THE EFFECT OF TIME OF YEAR FOR MATING ON PRODUCTIVITY OF A BEEF HERD IN A TROPICAL ENVIRONMENT

By

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CHAPTER I

INTRODUCTION

The Philippine Food Balance Sheet (NEDA Food Balance Series No. 5 1975) listed the country's total available protein food supply for human consumption at 56.6 grams per capita per day or approximately 20.7 kilos per capita per year. Vegetable source supplied 62.5% of the total and only 37.5% came from animal sources. Of the total food consumed originating from animal sources, 21% was imported and 79% was produced locally. Fish and other marine products were 65% of the locally produced animal foods while livestock and poultry meat contributed less than one-third of the total. Thus, Philippine livestock production has lagged behind the needs of the now forty million people.

It has been recognized that the present levels of non-ruminant production such as poultry and swine already compete with the grain needs of the people. The Bureau of Agricultural Economics (1976) reported a total of 6,428,270 head of pigs and 46,472,110 chicken as against 1,720,000 head of cattle and 2,711,000 head of carabaos, respectively.

Therefore, the most feasible and practical approach of increasing meat production in the Phillipines is to fully utilize the 3.5 million hectares of open grassland for cattle ranching. This area cannot be profitably used for other food or plantation crops because of some natural barriers to cultivation such as: topography, presence of stones and/or rocks, poor fertility and excessive erosions. Studies indicated that under proper grazing management, the Philippine native range can carry from 0.62 to 1.0 animal unit per hectare per year (Boloron 1970, Zablan 1970, and Magadan 1974). According to Madamba (1970) only about 900,000 hectares out of the 3.5 million hectares have been used for grazing purposes. The fact was that 76.5% of the total number of cattle reported in 1976 came from the backyard farmers who never utilized any specific grazing area other than the backyard space or boundary portion of their crop farms. The remaining 23.4% of the total cattle population that came from the commercial farms barely occupied one-third of the reported 3.5 million hectares grassland.

In retrospect, the beef cattle industry has been beset by a number of problems. These problems may be classified as: (1) poor financial supports, (2) low production and (3) unorganized marketing system.

The costs for supplies and materials increased by about 500 percent in the last ten-year period. Farm loans were hard to obtain without considerable property holdings for collateral. Numerous requirements and red tape discouraged potential and qualified beef cattle raisers to apply for such loans.

Production has been very low. Calf crop weaned ranged from as low as 37% to about 50% for cattle on native range. Preweaning mortality varied from 4% to as high as 20% (Zablan 1962, Ho 1968, Boloron 1970 and Lunaan 1970). This low productivity was due to a number of factors such as: (1) poor stock, (2) inbreeding, (3) absence of culling and/or selection, (4) poor pasture management and (5) absence or lack of disease and parasite prevention and control.

Market centers were not conveniently located to the ranching areas. In fact, in many cases market centers were located in a different island, thus resulting in transportation problems. Heavy shrinkage and losses of transporting live animals occurred during both land and sea transportation. Trucks and ships that were provided with cooling units to handle beef from one area to another were inadequate, if not totally absent, in some places. Cattle trade was controlled by a series of middlemen. In general, the buying and selling process was based on a per head basis rather than by weight or any classification of quality.

In view of these many problems, the government launched various programs beginning the year 1965 to help stimulate the full development of the beef cattle industry. Long-term cattle loans at lower interest rates were made available through the Development Bank of the Philippines to enable existing ranches to buy additional facilities and breeding stock. The National Cooperative Pasture Resources Development Program which started in 1971 has been designed to help accelerate pasture improvement. The number of livestock technicians of the Bureau of Animal Industry (BAI) has been increased to help disseminate information and practices relative to the prevention and control of diseases and parasites. Workshops, field days and short training courses were conducted by the Bureau of Animal Industry and various agricultural institutions while industry-oriented researches have been conducted by the various research centers as pinpointed by the Philippine Council on Agricultural Research.

The Central Mindanao University (CMU), being located in the heart of the most heavily ranched province of Bukidnon in the southern Philippines, has been involved in both research and extension activities related to the beef cattle industry. The university has provided training courses for ranch operators during the last six years. In addition, an extension program has been initiated which includes the dissemination of improved breeding stock, especially breeding bulls, not only within the local province of Bukidnon but also to neighboring provinces. Six pure American Brahman bulls were purchased in 1971 to upgrade the present high-Brahman grade stock of the CMU Beef Cattle Project.

Using the six pure American Brahman bulls with the high-Brahman grade cows, a study was conducted at CMU Beef Cattle Project on "The Effect of Time of Year for Mating on Productivity of a Beef Herd in a Tropical Environment." The main objective of this study was to compare two different three-month mating seasons with regard to cow herd productivity as measured by percent calf crop born and weaned.

This study was initiated primarily as a result of the popular opinion among Philippine cattle "experts" that high calf crop and efficient ranch management can be realized through limited time period pasture breeding as against commonly practiced year-round breeding.

Summer breeding (May, June and July) is characterized by light rainfall and by adequate amounts of herbage in the first half of the period to heavy rainfall and abundant grasses during the rest of the breeding and early gestation period (June to October). Expected calving from summer breeding will come about the months of February, March and April which is the driest period of the year. During this period both feeding quality and quantity of herbage are lowest.

Fall breeding (October, November and December) is characterized by heavy rainfall and abundant pasture grasses from four months prior to, and towards the first half of the breeding period to very light rainfall and declining herbage quality and quantity during the last half of the breeding period towards the early gestation period (from December to April). Expected calving period from fall breeding occurs in the months of July, August and September when heavy rainfall and abundant grasses prevail.

Using the six pure American Brahman bulls for this study would help determine the fertility of each of these bulls in terms of actual breeding performance. Thus, fertility-tested bulls may be used as semen source for the immediate and future A-I needs of the university and her service areas. In 1971 CMU conceived to establish an Artificial Insemination Center to serve the ranchers of the central Mindanao region in the southern Philippines.

CHAPTER II

REVIEW OF LITERATURE

Breeds and Observations on Breeding Activities of Cattle in the Philippines

The Philippine native cattle are generally small and less productive. Upgrading the native stock with the use of imported breeds has been done for the last twenty years. Lunaan (1970) reported a total of seventeen different breeds of both *Bos taurus* and *Bos indicus* cattle imported into the Philippines for breeding purposes between the period 1950 and 1967. The *Bos taurus* breeds imported were the Shorthorn, Hereford, Charolais, Angus, Australian Illawara Shorthorn, Red Poll and Devon; and the *Bos indicus* imported were the Ongole, Brahman, Hariana, Sahiwal, Tharparkar, Balinese and Madura. Crossbreds of *Bos taurus* and *Bos indicus* breeds imported included Santa Gertrudis, Charbray and Bradford. Lunaan's sampling of 23,704 head of cattle in the same study showed that Brahman-Ongole/Nellore predominated in number, followed by Nellore-Philippine Native, Nellore/Ongole, Brown Swiss-Santa Gertrudis-Angus and the Hereford-Angus-Nellore in descending order. Lunaan further indicated that of all the imported breeds, the Brahman has been used more extensively by most ranchers.

Villegas (1929) observed that of the 101 matings among cattle at Los Banos, Laguna high percentage of success occurred in the months of March through August. Villegas (1929) also reported that the highest level of fertilization in horse matings (53 matings) also took place in the month of March and April.

Rigor (1949) reported that at the Alabang Stock Farm, Alabank Rizal, the average length of gestation period for Red Sindhi cattle was 280 days and the average age at first fertile mating was 2 years-2 months-20 days. Rigor (1957) observations at Pangasinan Breeding Station under range conditions indicated that for Tharparkar, calving interval ranged from 541 to 974 days with a mean of 733 $\pm$ 157.56 days while the rest period (calving interval less 280 days) varied from 161 to 694 days and with a mean of 441 $\pm$ 50.86 days. In comparison, the Red Sindhi had a calving interval that ranged from 412 to 732 days with a mean of 685 $\pm$ 42.25 days, while the rest period varied from 132 to 452 days with a mean of 405 $\pm$ 42.25 days. The results from this study indicated that Red Sindhi had both a shorter calving interval and rest period than Sahiwal.

Various reports indicated low calving rate and high pre-weaning mortality (Zablan 1962, Ho 1968, Boloron 1970, De Guzman 1970 and Lunaan 1970). Percentage calf crop weaned for cattle on range varied from 37 to 57 percent, whereas pre-weaning mortality ranged from 0.86 to 19.0 percent. De Guzman (1970) reported higher percent of the cows calving (69.2%) for cattle raised on pasture under coconut palms, but pre-weaning mortality went as high as 17.2 percent. On the other hand, Lunaan (1970) reported higher calving percentage for grade cattle (56.99%) as against Nellore/Ongole (40.08%). Boloron (1970) in his survey of 150 cattle ranches all over the province of Bukidnon indicated that calf crop weaned for small and medium ranches (100-500 anim. units) averaged 38.45% as against 56% for the large ranches (over 500 anim. units). Similarly, pre-weaning mortality was highest among small ranches (19.1%) followed by the medium ranches (15.3%) and the lowest were the large ranches (4.1%). This result indicated that as the level of management increased with the size of the herd, production efficiency also increased. In this survey, a total of 257 cattle farms were found in the whole province of Bukidnon. Low productivity was attributed to mismanagement of both pastures and the breeding stock.

The Influence of Season and Climate on Reproductive Efficiency in Cattle

Studies in the United States on artificially inseminated dairy cows revealed that poor fertility occurred in winter and in the summer months (Mercier et al. 1947, Fryer et al. 1958 and Stott 1961) and maximum ambient temperature at the time of insemination was inversely related to fertility (Gwazdauskas et al. 1973 and Thatcher 1974). However, in contrast to the above findings, Wilson (1946) in his study of the seasonal incidence of calving and sexual activity in Zebu cattle in Nyasaland, Africa reported that the highest successful conception occurred during the period when the mean maximum temperature was over 84^{o} F, relative humidity below 50%, rainfall slight to nil and when pastures were at worst condition. The animals observed by Wilson (1946) were dependent on pastures and the state of nutrition was largely influenced by the season of the year. Similarly, Anderson (1944) observed the periodicity and duration of estrus in Zebu and grade cattle at Naivasha, Kenya and indicated that the period of increased sunshine and temperature was related to the increase in sexual activity of both Zebu and grade cattle.

Aside from the two related studies of Wilson (1946) and Anderson (1944), most reports indicated heat stress caused low fertility in cattle. Dutt (1959) pointed out that exposure to high temperature caused an increase of of body temperature in cattle followed by depressed body activity, reduced feed intake, lower metabolic activity and caused endocrine imbalance. On the other hand, Ulberge (1967) associated temperature stress during early development stages with embryonic death, while Rao et al.

(1976) reported a very high mortality rate of 22.2 to 23.7 percent for calves born at other times as against 8.2 to 9.7 percent for calves that were born within the regular season in the months of July through September. Lemka et al. (1973) in their study of the reproductive efficiency and viability in two *Bos indicus* (Hariana and Deshi) and two *Bos taurus* (Blanco Orejinegro and Bon Costeno Con Cuerno) reported a significant effect of season ($P<.05$) on calving interval. Bond et al. (1972) studied reproductive performance and physiological responses of beef female as affected by a prolonged high ambient temperature. This study indicated that females that were previously subjected to summer weather when exposed to 32° C and with a relative humidity of 60 percent experienced a shorter period of stress and returned to normal on the fifth week with normal cycles than the winter-accustomed females that experienced long stress and did not return to normal until the eleventh week and became anestrous within the period. This study suggested the necessity of animal adaptation to any given environment.

