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The effects of season on reproduction in beef cows — a review

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ABSTRACT

Season has important effects on reproduction in cows, although they may ovulate throughout the year. During winter, the effects of season delay puberty, prolong post-partum anoestrus and reduce fertility. There are seasonal differences in gonadotrophin secretion, pre-ovulatory follicular development and corpus luteum function.

Furthermore, effects of season are more likely to be expressed when factors such as nutrition, age and lactation limit reproductive performance. Significant interactions occur between season and nutrition in the onset of puberty and the length of the post-partum anoestrous interval. In the pasture-based agricultural system in New Zealand, minimum feed supply occurs in winter when season depresses cow reproductive performance.

A concentrated calving pattern is essential to improve feeding management and herd performance. To maintain a concentrated calving and high weaning percentage, calving date must be adjusted to reduce the effects of season and improve herd nutrition.

Keywords Cows; season; reproduction; puberty; post-partum anoestrus; ovarian activity; fertility; management.

INTRODUCTION

Female cattle of European origin (*Bos taurus*) do not have a defined breeding season in temperate latitudes and may ovulate throughout the year. Nevertheless, wild cattle such as those at Chillingham Park, Northumberland have a seasonal pattern of calving and there are many reports in the literature of effects of season on the fertility of cattle (for a review see Salisbury *et al.*, 1978). Season influences puberty, cyclic ovarian function and post-partum anoestrus in cattle and some of those effects of season have been reviewed recently (Hauser, 1984; Randel, 1984).

It is clear that season interacts with other factors and in particular nutrition. In pasture-based agricultural systems, poor nutrition in winter often coincides with lowered reproductive performance in cattle. The objects of this review are to summarise the effects of season on reproduction and discuss the implications for the management of beef cattle herds in New Zealand.

PUBERTY

Puberty in young females is taken as the initiation of regular oestrous cycles and is the final step in the process of maturation of the reproductive system. It can be markedly influenced by a number of different factors including breed (see for example Grass *et al.*, 1982). Within a breed, different planes of nutrition can result in heifers reaching puberty from 9 to 20 months of age. Despite the range in age, within a breed heifers attain puberty at similar live weights suggesting that live weight (body size) is the more

important factor (Salisbury *et al.*, 1978).

Season has an important effect on age at puberty and interacts with nutrition. Heifers born in the spring can reach puberty about 2 months younger than heifers born in other seasons (Hawk *et al.*, 1954; Menge *et al.*, 1962; Roy *et al.*, 1980). In 2 experiments designed to study effects of breed and energy intake on puberty (Grass *et al.*, 1982) the influence of season and interactions between season and nutrition were observed. In the first experiment there was a significant interaction between season of birth and nutrition with well-fed heifers born in spring reaching puberty at a younger age than well-fed heifers born in winter (345 and 394 days respectively) in agreement with data of Hawk *et al.* (1954).

The second experiment was conducted with crossbred heifers born in the autumn to Holstein cows mated to 4 sire breeds (Hereford, Angus, Chianina and Simmental) and fed 2 planes of nutrition from 168 days of age. Most high plane heifers reached puberty the following summer at about 300 days of age (Fig. 1). Winter conditions (Northern hemisphere) delayed the onset of puberty of low plane heifers until the following spring. The interaction between season, sire breed and nutrition resulted in a non-normal distribution of ages and dates at puberty.

In a study designed to separate effects of season of birth and season of subsequent development, heifers born at the spring equinox or the subsequent autumn equinox were reared in environmental

