?

_____ Dam's milk and fat production
_____ Ancestry (Pedigree)
_____ USDA Predicted Difference
_____ Pleasing color markings
_____ Conception Rate
_____ Price of Sire
_____ Repeatability factor
_____ Type traits of sire's daughters
_____ MSU-Ext. AI Summary List Breed Association Sire
_____ Recognition Programs
_____ Other (specify)

14. What is your average calving interval? ___________

15. Do you obtain better conception rate during: _______ Summer or _______ Winter

16. During summertime, most of your cows are bred during:

_____ Early Morning
_____ Late Morning
_____ Noon
_____ Evening

17. Do you have more cows in heat during:

_____ Early morning
_____ Late morning
_____ Noon
_____ Evening

18. What type of heat detection aids do you use?

_____ Chalk
_____ Paint
_____ K-Mar Heat Detector
_____ Gomer Bull
_____ Others (Specify)

19. How many services do you wait before to use the clean-up bull in a cow:

1 _____, 2 _____, 3 _____, 4 _____, More then 4 _____

20. % of calvings due to clean-up bulls: %

21. Are your cows infused with antibiotics after breeding:

_____ Always
_____ Often
_____ Sometimes
_____ Seldom
_____ Never
_____ According to your Vet instructions

22. When you observe a cow in heat, do you:

_____ Separate her
_____ Leave her with the herd
_____ Other Procedure (Specify)

23. Do you catch up cows in heat:

_____ Before Feeding Time
_____ During Feeding Time
_____ After Feeding Time
_____ Other Time (Specify)

24. Where do cows calve?

What is the sanitation of calving area?

25. What is the average number of days from calving to first breeding?

26. What is the average number of days from calving to first heat?

REPRODUCTION AND HERD HEALTH

1. Are cows examined after calving to determine if they are ready to rebreed?

_____ yes _____ no

2. Are cows examined for pregnancy after breeding?

_____ yes _____ no

If so, when are they examined after breeding? _______ days

By Whom? Veterinarian: ___________ Other (specify) ___________

3. How long after calving are your cows bred for the first time? _______

4. How many cows aborted in the past year? ________

5. How many cows had milk fever last year? ________

6. How many cows had ketosis last year? ________

7. How effective do you feel the use of A.I. is in combating the spread of disease?

_____ Very effective
_____ Effective
_____ Not effective

8. Are your calves vaccinated for:

Brucella _____
IBR (red nose) _____
Leptospirosis _____
BVD (virus diarrhea) _____
PI_3 (shipping fever) _____
Pasteurella (shipping fever) _____

9. How many cows were culled last year? _____

10. How many cows died last year? _______

11. How would you describe your dairy operation-type of facilities?

Stanchion barn or tie stalls _____
Open lot-free stalls and parlor _____
Warm enclosed - free stalls and parlor _____
Cold covered-free stalls and parlor _____
Loose housing and parlor _____
Stanchion barn and parlor _____
Stanchion barn and free stalls _____
Stanchion barn and loose housing _____
Corrals and Milking Parlor _____
Other __________________

12. What problems do you have more frequently with your high producing cows that you do not have with your average cows:

_____ Going off feed
_____ Reproduction problems
_____ Mastitis and Udder Problems
_____ Ketosis
_____ Milk fever
_____ Other

13. Rank in order of importance the following for culling cows:

_____ Milk Production
_____ Feet and Legs
_____ Mastitis and Udder Problems
Reproduction _____
Type _____
Disposition _____
Other (specify) ___________

14. How many cows had retained placenta last year? ________

15. How many cows had Metritis last year? _______

16. When do you have more calving problems? ________ Summer ______ Winter

17. Do you routinely medicate the uterus of cows after normal calving?

_____ yes _____ no

If so, what % are medicated? __________

18. Do you worm your cows?

If so, with what product?