Several studies indicated the effects of season and climate on the condition and milking ability of cows. Mcdowell et al. (1976) studied the effects of climate on performance during first lactation of Holstein cows and found that those cows exposed to maximum temperature greater than 27° C for 20 days in their first 100 days of lactation averaged 27 percent higher in gross efficiency

(Kg. milk/Mcal. of est. energy) than cows exposed at the same temperature for 40 to 80 days. In this study, climatic conditions appeared to have greatest influence in the first 60 days of lactation. During such periods, high temperature restricted feed intake, causing rapid utilization of body reserves and high losses in body weight. On the other hand, Matsoukas et al. (1975) using Holstein and Jersey cows did not find any evidence of seasonal effect on the number of services per conception nor on the average calving interval. Fallon (1962) suggested proper timing of insemination during summer months. In his study using Jersey and Australian Illawara Shorthorn dairy cows, Fallon (1962) reported higher fertility ($P<.05$) on cows inseminated at late estrus periods on cows with elevated temperature than those with low values.

The reported effects of season on fertility of bulls were not explicit. Mercier and Salisbury (1946) reported that the fertility of five Holstein and five Guernsey bulls varied from month to month. Nakabagashi and Salisbury (1959) in their study on factors influencing metabolic activity of bovine spermatozoa indicated that the summer-collected cells live through the four-hour incubation at 37° C, consumed more oxygen and accumulated less lactic acid whether incubated or semen washed cells resuspended in fructose or in their own diluted seminal plasma than those collected in winter.

The Effects of Levels of Nutrition on Reproduction

The study on three different levels of protein with and without alfalfa fed to Brahman cows for 84 days before breeding and another 84 days after breeding season by Witt et al. (1958) revealed that during the whole 168-day feeding period, those cows given 100 percent of the NRC protein requirement plus three pounds of alfalfa meal daily (Group I) incurred low average weight loss (15 lbs./ head) versus 38 pounds and 172 pounds per cow, respectively for Group II fed with 100 percent and Group III fed with 50 percent of the NRC protein requirement. In the same study, the interval from calving to first breeding was also shorter for those three-year old cows in Group I (56 days) as against 91 and 160 days, respectively, for the heifers of similar age in Group II and Group III. Similar differences were not noticed among the 8-year old cows from different groups. In general, this study indicated that hay intake by the cows decreased with decreasing levels of protein in the ration.

Wiltbank (1962) using mature Hereford cows (6 years and older) studied the effect of high energy level (9 lbs. TDN/day/head) and low energy level (4.5 lbs. TDN/day/head) given prior to and after calving. The experimental design was that following calving, one-half of the cows on the high ration and also one-half of the cows on the low ration received 16 lbs. of TDN/day/head (high-high and low-high), while the remainder received eight lbs. of TDN/day/head (high-low and low-low). Conception rates were: 95% for high-high, 77% for low-high, 95% for high-low and 20% for low-low. This study showed that a large proportion of cows failed to show estrus on low energy levels. Low energy levels also markedly influenced reproduction in the mature beef cows suckling a calf.

Reid (1960) looked into the effect of energy level on the age of puberty, size of the calves and fertility in cattle. This study based the TDN requirements obtained from the Morrison Feeding Standard (Morrison 1951) and divided feeding into two phases as follows: feeding from birth to first calving; low, medium and high at 65%, 100% and 140% of the TDN requirements, respectively, and the feeding from the first to the second calvings was 118%, 109% and 100% of the TDN requirements for the low, medium and high, respectively, of the original group. This study indicated that low energy levels at early life retarded puberty and produced smaller calves. However, this study failed to detect differences in fertility among heifers fed with different levels of energy.

Wiltbank et al. (1957) studied the effect of various combinations of energy and protein on the reproductive performance of beef heifers. In this study, energy levels were full feeding (H), 2/3 of full feeding (M) and just weight maintenance (L) while protein levels as digestible protein per CWT were .23 lb. (H), .15 lb. (M) and .06 lb. (L). Fifty-four heifers were divided into nine groups and were distributed to the nine different combinations of energy and protein levels. This study pointed out that high energy with low protein intake depressed growth of heifers, delayed estrus and lowered the number of heifers that came to estrus, whereas low on both nutrients profoundly reduced growth rate, lengthened time to estrus and with very few heifers exhibited estrus. An almost similar report (Bond et al. 1958) varying the amount of energy and protein levels in the ration of beef heifers revealed that great loss of weight occurred when energy was low and much loss in weights when both energy and protein were low.

Variation in female fertility may be due to change in ovulation rate, fertilization rate and embryonic or foetal survival rate. Boyd (1965) suggested that in sheep, flushing increased ovulation rate. Boyd further stressed that grain feeding of animals increased pituitary weight indicating increased total FSH potency and increased protein synthesis rate.

Joubert (1954) using Shorthorn, Africander, Friesian and Jersey heifers investigated the effect of high and low plane of nutrition on reproductive efficiency. By high plane, the heifers received supplemental feed before and after calving and during winter, whereas on low plane, the heifers simply depended on natural grazing throughout the year without any form of supplement prior to calving. However, in this study, both groups as described above received the same ration in accordance with individual milk yield after calving. The results in this study conformed with most results from studies discussed earlier in this unit in that early puberty age was attained on heifers at a high plane of nutrition. Low plane nutrition heifers took about one year after calving before estrus cycles resumed. This suggested that malnutrition during pregnancy depleted body reserves during lactation time which in turn delayed succeeding estrus after calving. This study indicated further that there was no significant difference in the number of services per conception among heifers from both treatments nor cycle length except for the Friesian which exhibited longer cycles than the rest of the breeds studied (Shorthorn, Africander and Jersey).

Effect of Age of Cow on Reproduction

The influence of age on cow fertility was divided. Lasley and Bogart (1943) and Burke (1954) indicated that the age of cow at breeding influenced fertility. These workers also agreed that the peak of fertility was between the age of five to seven years and that fertility declined after reaching the age of nine. Burke (1954) also indicated that older cows conceived later in the breeding season.

Contrary to the above findings, Baker and Quesenbury (1944) and Schilling et al. (1968) did not detect any significant effect of age of dam on fertility. Baker and Quesenbury's findings were based on a 4,753 cow year records over an 18-year period from the U.S. Range Livestock Experimental Station at Miles City, Montana, whereas that of Schilling et al. (1968) were based on a ten-year study involving 2,035 matings at the Louisiana Agricultural Experiment Station at Baton Rouge, Louisiana.

However, Mercier and Salisbury (1947) indicated that both younger and older cows were more influenced by season than those of the intermediate ages. This finding was in agreement with Lasley and Bogart (1943) and Burke (1954) in that five- and seven-year-old cows or cows at an intermediate age exhibited maximum fertility. This may be due to fertility apparently being affected very much by the changing season.

On the other hand, Warnick (1955) studied the factors associated with the interval from parturation to first estrus in Angus and Hereford cattle. This study indicated that the age of cow at calving did not significantly influence the postpartum interval. Wiltbank et al. (1961) in a similar study using Angus, Hereford and Shorthorns at the Beef Cattle Research Station, Front Royal, Virginia and another group of Brahman, Brahman-Angus and Africander-Angus at Iberia Livestock Experiment Station in Jeanerette, Louisiana, indicated otherwise, in that age of cows that were suckling calves did in fact influence interval from calving to first estrus being longer in the younger than in the older cows. Wiltbank et al. (1961) also found that the proportion of cows diagnosed pregnant was higher in older cows than in the younger ones for all breeds studied except Shorthorn.

Breed Effect on Reproduction

Marshall et al. (1976) investigated some of the factors affecting efficiency of calf production to weaning in Angus, Charolais and reciprocal cross cows and found, among other things, that Angus and crossbred cows were more fertile ($P<.05$) and weaned more calves ($P<.05$) than the Charolais cows. In a parallel study, Schilling et al. (1968) looked into some of the factors affecting reproduction in beef cows using Angus, Brahman, Brangus and Hereford and found that breed of dam significantly affected calving rate. In this study straightbred cows had lower calving rate than any of the crossbreds except the Shorthorn-Angus cows. Another study comparing straightbred to the crossbred was that of Mcdowell (1976) using pure Jersey and Red Sindhi and crossbreds 3/4, 1/2 or 1/4 European dairy inheritance (Brown Swiss, Holstein or Jersey). This study indicated that both the 1/2 and 3/4 crosses rebred earlier and with a shorter calving interval than the respective parental straightbred.

Stott (1961) reported that the Holstein and Guernsey showed steep decline in fertility in summer months but not in the Jersey.

Some studies did not detect breed differences in some performance traits. Warnick (1955) in observing the interval from parturation to first estrus indicated no difference between lines within Hereford cows nor between Hereford and Angus cows. Similarly, Joubert (1954) observed no difference in postpartum interval among Shorthorn, Africander and Jersey but found Friesian cows to be approximately 1.5 days longer. Bhatnagar and Sharma (1976) did not detect significant differences in breeding efficiency between F1 and F2 Sahiwal-Brown Swiss crosses and 75% Brown Swiss except on age at first calving and on 305-day milk yield. In addition, this study indicated that straightbred Sahiwal heifers were significantly older than the crossbred heifers at first calving (38.0 $\pm$ 0.4 mo.) as compared to the Brown Swiss crossbreds; 29.0 $\pm$ 0.8 mo. for the F1, 33.8 $\pm$ 0.7 for the F2 and 29.9 $\pm$ 0.8 mo. for the 75% Brown Swiss crossbreds.

Sire Effect on Reproduction

Early workers recognized the fact that fertility among bulls differed (Baker and Quesenbury 1944 and Mercier and Salisbury 1946). In the later study by Dearborn et al. (1973) involving reproductive performance of all heifers and cows mated by seventy bulls revealed that sire effects were largely significant ($P<.01$) for traits related to the direct effects of bulls on conception.

Everett and Magee (1965) using Holstein in studying the influence of the maternal ability of the dam of the calf as well as the influence of calf individual genotype on birth weight and gestation length came up with contrasting findings that the sire influenced birth weight and gestation length greater than the dam. The above workers, however, recognized high sampling errors existed in the estimating procedures of the genetic parameters for maternal ability.

The age of the bull, according to the early workers (Baker and Quesenbury 1944) did not have any significant effect on calf crop. However, Burke (1954) in analyzing the performance of 178 purebred Hereford bulls and with a total of 4,470 pasture exposures of purebred Hereford females indicated that old bulls produced a larger number of calves than the young bulls when mated to old cows. Young bulls or cows in Burke's classification included those within the age of two to five years. However, there was no further explanation why such variation occurred. In contrast, Bishop (1964) in studying the paternal contribution to embryonic death pointed out that there was a significant decrease in fertility of the bulls with age. Bishop further stated that the older bulls tended to produce ejaculate of larger volume.