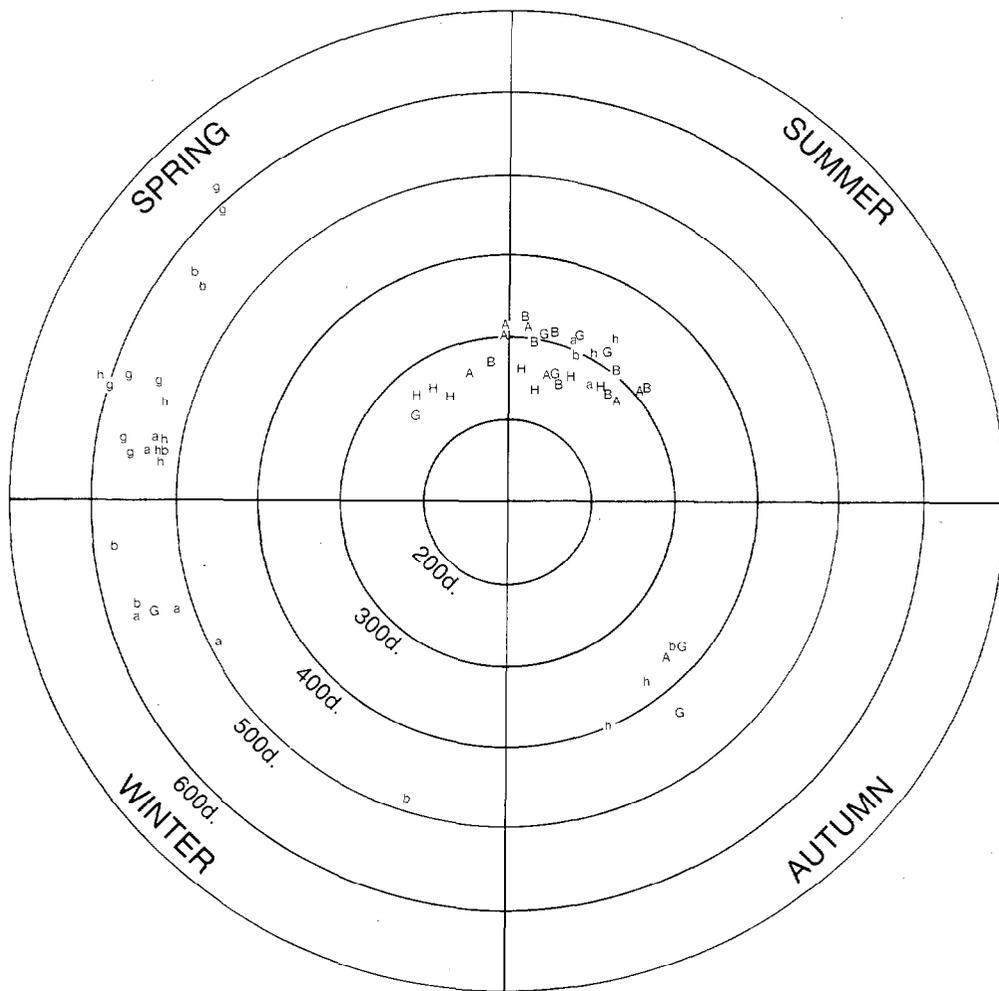


FIG. 1 Circular distribution of dates of puberty. Distance from the centre to the symbol represents age at puberty and the angle represents the date. Capital letters represent animals fed H diets and lower case letters represent animals fed L diets. Breed symbols are A and a (Angus), B and b (Simmental), G and g (Chianina) and H and h (Herefords) (from Grass *et al.*, 1982 with the permission of the American Society of Animal Science).

chambers from 6 months of age (Schillo *et al.*, 1983). During 6 months in the environmental chamber both groups were exposed to changes in daylength and temperature representative of changes from spring to autumn or from autumn to spring. Under these conditions heifers born in the autumn reached puberty before heifers born in spring. Exposure to spring-autumn environmental changes from 6 to 12 months of age advanced the onset of puberty at both seasons of birth.

POST-PARTUM ANOESTRUS

Long post-partum anoestrous intervals are characteristic of New Zealand beef herds with poor reproductive performance. Season (calving date) combined with the effects of nutrition contributes substantially to variation in the post-partum anoestrous interval. In both dairy cows and beef cows, intervals to first ovulation or first oestrus are longer in spring-calving compared with autumn-

calving cows (Bulman and Lamming, 1978; Montgomery *et al.*, 1980; Peters and Riley, 1982; King and Macleod, 1984). In a herd calving throughout the year post-partum anoestrous intervals were shortest during summer and longest during winter (Thibault *et al.*, 1966).