NUTRITION

1. What has been the composition of your grain mix since January 1?

a. Shelled corn__________ Amount ________ Prot. ________ ENE ________
b. Oats__________ Amount ________ Prot. ________ ENE ________
c. Wheat__________ Amount ________ Prot. ________ ENE ________
d. Beet pulp__________ Amount ________ Prot. ________ ENE ________
e. Protein supple.__________ Amount ________ Prot. ________ ENE ________
f. Salt__________ Amount ________
g. Minerals__________ Amount ________
h. Corn & cob__________ Amount ________ Prot. ________ ENE ________
i. H. M. Corn__________ Amount ________ Prot. ________ ENE ________
j. Barley__________ Amount ________ Prot. ________ ENE ________
k. Molasses__________ Amount ________ Prot. ________ ENE ________
l. Linseed meal__________ Amount ________ Prot. ________ ENE ________
m. Soybean meal__________ Amount ________ Prot. ________ ENE ________
n. Other__________ Amount ________ Prot. ________ ENE ________
o. __________ Amount ________ Prot. ________ ENE ________
p. __________ Amount ________ Prot. ________ ENE ________

2. Do you feed your cows in dry lot during the summer? Yes ______ No ______

3. Do you change your grain mix composition during the year? Yes ______ No ______

4. If no supplement is included in the ration, is any additional supplement fed?

_____ Yes _____ No

How much? __________

How fed? Mixed with feed by hand ______
Top dressed ______
Other (specify) ______

5. Do you know the crude protein percent of your corn silage? Yes _____ No _____

If yes, what is it? __________

6. Do you add any additive to your corn silage? Yes ______ No ______

If yes, what?

Urea ______ Commercial Additive ______ Anhydrous Ammonia ______ Other ______

How much per ton? __________

7. Do you have your hay tested? Yes ______ No ______

If yes, what percent protein? 1st Test ______ 2nd Test ______

8. What is the criteria for cutting alfalfa for hay:

Prebloom ________ Half bloom ______
1/10 bloom _______ Mature __________

9. In your winter feeding program, how many pounds of grain per day was fed to your average producing cows? ________________

10. What is your feeding guide? Pounds of grain:

According to Milk Production ____________________
According to Fat Production ____________________
According to Cows condition ____________________
Give all the cows the same ____________________
Other ______________________________________

11. How many pounds of grain does the average dry cow get? _________

12. Do you increase the pounds of grain to dry cows before calving? _____ Yes _____ No

13. How many pounds of corn silage per day do you feed your milking cows in an average year? __________

14. How many pounds of hay is fed per day to your milking cows in an average year?
____

15. How many pounds of haylage is fed per day to your milking cows in an average year?
____

16. If haylage is fed, what is the percent protein? _______________

17. Is salt and mineral available?

Free Choice _________________ Mixed in the Ration _______________

18. How many pounds of grain a day did your top cow receive last year? ___________

19. Do you think your cows would eat more grain? Yes _____ No ______

If yes, why not give them more?

20. How many times per day are your cows fed:

Roughage __________
Concentrate ________

21. What time of the year do you have more cows going off feed:

22. Is Selenium included in the feed? Yes _____ No ______

23. Average body weight of your cows? ________ lbs.

24. What is the ration given to dry cows:

Kind of Feed — Amount (lbs) per day

\# of cows in this group _______

25. Ration given to High-Producing cows:

Kind of Feed — Amount (lbs) per day

\# of cows in this group _______
average milk production _______ lbs

26. Ration given to Medium-Producing Cows:

Kind of Feed — Amount (lbs) per day

\# of cows in this group ______
average milk production _______ lbs

27. Ration given to Low-Producing Cows:

Kind of Feed — Amount (lbs) per day

\# of Cows in this group ______
Average Milk Production _______ lbs

28. How many cows are you milking today? __________

29. How many dry cows do you have today? __________

30. Number of services per conception (from you DHIA Report) ____________

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