On the effect of sire on birth weight and gestation length, O'Mary et al. (1966) found that Charolais-sired calves had 4.5 days longer ($P<.05$) and 5.0 kilograms heavier ($P<.01$) than those calves sired by Angus bulls. This study further indicated that gestation length and birth weight were correlated in both Charolais and Angus sired calves.

The Effect of Lactation Status of Cow on Subsequent Reproduction

Early work by Lasley and Bogart (1943) using a strictly range-fed Hereford herd owned by San Carlos Apache tribe of San Carlos, Arizona, indicated that dry cows were harder to settle than the lactating cows, probably because of the inclusion of few non-breeders to the dry cow group. Lasley and Bogart concluded that the difference in fertility between the dry and the lactating cow groups may be eliminated if the non-breeder cows were removed from the experiment.

Wiltbank et al. (1961) using the herd of Angus, Hereford and Shorthorn at the Beef Cattle Research Station, Front Royal, Virginia and another herd of Zebu breeds (Brahman, Brahman-Angus and Africander-Angus) at Iberia Livestock Experiment Station in Jeanerette, Louisiana, found that the proportion of suckling cows not showing estrus was higher in Zebu than in the other breeds (Angus, Hereford and Shorthorn). However, the data in this study did not permit estimation of whether the observed differences in fertility among lactating cows at the two stations mentioned above were the result of real breed differences or location differences.

Two papers (England et al. 1963 and Wiltbank et al. 1961) both reported a higher conception rate for the lactating cows than for the dry cows of European breeds (Hereford, Angus and Shorthorn). However, both of these studies failed to explain the real cause of difference in fertility between the dry and lactating cow groups. Apparently, some non-breeders or cows with some pathological problems were included in the dry cow group which might have accounted for the low conception rate for this group.

Early Embryonic Mortality

Boyd (1965) recognized the necessity of conducting more experiments in order to identify and quantify various factors affecting early embryonic mortality. In his review papers, Boyd enumerated some of the genetic and environmental factors causing embryonic survival which were the family group, inbreeding, blood groups, lethal and semi-lethal factors for the genetic factors and nutrition, age, season, condition at service, exogenous hormones, infections and other miscellaneous diseases for the environmental factors.

Ulberg and Burfening (1967) in their summary presentation of facts on embryonic death concluded that temperature stress during early development stages results in later death of the embryo.

Various estimates of embryonic death were reported. Hawk et al. (1955) estimated 51.7% of embryonic deaths occurred between 16 to 34 days after conception. Bishop (1964) estimated a 15 to 60 percent embryonic death rate in cattle and Dearborn et al. (1973) found that 2/3 of the 31% heifers exposed for breeding and failing to wean a calf was due to failure to conceive or early embryonic loss.

Fosgate and Smith (1954) investigated the incidence of embryonic loss between the period during which pregnancy diagnosis was made (34-50 days postpartum) and the period of parturation using 1946 to 1952 records of the Wisconsin dairy herd. These investigators found out that on the average, the incidence of fetal mortality during the period mentioned above was 6.38% with a standard deviation of 1.87 percent. It was further pointed out that during gestation, the variation in loss of pregnancy between the 30-day period within the period of gestation was not significant.

Summary of Literature Review

Early reports on most successful matings among cattle in the Philippines fall in the period between the months of March and August and calving interval under range conditions varied from less than a year to three years and with an average of about two years.

Typical Philippine ranching largely depends on native pastures for feeds. Cattle of different ages are not usually segregated and the bulls run with the cows at all times.

Production has been very low. Calf crop weaned varied from 37 to a little over 50 percent, while pre-weaning mortality averaged from 0.86 to 19.0 percent.

Various studies in the United States on artifically inseminated cows indicated low fertility in winter and summer. High ambient temperature during early stages accounted for high embryonic mortality. However, studies on the Zebu breed in tropical Africa revealed opposite results in that a high conception rate occurred during the period of high temperature (84° F or higher) and when pasture condition was at its worst.

Nutrition, especially the amount of energy and protein greatly influences reproductive efficiency.

Reports on the influence of age of cow on fertility were divided. Many workers indicated that the highest fertility occurred between the intermediate ages (five and seven years) while others failed to detect such differences. However, older cows tended to give birth to heavier calves and the male calf is generally heavier than its female counterpart at birth.

Variation in fertility exists among different breeds of cows and under certain types of conditions and feeding.

The effect of lactation status on subsequent conception rate was not clear. Two studies indicated higher conception rate for lactating cows over dry cows but both studies failed to define the real cause of difference in fertility between the two cow groups (dry and lactating). Apparently, real non-breeder cows or cows with some pathological problems influenced the results of the above-mentioned studies.

Early embryonic mortality has been recognized as one of the most important factors causing a cow's failure to wean a calf.

CHAPTER III

MATERIALS AND METHODS

Location

This study was conducted at the Beef Cattle Project of the Central Mindanao University (CMU), Musuan, Bukidnon, Philippines beginning October 1, 1971 and lasting until December 31, 1976.

The province of Bukidnon is situated in the center of Mindanao Island in the southern Philippines and lies between parallel $7^{\circ}25'$ and $8^{\circ}38'$ north latitude and the meridians $124^{\circ}31'$ and $125^{\circ}16'$ east longitude with an elevation of 160 meters above sea level (Mariano et al., 1955). Its extensive open grasslands, its mild temperature and distributed rainfall offer bright potential for beef cattle ranching.

Bukidnon province ranked first throughout the Philippines in the number of cattle (60,980 head) from the commercial ranches according to the Bureau of Agricultural Economics (1976). There are approximately 257 existing cattle ranches in the entire province of Bukidnon (Boloron, 1970).

The CMU Beef Cattle Project is virtually located in the heart of the farming areas of the province. The

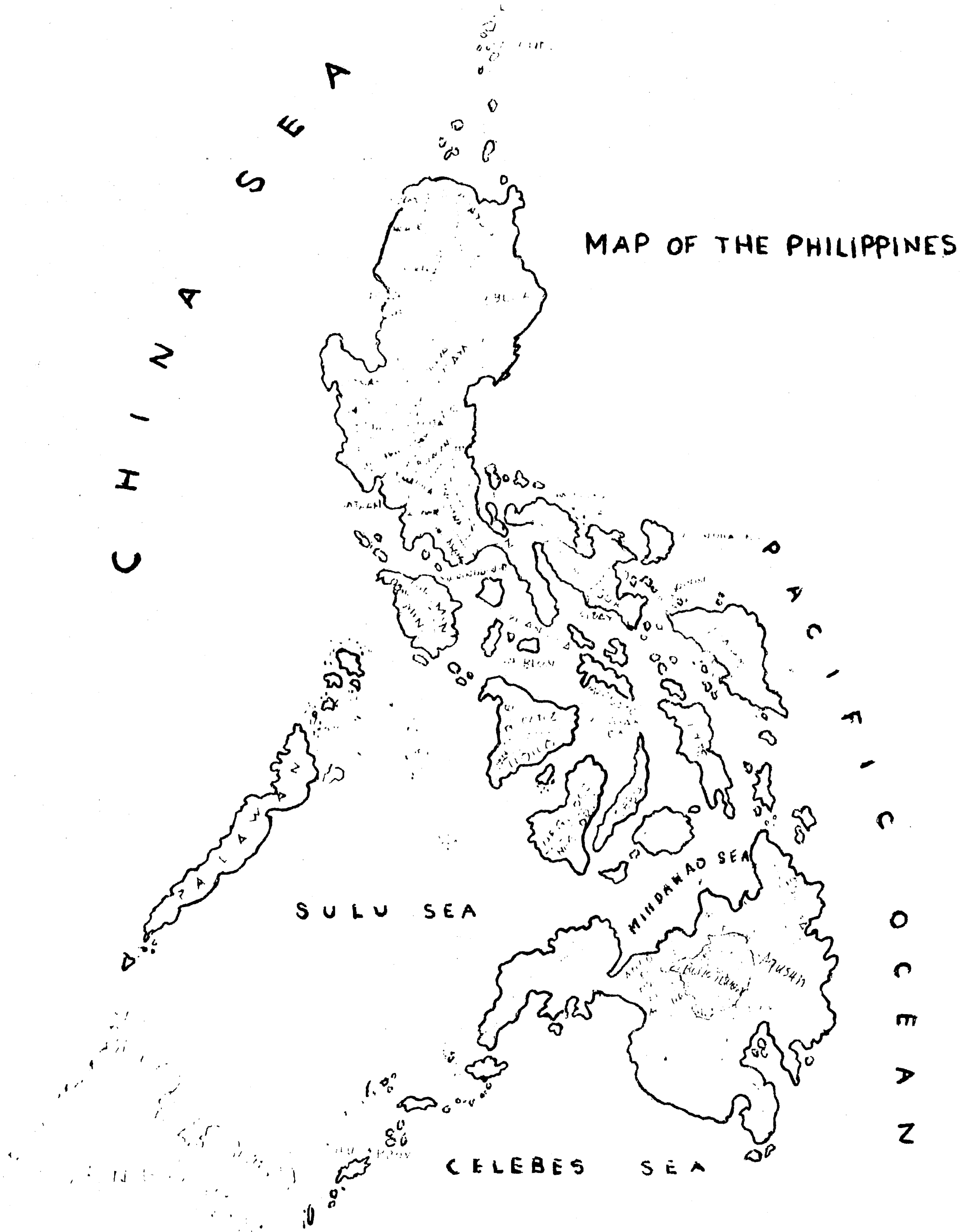

Figure 1. Province of Bukidnon in Relation to Other Provinces in the Philippines

research station has an area of about 1,000 hectares of native pastures and 150 hectares of improved pastures. There are 1,100 head of cattle on current inventory of this research station with the majority of the cattle being high-grade Brahman. Santa Gertrudis, Zebu crosses, grade Brown Swiss and grade Red Sindhi total approximately 82 head. There are also six pure American Brahman bulls which were used in this study.

Climatological Data

Climatological data were obtained from the Central Mindanao University Weather Station. Daily climatological observations included the amount of rainfall, using an eight inch non-recording rain gauge and relative humidity, using sling psychrometer. These readings were taken twice daily; once at 8:00 a.m. and then at 2:00 p.m. they again were taken. Air temperature was measured by maximum and minimum thermometers and at 8:00 a.m. daily readings were taken. Daily maximum temperature plus daily minimum temperature divided by two gave the average daily temperature. Also included was the number of days in each month that rain occurred.

Rainfall

The amount of rainfall within any given month varied from year to year (Figure 2). On the average (1970-1976), the wet months fell between the period from May through

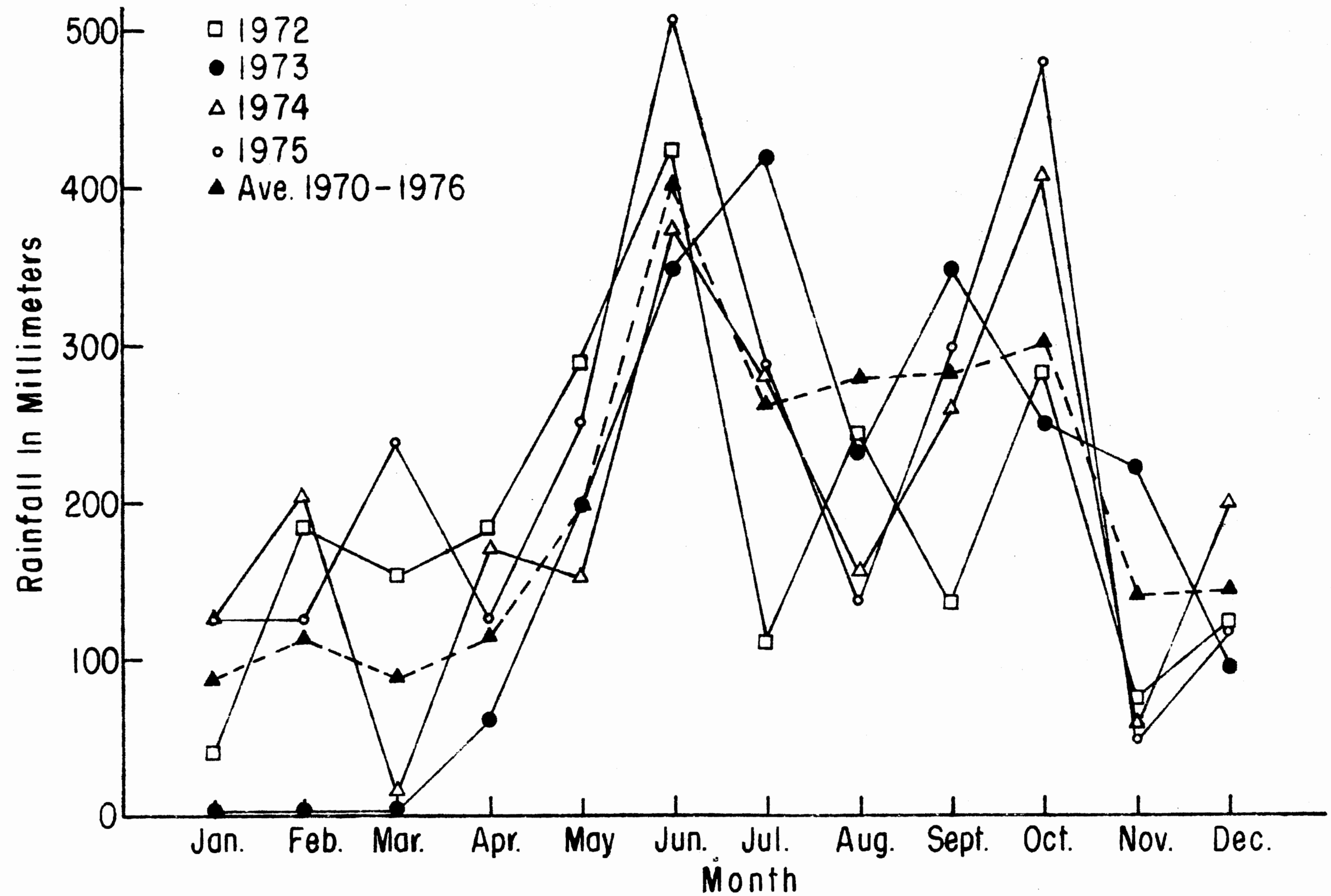

Figure 2. Monthly Rainfall by Year and Average Monthly Rainfall, Central Mindanao University, Musuan, Bukidnon, Philippines (1970-1976)

October. Heaviest precipitation occurred in June (402.34 mm.). The dry season was from November through April. Rainfall within this period varied from 78.74 mm. to 145.29 mm. per month. The mean yearly rainfall was 2,432 millimeters.

Figure 3 shows the number of rainy days by month. A rainy day did not necessarily mean a 24-hour downpour but rather simply the occurrence of rain any time within the day. On the average, the month of June had the greatest number of rainy days (23.43), followed by October (22.43), August (21.71), September (20.71) and July (20.57). Within the period from May to December there were no fewer than 15 rainy days within any given month. January to April had eight to eleven rainy days per month with the month of March having the lowest number.

Temperature

Based on the seven-year record (1970-1976), the mean maximum temperature was highest in the month of April (34.4° C), whereas the lowest minimum temperature was in the month of July (18.0° C) as shown in Figure 4. Temperature became milder from the month of November until February and then began rising in the month of March through the month of May. Heavy rainfall provided a cooling effect in the months of June through August.

Diurnal range in temperature was greatest in April, having a difference of 16.1° C between the mean maximum

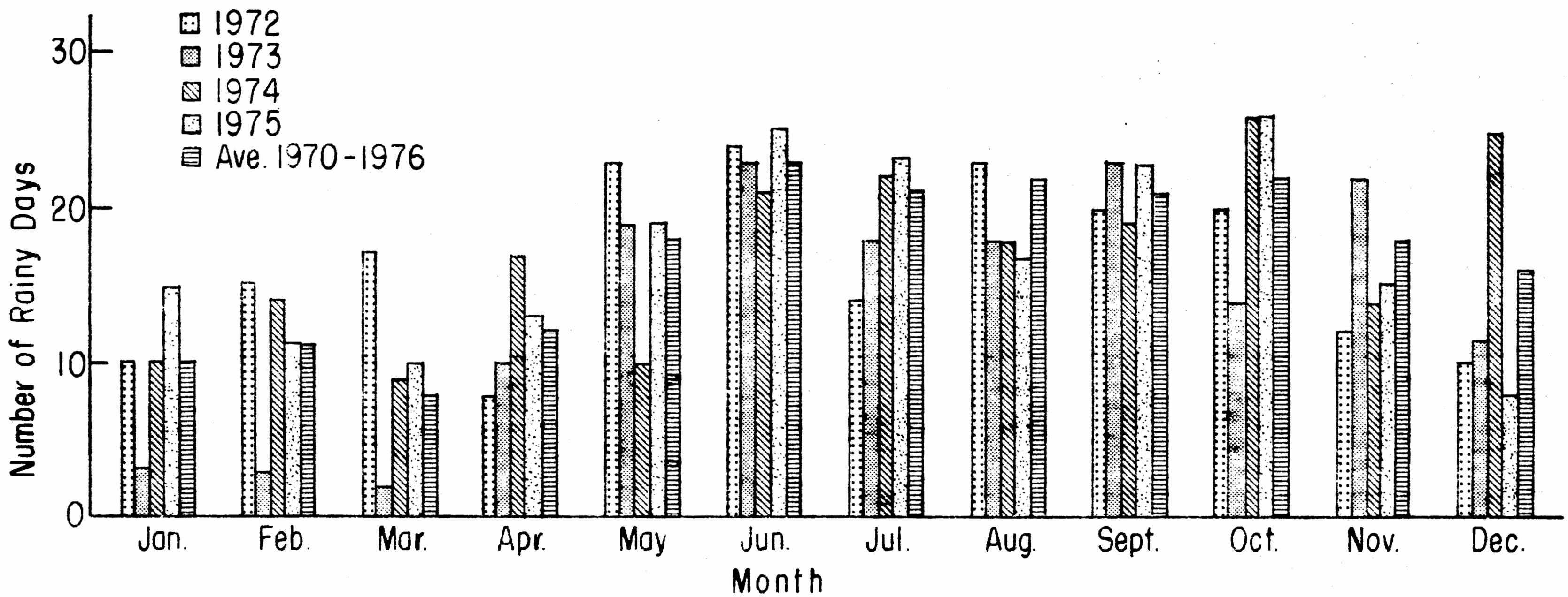

Figure 3. Number of Rainy Days Per Month, Central Mindanao University, Musuan, Bukidnon, Philippines (1970-1976)

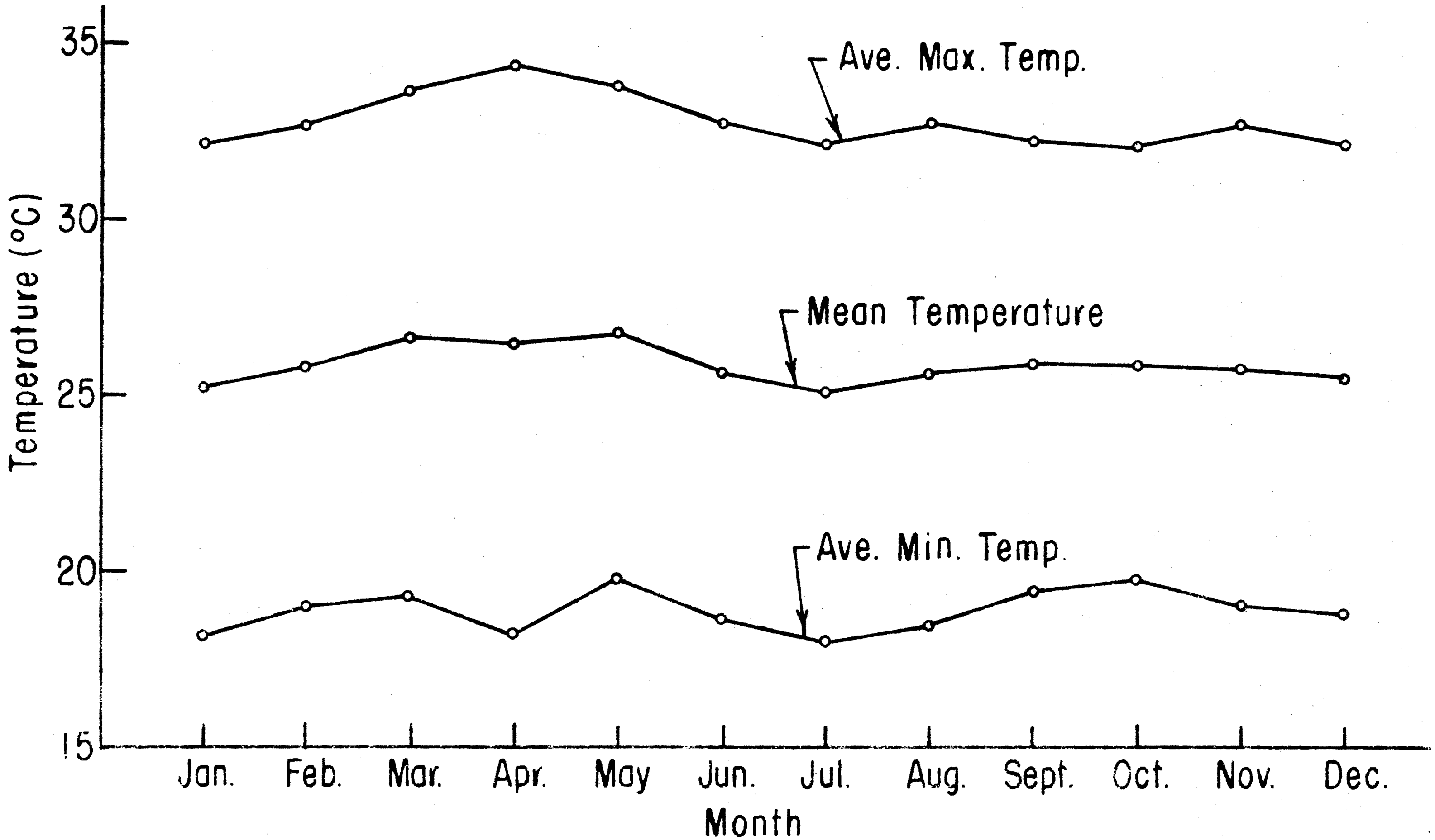

Figure 4. Average Minimum and Maximum Temperature, Central Mindanao University, Musuan, Bukidnon, Philippines (1970-1976)

and minimum temperature within the month. The average diurnal range in temperature monthly was 13.86° C with the months of September and October having the narrowest range of 12.9° C and 12.3° C, respectively.

The overall mean temperature (the average of the maximum and minimum) was considerably mild and more uniform throughout the year. It only slightly varied from 25.05° C in July (lowest) to 26.80° C in May (highest). Its overall monthly average temperature was 25.90° Centigrade.

Relative Humidity

On the average (1970-1976), the highest monthly value of relative humidity occurred in the month of June (80.3%) and then slightly declined in the following months through December (78.4%) as shown in Figure 5. During the dry season, relative humidity declined significantly from January (76.8%) until the month of April (68.3%). Mean monthly values were low during the dry period, as was expected.

Pastures

This study virtually used the entire pasture resources of the CMU Beef Cattle Project.

The native range is typical of the Bukidnon grassland: hilly, traversed by ravines and gullies with forestal portion at the ridge. The open portion is dominated by cogon (*Imperata cylindrica*) and bagocboc (*Themeda triandra*)

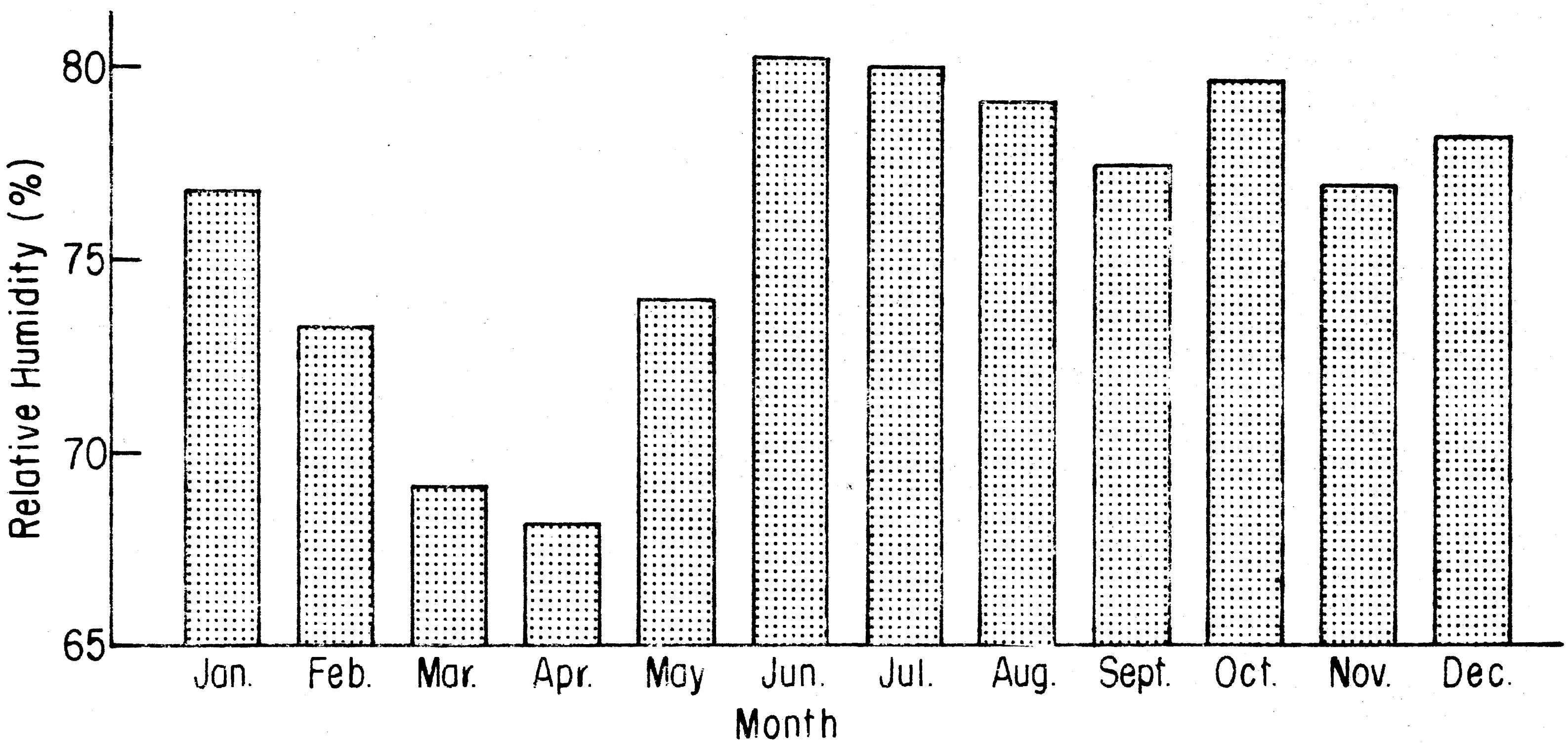

Figure 5. Average Relative Humidity (Percent), Central Mindanao University, Musuan, Bukidnon, Philippines (1970-1976)

which are the two dominant species of the Philippine grasslands. Two live springs supply water for the animals. This type of pasture, according to various reports, can carry from 0.62 to 1.0 animal unit per hectare per year (Boloron, 1970; Zablan, 1970 and Magadan, 1974).
The entire native range area has been divided into six compartments so as to accommodate rotation grazing. An area such as this has been subjected to annual fire (intentional, accidental or spontaneous).

The improved pastures consist of 150 hectares of predominantly paragrass (Brachiaria mutica). This area is flat and fertile with water for the cattle supplied by pipes. A 30-hectare portion of it was divisioned into one-hectare paddocks or 30 paddocks for the breeding herd during the breeding period. Four other large pasture divisions were established for calving cows, calves and weaned calves.

Renovation of the improved pasture area consisted of yearly clipping or harrowing followed by fertilization at the rate of 20 to 40 kilograms of nitrogen per hectare.

General Procedure

Two three-month breeding seasons were compared: (1) the summer breeding season in May, June and July and (2) the fall breeding season in October, November and December. Summer and fall breeding periods differed in terms of the amount of rainfall as well as pasture conditions both during the breeding periods *per se* and during the calving periods.

The following breeding plan (Table I) compares summer and fall breeding seasons which may vary in terms of the amount of precipitations and availability of herbage both during the breeding periods and during the expected calving time.

TABLE I

SUMMER AND FALL BREEDING PLAN

Breeding Period		Expected Calving Period	
Month	Rain/Pasture Cond.	Month	Rain/Pasture Cond.
May-June-July (summer)	Light rain with adequate grasses during first half to abundant rain and grasses in the last half of the period.	Feb-Mar-April	Light rainfall to dry with inadequate grasses in the entire period.
Oct-Nov-Dec. (fall)	Good amount of rain and grasses during first half to light or very light rain and declining amount and quality of herbage in the second half of the period.	July-Aug-Sept.	Heavy rainfall and abundant grasses for the entire period.

Six pure American Brahman bulls whose ages ranged from 2.5 to 3 years in the fall of 1971 when they were first used for breeding were used for the entire study. These bulls were fertility tested and registered in the American Brahman Breeders Association. Cows and/or heifers used in this study were Brahman-Nellore cross with Brahman breeding predominating. Non-pregnant cows were picked from the main cow herd of the CMU Beef Cattle Project every breeding season. Beginning with the fall breeding season of 1971 up to the fall breeding season of 1975, each bull was assigned at random to approximately 20 cows for every three-month breeding period on pasture. However, in the fall of 1973 more cows were assigned to each bull due to so many non-pregnant cows being available from the cow herd. Also in the fall of 1975, lesser numbers of cows were assigned to each bull as there were few non-pregnant cows available for breeding purposes (Table II). Rectal palpation was used to determine whether a cow was open or pregnant.

Few errors in pregnancy analysis did occur. Those cows assigned in the breeding herd but which were already pregnant prior to the breeding season based on calving data were eliminated from the records. This type of error partly accounted for the small variation in the number of cows assigned to each bull each breeding season. The other cause of slight variation in the number of cows assigned for each bull was that a few "high jumper" high-grade

Brahman cows during the first day of segregation in the breeding pastures leaped over the five-strand divisional fences and joined their "preferred sire group." No similar incidence was observed during the rest of the breeding period when "affinity" among members of the sire group had been established.

TABLE II

NUMBER OF COWS RANDOMLY ASSIGNED TO EACH BULL EACH BREEDING SEASON FROM FALL OF 1971 TO FALL OF 1975

Bull ID Number	Year and Breeding Season (S and F[a])									
	1971		1972		1973		1974		1975	
	S	F	S	F	S	F	S	F	S	F
20	-	20	22	20	19	25	20	20	20	14
23	-	19	19	22	20	27	13	21	19	17
28	-	19	18	20	21	23	20	22	22	15
33	-	19	23	21	19	19	19	19	19	10
34	-	15	19	21	22	25	20	22	21	8
36	-	21	19	20	21	22	20	18	19	14

[a]S=Summer, F=Fall

Randomization in the assignment of cows to each bull was done every breeding period. A cow that was assigned to this project in one breeding season may have also reappeared more than once in the succeeding breeding periods or may not have reappeared at all. The purpose was to randomly assign to each bull a set of non-pregnant cows to obtain an unbiased estimate of reproductive performance for each bull in each breeding season.

Cows from the native range were usually flushed on improved pasture for two or more weeks before the start of the breeding period. Cows were on strictly pasture feeding both within and outside of the breeding period, which is typical of Philippine ranch management. Salts were given weekly at about 0.25 kilo per head. Sometimes salt ran out of stock for one to two weeks and this happened three to four times in a year. Management and handling of the cows under the different sire groups were similar throughout the period.

Each bull was given two to three kilos of either ground corn or corn bran or mixture of both daily throughout the year. Salts and bone meal were fed weekly. Records were not kept on the consumption of these supplements. These bulls were enclosed together in the improved pastures during their rest period. Feeding and management of the bulls were uniform throughout the entire study.

During each breeding season, the six sire groups were rotated within the thirty one-hectare paddocks. Assignment of grazing paddocks during rotation for any given group was done at random. Each paddock was provided with drinking water at all times. Pasture and herd management of the six sire groups were essentially the same throughout the entire mating season.

All bulls and cows used in this study were identified by brand number. Calves were identified by earnotches.

At the end of each breeding season, bulls were withdrawn and cows from different sire groups were placed together in a single herd. Pregnancy diagnosis by rectal palpation was done one month after the withdrawal of the bulls. Those found open were sent back to the main herd for rebreeding. Pregnant cows were placed together in one herd until the calving period. The pregnant cow herd would be transferred to the calving pasture, which is an improved pasture complete with watering facility. A portable livestock scale that provided weights in one pound increments was mounted on a buffalo sled and moved around for weighing newly-born calves. One full-time man was assigned the job of obtaining the necessary data on the calf such as birth weight, sex, date of birth, identification number (earnotch), sire and dam. Weighing and earnotching were done within a 12-hour period from birth of the calf.

The cow and calf were raised strictly on pasture. Cows picked for rebreeding brought the calf to the breeding herd. No other form of feed supplement was given except the weekly salts.

Weaning was normally done at one time for all the calves born within the same calving period as soon as the youngest in the group would be able to graze, usually from seven to eight months old. Segregation of calves by sex was done at weaning time if there were enough improved pasture compartments to accommodate them. Otherwise, segregation of sexes would be done later. In addition to good pastures for the weaning calves, ground corn, corn bran or a mixture of the two was given at about one kilo per head per day. Sometimes if copra meal or fish meal were available, this was mixed into the ground corn or corn bran at no more than ten percent. This latter item, however, was very unreliable and supplies were often depleted.

Unfortunately, weaning weights and weights on pasture were not taken as there was no suitable livestock scale available. As soon as male calves were weaned, buyers took them for breeding purposes, except for those having some apparent defects.

Data that were kept for evaluation purposes were: (1) number of cows exposed; (2) number of calves dropped and (3) number of calves weaned, respectively, per bull at any given season in any given year. In addition, birth weights were also recorded.

Statistical Treatment of the Data

Phase I of the analysis was primarily aimed at identifying the effects of season and sire on the overall breeding efficiency in terms of the number of calves born, number of calves weaned and number of calves that survived. These three variables were expressed in percentages and were defined as follows:

$$\text{Percent calves born} = \frac{\text{Total number of calves born}}{\text{Total number of cows exposed}}$$

$$\text{Percent calves weaned} = \frac{\text{Total number of calves weaned}}{\text{Total number of cows exposed}}$$

$$\text{Percent calves survived} = \frac{\text{Total number of calves weaned}}{\text{Total number of calves born}}$$

Phase II of the analysis was intended to determine the factors influencing birth weight of calf. A computer program (SAS) developed by Barr and Goodnight (1972) was used to carry out the above analysis.

Attempts to classify data by parity of the cows were discontinued because there were very few cows belonging to parity three and above in this study. The majority of the cows belonged to parity one and parity two.

Analyses of Variance for Reproductive and Calf Survival Traits

The effects of season and sire on breeding efficiency in terms of the total number of calves born, total number of calves weaned and total number of calves survived were examined from the performance records of the six pure American Brahman bulls in four summer and five fall breeding periods, respectively. Three dependent variables were evaluated. These were percent calves born, percent calves weaned and percent calves survived. The model assumed for each analysis was:

$$Y_{ijk} = M + B_i + Y_j + S_k + (BY)_{ik} + (YS)_{jk} + e_{ijk}$$

where

Y_{ijk} = the percent calves born, percent calves weaned or percent calves survived, respectively, by any given bull at any given season in any given year;

M = the overall mean common to each sire-season-year subclass;

B_i = the effect of the i^{th} bull (i=1, 2, ..., 6);

Y_j = the effect of the j^{th} year (j=1, 2, ..., 5);

S_k = the effect of the k^{th} season (k= 1 and 2);

$(BY)_{ij}$ = the effect of bull x year interaction;

$(BS)_{ik}$ = the effect of bull x season interaction;

$(YS)_{jk}$ = the effect of year x season interaction; and

e_{ijk} = the random variable assumed to be normally distributed with mean 0 and variance σ^2.

Season, bull and year were considered as fixed effects. Least square means for each trait were obtained for each season adjusted for year, bull, bull x year, year x season and bull x season. Least square means for each trait were also obtained for each bull adjusted for year, season, year x season, bull x year and bull x season.

The standard errors for least square means were obtained by the general formula:

$$S\overline{X} \pm \sqrt{\sigma^2 e \ (C^{mm} + C^{ii} + C^{im})}$$

where

$S\overline{X}$ = the standard error for any given least square mean;

$\sigma^2 e$ = the error mean square;

C^{mm} = the intercept at the inverse matrix;

C^{ii} = the corresponding diagonal inverse element for that constant at i^{th} row and i^{th} column of the complete inverse matrix; and

C^{im} = the inverse element for the i^{th} row and m^{th} column of the complete inverse matrix.

Duncan's multiple range test as modified by Kramer (1957) was used to compare means with the following formula:

$$(\overline{Y}_i - \overline{Y}_j) \sqrt{\frac{2}{C^{ii} + C^{jj} + 2C^{ij}}}$$

where

$(\overline{Y}_i - \overline{Y}_j)$ = the difference between the i^{th} mean and the j^{th} mean;

C^{ii} = the corresponding diagonal inverse element for that constant at i^{th} row and i^{th} column of the complete inverse matrix;

C^{jj} = the corresponding diagonal inverse element for that constant at j^{th} row and j^{th} column of the complete inverse matrix; and

C^{ij} = the inverse element for the i^{th} row and j^{th} column of the complete inverse matrix.

Sources of Variation for Average Birth Weight of Calf

Variation in birth weight was analysed from a total of 429 calves that were sired by the six Brahman bulls during the nine breeding periods from fall breeding season of 1971 to the fall breeding season of 1975. The dependent variable was birth weight of the calf in pounds. The model used for this analysis was:

$$Y_{ijkl} = M + B_i + Y_i + T_k + S_l + (BY)_{ik} + (BT)_{ik} + (BS)_{il} + (YT)_{jk} + (YS)_{jl} + (TS)_{kl} + e_{ijkl}$$

where

Y_{ijkl} = the birth weight of the calf of the l^{th} sex, born in the k^{th} season in the j^{th} year and sired by bull i;

M = the overall mean common to all calves;

B_i = the effect of the i^{th} bull (i= 1, 2, ..., 6);

Y_j = the effect of the j^{th} year (j= 1, 2, ..., 5);

T_k = the effect of the k^{th} season (k= 1 and 2);

S_l = the effect of the l^{th} sex (l= 1 and 2);

$(BY)_{ij}$ = the effect of bull x year interaction;

$(BT)_{ik}$ = the effect of bull x season interaction;

$(BS)_{il}$ = the effect of bull x sex interaction;

$(YT)_{jk}$ = the effect of year x season interaction;

$(YS)_{jl}$ = the effect of year x sex interaction;

$(TS)_{kl}$ = the effect of season x sex interaction; and

e_{ijkl} = the random variable assumed to be normally distributed with mean 0 and variance σ^2.

Year, bull, season and sex were considered as fixed effects.

Least square means for birth weight were obtained for each of the following: season was adjusted for bull, year, sex, bull x sex, year x sex, bull x season, year x season and season x sex; sex was adjusted for bull, season, year, bull x season, bull x year, year x season, bull x sex, year x sex and season x sex; and bull was adjusted for year, season, sex, year x season, year x sex, season x sex, bull x year, bull x season and bull x sex.

The standard errors for least square means were obtained by the general formula

$$(S\bar{X} \pm \sqrt{\sigma^2 e \ (C^{mm} + C^{ii} + 2C^{im})})$$

which was defined earlier.

CHAPTER IV

RESULTS AND DISCUSSION

Factors Affecting Reproductive and Calf Survival Traits

Mean squares from the analysis of variance of reproductive and calf survival traits are presented in Table III. The breeding season affected both percent calves born and weaned ($P<.05$) but not the percent calves survived. Sire effect significantly influenced percent calves survived ($P<.01$) but not the percent calves born and weaned. The year highly influenced both percent calves born and weaned ($P<.01$) and significantly affected percent calves survived ($P<.05$). Percent calves survived was the only trait highly affected by bull x year interaction ($P<.01$). Other two-factor interactions did not significantly affect reproductive and calf survival traits.

The Effect of Breeding Season on Reproductive and Calf Survival Traits

Least square means and standard errors are presented in Table IV. Summer pasture breeding had 27.6 $\pm$ 10.21

TABLE III

ANALYSIS OF VARIANCE FOR REPRODUCTIVE AND CALF SURVIVAL TRAITS

Source	df	Mean Squares		
		% Calves Born	% Calves Weaned	% Calves Survived
Season	1	0.228*	0.215*	0.001
Bull	5	0.063	0.053	0.539**
Year	4	0.214**	0.159**	0.021*
Bull x Year	20	0.019	0.022	0.029**
Bull x Season	5	0.004	0.002	0.002
Year x Season	3	0.032	0.025	0.005
Error	12	0.032	0.025	0.005

*P<.05.

**P<.01.

TABLE IV

LEAST SQUARE MEANS AND STANDARD ERRORS FOR PERCENT CALVES BORN, CALVES WEANED AND CALVES SURVIVED FOR SUMMER AND FALL BREEDING SEASON

Trait	Summer Mating Mean ± S.E.	Fall Mating Mean ± S.E.	Difference (Sum.-Fall) Mean ± S.E.
% Calves Born	62.5 ± 9.97	34.9 ± 3.99	27.6 ± 10.21*
% Calves Weaned	57.9 ± 9.99	31.2 ± 9.01	26.8 ± 10.24*
% Calves Survived	90.6 ± 3.87	92.3 ± 1.55	-1.7 ± 3.97

*P<.05.

percent more calves born and 26.8 $\pm$ 10.24 percent more calves weaned over fall pasture breeding. This result agreed with the normal calving record of the CMU Beef Cattle Herd from 1970 to 1976 (Appendix, Table X) with year round calving which indicated that calvings were heaviest in the months of February through April. Counting back, this early spring of heavy calving corresponds to the high rate of successful summer matings.

Villegas (1929) observed that the period of highest conception rate in cattle at Los Banos, Laguna, Philippines occurred in the months of April through July. Similarly, Lunaan's (1970) study on 60 cattle ranches in Masbate and Bukidnon, Philippines revealed that heavy calving also came about in the month of March, which also suggested high conception rates in the summer months.

Some studies outside of the Philippine islands corroborate with the above result. Anderson (1944) in studying the periodicity and duration of estrus in Zebu and grade cattle in Naivasha, Kenya found that the period of increased sunshine and temperature were related to the increase in sexual activity in cattle and, likewise, found the period of decreased sunshine and temperature resulted in a corresponding decrease in sexual activity. Also, Mercier and Salisbury (1947) stated that under semi-feral conditions, where the bulls remain with the cow herd throughout the year, the majority of the matings took place during late spring and summer months.

However, studies in the United States on artificially inseminated dairy cattle revealed that poor fertility occurred both during winter and summer breedings (Mercier et al. 1947, Fryer et al. 1958 and Stott 1961).

Nutrition of the breeding herd in this study (CMU study) solely depended on pastures throughout the year. It is common knowledge that pasture quality as well as quantity are influenced by the season of the year and by the age of the plants. A compilation of published data pertaining to the composition and digestibility of fresh tropical herbage (Hardison 1966) revealed that both TDN and DCP content of the herbage varied throughout the year in that the amount of DCP in the grasses sharply fluctuated from a level insufficient to support body maintenance to that capable of giving an output of 20 to 25 kilograms of milk daily. In the same report, the yield predicted from the TDN levels ranged from only about four to seven kilograms of milk per day. It was also indicated that grasses in general are more nutritious in the wet season than during the dry period of the year and that the DCP content declined sharply with maturity.

During the onset of the rainy period, native tropical grasses grow fast and mature fast. High feeding value of the herbages may occur only during a short period of the growth cycle of the plants. Stoddart et al. (1975) indicated that the more readily digested carbohydrates, phosphorus and crude protein decreased as plants matured due to the change in stem-leaf ratios and also due to the actual changes in the composition within each plant part. Stoddart et al. further explained that much of the change in the composition of forage with advancing maturity is caused by leaching of the soluble constituents by rain, especially in the hotter and more humid climates.

Another highly variable nutrient in forage as the plant matures is vitamin A. Atkeson et al. (1937) reported that all pasture plants have a relatively high carotene content during early summer which declines markedly with the advancing season.

While energy, protein, phosphorus and carotene contents decline with the advancing season and/or maturity of the plants, crude fiber, lignin and cellulose content increase. Burzloff (1971) pointed out that during the early growing season, digestibility of most grasses are within the neighborhood of 40 to 70 percent and then decline considerably to less than 40 percent with the advancing season.

Plant composition in terms of TDN, DCP, P and vitamin A, which are highly variable, are also recognized to be highly important in reproduction. Deficiencies in any of these nutrients or combination of nutrients have been known to cause reproductive failures such as cessation of estrus and infertility in cows, death of the fetus *in utero*, or the birth of a premature or weak calf. In males, undernutrition decreases the number and vigor of sperm or may even cause cessation of spermatogenesis.

Nelson et al. (1953) in their study with rats reported that low protein diet causes a cessation of estrus and that if fertilization occurred, fetal resorption or premature birth resulted. Witt et al. (1958) in studying the effect of protein intake and alfalfa meal on reproduction and gains in beef cows found that feeding a ration 100 percent of the NRC protein requirement plus three pounds of alfalfa meal for 84 days before and another 84 days during breeding significantly reduced weight loss of cows and shortened calving interval in comparison to those cows fed with 50 percent of the NRC protein requirement only. Wiltbank et al. (1962) looked into the effect of energy level on the reproductive phenomena of mature Hereford cows. They found that cows fed a low energy diet (4.5 lb. TDN per head per day) before and after calving had a lower subsequent conception rate (20%) as compared to a 95% conception rate for cows on a high energy diet (9.0 lb. TDN per head per day). Wiltbank et al. (1947) studied the effect of various combinations of energy and protein on the breeding performance of beef heifers. This study revealed that full energy feeding with low protein (0.06 DP/CWT) depressed the growth of the heifers and delayed estrus, while those on low energy and low protein showed further reduction in growth rate and a considerably lengthened time to first estrus. A similar study by Joubert (1954) compared high and low planes of nutrition on the estrous cycle and conception rate of heifers and the results showed that those heifers receiving supplementary feeds before and after calving attained puberty age earlier than those heifers entirely fed with pastures only prior to calving. Restoration of sexual activity after calving was also longer (one year or more) in the latter group.

Phosphorus and vitamin A deficiencies impose profound effects on reproduction. An early study by Theiler et al. (1928) demonstrated that calf crop significantly increased to 80% for the group of breeding cattle fed with bone meal or other sources of phosphorus as against 50% for the group without phosphorus supplementation when grazing on phosphorus-deficient pastures. Hafez (1974) stated that deficiencies of minerals or vitamins caused anestrus. Hafez further emphasized that phosphorus deficiency in range cattle and sheep causes ovarian dysfunction which in turn leads to delayed puberty, depressed sign of estrous and eventually cessation of estrus.

The present economic situation of the Philippines does not warrant the raising of cattle on grain feeds. Sound ranching business may be realized through full use of the existing pasture resources and the proper timing of the various ranch activities in accordance with the availability of the natural feeds.

This study indicated that if pasture breeding for a restricted time period is to be practiced, especially in areas where pasture improvement is minimal, and where the breeding herd largely depends on natural grazing throughout the year, the selection of the right breeding season is one of the most important considerations.

Rainfall pattern and growing season of the plants appeared to be a good basis for selecting the most suitable breeding season in any given area if maximum net calf crop is the ultimate goal.

The general climatic conditions from which this experiment was conducted are that the mean daily temperature is more or less uniform throughout the year (average of 25.9^{o} C) except for a slight rise in the months of March through May, as shown in Figure 4. Monthly rainfall, however, fluctuated markedly. It was heaviest in the month of June (402.34 mm) and lowest in the months of January through March (78.74 to 117.09 mm) as shown in Figure 2. In general, adequate to heavy rainfall occurs between the period beginning the last part of April to the early part of November. The period from the later part of December to the middle of April is considered dry. During this period, the amount and quality of natural grazings are lowest and uncontrolled burning of pastures, from either accidental or spontaneous causes is rampant.

Planting seasons and/or early growing seasons start in the later part of April to the early part of May. Natural grazings are abundant and of high feeding value, especially during the first half of the rainy period.

High feeding value of herbages, however, can be maintained throughout the entire rainy period through right stocking rate and grazing management systems.

It is, therefore, evident that a limited period of summer pasture breeding has an advantage over fall breeding in terms of good nutrition both during the three-month period and during the early gestation period. The fall breeding period is facing the dry season and poor pasture nutrition. Dearborn et al. (1973) found that 31% of the heifers exposed for breeding failed to wean a calf. This was largely due to the failure to conceive or early embryonic loss. Hawk et al. (1955) estimated that 51.7% of the total embryonic deaths occurred between the period from 16 to 34 days after conception. Embryonic death may be substantially high. Bishop (1964) estimated embryonic death to run from 15 to 60 percent of the total loss.

Summer breeding results in a dry calving period (February, March and April) whereas, fall breeding results in a wet calving time (July, August and September). The analysis on percent calves survived (Table III) shows that neither of the above calving periods had any particular advantage of survival of the calves. However, it has been a common experience among ranchers that pneumonia and calf scour are rampant maladies affecting wet-season born calves due to excessive exposure to heavy downpour and wet grounds. Wet calving appeared less economical in terms of veterinary costs as there are more calf diseases during this period of the year.

Sire Effect Upon Net Calf Crop

The six pure American Brahman bulls used in this study were locally born (Phillipine born) by pure American Brahman parents which were imported to the Philippines from different United States Brahman breeders. These bulls were of similar ages and were selected based on fertility ratings (sperm motility and concentration count) at the time they were purchased during the early part of 1971. Analyses of variance in Table III showed that sire effect did not significantly influence percent calves born and weaned but did highly affect percent calves survived ($P<.01$). However, pairwise comparisons of least square mean values for percent calves born and weaned applying Duncan's multiple range test, as modified by Kramer (1957), showed that Brahman bull number 20 had the highest percentage of calves born (59.1 ± 8.50) and weaned (53.0 ± 8.53), and bull number 34 was lowest for both percentage calves born (31.0 ± 8.50) and weaned (28.8 ± 8.52) (Table V). Fertility ratings based on percentage calves born are: bull number 20 (first), bull numbers 33 and 36 (second), bull numbers 23 and 28 (third) and bull number 34 (fourth and last). Similarly, ranking the bulls based on percent calves weaned are: bull number 20 (first), bull numbers 23, 28 and 33 (second), bull number 36 (third)

TABLE V

LEAST SQUARE MEANS AND STANDARD ERRORS FOR PERCENT CALVES BORN, CALVES WEANED AND CALVES SURVIVED FOR EACH BULL

Bull ID Number	Means ± Standard Errors[a]		
	Percent Calves Born	Percent Calves Weaned	Percent Calves Survived
20	59.1±8.50[a]	53.0±8.51[a]	88.1±3.30[d]
23	49.4±9.61[c]	48.6±7.82[b]	98.8±3.03[a]
28	49.8±9.61[c]	47.3±7.82[b]	94.9±3.03[c]
33	51.0±8.50[b,c]	48.5±8.53[b]	95.9±3.30[b]
34	31.0±8.50[d]	28.8±8.52[d]	94.7±3.30[c]
36	52.0±10.62[b]	41.3±10.26[c]	76.1±3.97[e]

[a]Means within the column without at least one common superscript are significantly different ($P<.05$).

and bull number 34 (fourth).

The significant effect of sire on percent calves survived is hard to explain. It appeared in the analysis that the bull number 23 had the highest number of calves that reached weaning age (98.8 ± 3.03%) over the rest of the bulls, whereas bull number 36 had the lowest (76.1 ± 3.97%). Calf survival ratings are: bull number 23 (first), bull numbers 28 and 34 (second), bull number 20 (third), bull number 33 (fourth) and bull number 36 (fifth and last).

If bulls are selected for extended services through A-I, bull numbers 20, 23, 28 and 33 may be used for the purpose.

Baker and Quesenbury (1944) in analyzing the breeding records obtained from the United States Range Livestock Experiment Station at Miles City, Montana which consisted of 4,753 cow years over an 18-year period, found significant effect of sire (both purebred and grade beef cattle) on percent calf crop. This finding also agreed with the finding of Mercier and Salisbury (1946) on Holstein and Guernsey bulls.

Year Effect on Net Calf Crop

Year highly influenced percent calves born and weaned ($P<.01$) and percent calves survived ($P<.05$). Variation in the improvement and maintenance of pastures and in the management of the breeding herd accounted for the greater portion of the yearly variation. This finding agreed with that of Schilling and England (1968) who found highly significant effect of year on calving rate in beef cattle.

For limited pasture breeding (limited time period mating) to be a success, efforts must be made to plan ahead of time yearly pasture renovation such as clipping, discing and fertilization in order to have the best pasture stand shortly before breeding time for flushing the cows that are picked from the native range and to have adequate forage throughout the three-month breeding period.

Pasture plan must include improved pastures for pregnant cows and for cows suckling calves for use when the native range is depleted. Improved pasture also provides feed in the form of standing hay for the dry season. This standing hay field may be a part of planted pastures that is conservatively grazed during the last half of the rainy period and protected from the annual range fire during the summer period.

The value of urea supplementation is not yet clear. However, the use of urea alone and urea-molasses mixture as supplement during the dry period of the year when grazing declined will be a good area for research in tropical ranching.

Factors Affecting Birth Weights

Birth weights were obtained on a total of 244 male and 184 female calves. Of the 428 male and female calves, 225 were produced from summer and 203 from fall breeding.

The analysis of variance for calf birth weights is presented in Table VI. The only significant source of variation for birth weight was year effect.

TABLE VI

ANALYSIS OF VARIANCE FOR CALF BIRTH WEIGHT

Source	df	Mean Square
Bull	5	13.859
Year	4	76.308**
Season	1	4.984
Sex	1	3.117
Bull x Year	20	6.905
Bull x Season	5	12.016
Bull x Sex	5	11.738
Year x Season	3	16.167
Year x Sex	4	12.929
Season x Sex	1	4.873
Error	378	7.892

**P<.01.

Breeding season did not significantly affect birth weight. The least square means and standard errors for birth weights by season are presented in Table VII. It shows that fall pasture bred calves were slightly heavier by 0.7 $\pm$ 0.87 pounds over the summer bred calves. Although not significant, this slight difference may be partially due to the better pasture nutrition of the fall bred cows during the last 1/3 to 1/2 of the gestation period. Thus, while fall breeding faced a dry period and poor pasture during the first half of the gestation period which may account for high early embryonic mortality and low calf crop, those that survived this early period received better pre-natal nourishment during the last stage of pregnancy when pasture condition was at its best.

Summer bred cows, on the other hand, enjoyed better pasture grazings during the early gestation period but experience nutritional deficiency at the last 1/3 to 1/2 of pregnancy, during or before calving period in the months of February, March and April.

These findings agree with that of Koch and Clark (1955) who attributed the slight difference in birth weights between early- and late-season born calves in favor of the latter to good pasture condition or variation in the gestation length of cows.

In this study, gestation length was not included in the model. However, Ruppanner et al. (1976) reported a positive correlation between gestation length and birth weight.

Sex effect on birth weight was not significant. The least square means and standard errors for birth weights by sex are presented in Table VIII. Although not statistically significant, the bull calves averaged 0.2 ± 0.36 pounds heavier than the female calves.

TABLE VII

LEAST SQUARE MEANS AND STANDARD ERRORS FOR BIRTH WEIGHTS OF CALVES BY SEASON

Means and Std. Errors for Birth Weights (lb.)[a]		Difference (Summer - Fall)[b]
Summer (225)	Fall (203)	
54.5± 0.81	55.2±0.35	-0.7±0.87

[a]Numbers in parenthesis after each season represent the total number of observations each season.

[b]Difference was not statistically significant.

Most previous studies indicated male calves to be significantly heavier than the female calves (Botkin and Whatley 1953, Koch and Clark 1955, Andersen and Plum 1965 and Everett and Magee 1965).

Sire effect on birth weight was not significant. Table IX presents the least square means and standard errors for birth weights by bull. Average birth weight of calf by bull ranged from 53.9 ± 1.19 pounds for bull number 36 to 55.8 ± 0.83 pounds for bull number 34.

Some reports, however, indicated significant effect of sire on birth weights (Andersen and Plum 1965 and Everett and Magee 1966).

TABLE VIII

LEAST SQUARE MEANS AND STANDARD ERRORS FOR BIRTH WEIGHTS OF CALVES BY SEX

Means and Std. Errors for Birth Weights (lbs.)[a]		Difference
Male (244)	Female (184)	(Male - Female)[b]
55.0±.47	54.7±.49	0.2±.36

[a]Number in parentheses after each sex represent the total number of observations.

[b]Difference was not statistically significant.

TABLE IX

LEAST SQUARE MEANS AND STANDARD ERRORS FOR BIRTH WEIGHTS BY SIRE

Bull ID Number	Number of Calves	Birth Weights (lb.)[a] (Means$\pm$Standard Errors)
20	86	54.7 ± 0.58
23	75	54.7 ± 0.57
28	72	55.2 ± 0.52
33	77	54.7 ± 0.57
34	42	55.8 ± 0.83
36	76	53.9 ± 1.19

[a]Differences among means were not statistically significant.

CHAPTER V

SUMMARY

The primary objective of this study was to compare summer and fall breeding seasons with regards to conception rate and percent calf crop weaned. This comparison is of great importance to the Philippine beef industry because of the current popular opinion among Philippine beef cattle "experts" that the highest percent calf crop weaned can be attained from restricting calving to a single period of time each year of about ninety days. In addition, more efficient ranch management can be realized through limited periods of pasture breeding. This results from the production of calves that are more uniform in age and size which in turn allow simpler and more efficient scheduling of ranch activities such as weaning, branding, castration, deworming and other similar activities.

The data collected included the breeding performance of the six Brahman bulls in four summer and five fall mating seasons covering the period from the fall of 1971 to the fall of 1975. Approximately 20 cows were assigned to each bull at random every mating season. Pastures were the main source of feeds. Breeding efficiency was expressed in terms of percent calves born, calves weaned and calves survived. Breeding season significantly affected both percent calves born and calves weaned ($P<.05$) but not percent calves survived.

Summer pasture breeding had 27.6 ± 10.21 percent more calves born and 26.8 ± 10.24 percent more calves weaned over fall pasture breeding. Adequate rainfall and good pasture conditions in terms of feeding quality and quantity during breeding period and at early pregnancy appeared to be the most important factors contributing to high calf crop from summer mating. Sire effect was not significant on either percent calves born or calves weaned but was highly significant on percent calves survived ($P<.01$). However, pairwise comparisons of least square mean values on percent calves born and calves weaned applying Duncan's multiple range test as modified by Kramer (1957) showed that bull number 20 had the highest percent calves born (59.1 ± 8 .50) and calves weaned (53.0 ± 8.53) as against bull number 34 having the lowest percent calves born (31.0 ± 8.50) and calves weaned (28.8 ± 8.52).

Year effect was highly significant on both percent calves born and calves weaned ($P<.01$) and on percent calves survived ($P<.05$). Yearly variation in rainfall and in the management of pastures and the breeding herd may account for the large portion of the year's effect on calf crop.

A total of 244 male and 184 female calves were used to evaluate the factors affecting birth weights. Sex of calf did not significantly affect birth weight, although the male was heavier than the female by an average of 0.2 $\pm$ .37 pounds. Season did not significantly influence birth weight. However, fall season bred calves were slightly heavier by an average of 0.7 $\pm$ .87 pounds over summer bred calves. This slight difference may be attributed to the better pasture nutrition of fall bred cows during the last one-third to one-half of their gestation period. Sire did not significantly affect birth weight. Year effect on birth weight was highly significant ($P<.01$). Yearly variation in pasture conditions or variations in the nutrition and management of the breeding and pregnant cows may account for the large portion of year effect on birth weight.

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APPENDIX

TABLE X

NORMAL CALVING TREND OF CMU BEEF CATTLE HERD

Month	Year 1970	1971	1972	1973	1974	1975	1976	Ave. (%)
(Total Calves)	161	196	155	272	331	161	155	
	In Percent							
Jan.	2.48	16.84	0.00	15.81	5.74	1.86	0.65	6.20
Feb.	7.45	9.18	20.00	23.90	6.95	21.12	13.55	14.59
Mar.	9.32	18.88	3.87	13.24	12.69	23.60	27.74	15.62
Apr.	14.91	7.65	10.32	7.35	22.36	6.83	10.32	11.39
May	9.32	13.78	7.74	0.00	13.29	5.59	1.94	7.38
June	5.59	9.69	9.68	1.10	8.16	13.04	3.23	7.21
July	0.00	5.10	11.61	4.04	6.65	3.11	14.84	6.48
Aug.	3.73	2.55	10.32	14.71	13.29	8.70	8.39	8.82
Sept.	10.56	3.06	12.26	6.62	8.16	1.86	5.81	6.90
Oct.	6.21	1.02	9.68	10.66	2.11	5.59	5.81	5.87
Nov.	9.94	0.00	1.94	1.84	0.00	1.86	5.81	3.06
Dec.	16.15	12.24	2.58	0.74	0.60	6.83	1.94	5.87

TABLE XI

MONTHLY RAINFALL AT CMU FROM 1970 TO 1976

Month	Year							Average By Month
	1970	1971	1972	1973	1974	1975	1976	
	Rainfall in Inches							
Jan.	2.94	3.89	1.58	0.07	5.22	5.08	6.76	3.65
Feb.	3.79	6.69	7.36	0.15	8.08	4.91	1.27	4.61
March	1.70	2.32	6.27	0.12	0.74	9.47	1.08	3.10
April	0.33	7.67	7.29	2.60	6.99	4.98	3.19	4.72
May	5.90	10.16	11.45	7.44	6.18	10.16	2.14	7.63
June	17.73	15.41	16.97	14.06	15.07	20.05	11.56	11.84
July	8.94	9.86	4.39	16.68	11.05	11.27	11.45	10.52
Aug.	17.83	17.40	9.57	9.32	6.28	4.71	12.59	11.10
Sept.	6.49	18.41	5.36	13.69	10.30	11.70	12.99	11.28
Oct.	10.74	9.74	11.41	9.90	16.15	19.19	6.20	11.90
Nov.	6.33	13.36	3.12	8.68	2.34	2.30	3.62	5.68
Dec.	5.62	7.01	5.10	3.71	8.05	4.82	5.72	5.72

TABLE XII

NUMBER OF RAINY DAYS PER MONTH AT CMU
FROM 1970 TO 1976

	Year							Average Per Month
Month	1970	1971	1972	1973	1974	1975	1976	
Jan.	9	12	10	3	10	15	12	10.14
Feb.	13	15	15	3	14	11	4	10.71
March	8	10	17	1	9	10	2	8.14
April	6	14	8	10	17	13	7	10.71
May	17	25	23	19	10	19	11	17.71
June	25	25	24	23	21	25	21	23.43
July	21	22	14	18	22	23	24	20.47
Aug.	24	25	23	18	18	17	27	21.71
Sept.	14	26	20	23	19	23	20	20.71
Oct.	26	27	20	14	26	26	18	22.43
Nov.	21	24	12	22	14	15	17	17.86
Dec.	23	18	10	11	25	8	16	15.86

TABLE XIII

AVERAGE MONTHLY TEMPERATURE AT CMU
FROM 1970 TO 1976

Month	Year 1970	1971	1972	1973	1974	1975	1976	Monthly Mean
	Temperature in F							
Jan.	78.9	77.6	76.5	79.3	77.2	77.4	77.8	77.8
Feb.	79.5	78.7	76.7	79.7	77.8	77.4	79.7	78.5
March	80.7	79.5	77.3	80.4	79.8	73.0	83.6	79.2
April	82.8	80.2	79.4	80.3	79.4	81.1	80.5	80.5
May	82.6	79.0	77.6	81.2	81.0	78.2	78.0	79.6
June	80.6	78.5	77.0	79.3	71.6	80.5	78.9	78.1
July	79.2	77.0	76.2	77.1	77.3	72.4	78.8	76.9
Aug.	79.4	77.2	76.2	79.2	79.1	78.9	79.2	78.5
Sept.	80.1	78.1	76.4	71.7	90.1	80.2	76.7	79.0
Oct.	79.6	76.0	78.1	79.4	78.7	80.2	76.7	78.4
Nov.	79.4	77.8	78.3	79.1	79.3	79.4	77.0	78.6
Dec.	77.8	76.8	77.4	79.8	79.7	78.5	77.9	78.3

TABLE XIV

AVERAGE RELATIVE HUMIDITY AT CMU FROM 1970 TO 1976

Month	1970	1971	1972	1973	1974	1975	1976	Monthly Mean
	Relative Humidity in %							
Jan.	67.6	92.4	76.7	67.7	83.9	73.2	75.9	76.76
Feb.	71.4	74.3	72.1	66.1	84.8	71.1	73.4	73.31
March	65.2	69.4	72.6	64.0	77.9	67.9	67.9	69.27
April	56.2	66.3	64.1	68.8	80.3	72.3	69.8	68.26
May	62.7	74.7	74.4	69.4	81.5	78.6	77.1	74.06
June	74.9	78.7	79.8	79.6	82.0	86.7	80.1	80.26
July	75.4	80.8	78.7	81.4	78.4	83.3	83.2	80.17
Aug.	75.7	78.5	80.4	79.8	74.6	82.3	84.2	79.36
Sept.	67.5	74.7	79.0	84.3	73.1	81.9	82.2	77.53
Oct.	74.3	83.7	76.2	87.1	82.4	79.3	73.7	79.53
Nov.	74.5	79.2	74.8	85.1	76.6	75.2	74.1	77.07
Dec.	76.4	78.8	76.1	82.9	77.9	78.5	78.1	78.39

VITA

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