As part of the seasonal change, post-partum anoestrous intervals are shorter for cows calving in early summer than for cows calving in late winter in a herd grazed on pasture (Morris *et al.*, 1978; Knight and Nicoll, 1978; Montgomery *et al.*, 1980). The decrease in interval to oestrus with later calving varies between years (range in regression -0.3 to -0.8 d/d, Knight and Nicoll, 1978; Montgomery *et al.*, 1980) and is more important for 2-year-old cows than for mature cows (regression -0.7 and -0.4 d/d respectively, Knight and Nicoll, 1978).

In spring daylight hours are increasing, temperatures are rising and with increased grass growth, the amount of feed available to the herd is also increasing. Nutrition influences the length of the post-partum anoestrous interval (for review see Peters, 1984) and the effects of nutrition and other seasonal factors on the post-partum anoestrous interval were studied in Angus cows calving for the first time at 3 years of age (Montgomery *et al.*, 1984). Cows calved early (August-September) or late (September-October) and were fed a high or medium plane of nutrition around calving. There was an effect of season (time of calving) since despite a controlled high level of feeding both before and after calving, early calving cows took longer to return to oestrus than late calving cows (Table 1). Furthermore, there was an interaction between calving date and nutrition. Level of nutrition had a much greater effect on the post-partum anoestrous interval in early compared with late calving cows.

TABLE 1 The effect of calving time and nutrition on the length of the post-partum anoestrous interval (d) in 3-year-old Angus cows (Montgomery *et al.*, 1984).

Nutrition	Calving time	
	Early 21 July-15 Sept	Late 9 Sept-30 Oct
High plane	67	57
Low plane	83	62

SED of treatment differences = 2.35

A similar interaction between season and nutrition has been reported in 2-year-old cows (Nicoll *et al.*, 1984) and the effects of season on post-partum anoestrus also interact with other environmental factors (Hansen and Hauser, 1983). Differences in post-partum anoestrous interval between suckled and non-suckled cows and high and low milk-producing cows, were greater during winter than summer.

From observations on the effects of housing in winter, it has been proposed that photoperiod influences the return of ovarian cycles after calving (Terqui *et al.*, 1982) and the provision of supplemental light to cows calving in winter reduced the post-partum anoestrous interval in 2 out of 3 experiments (Hansen and Hauser, 1984).

CYCLIC OVARIAN ACTIVITY AND FERTILITY

Following puberty, heifers that are not mated may cycle throughout the year. Effects of season do not become apparent unless other factors limit reproduction. For example in heifers fed a low plane of nutrition oestrous activity ceased during winter (Joubert, 1954).

In an autumn calving herd at Invermay the lactating cows were not mated, but continued to run with vasectomised bulls during winter. The cows commenced regular oestrous cycles after calving, but in the following winter all cows stopped cycling for a period during June and July (Fig. 2, G.W. Montgomery, unpublished observations). In these 2 studies, seasonal changes in daylight hours, temperature and seasonal feed supply are confounded. There are no data available to indicate whether interactions between season and nutrition occur in oestrous cycle activity as described for both puberty and post-partum anoestrus.

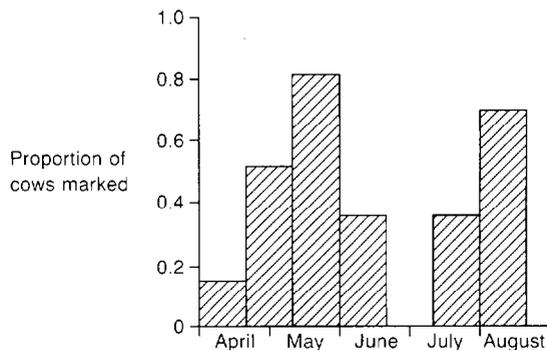


FIG. 2 The proportion of cows cycling in successive 21-day periods following calving in autumn.

The conception rate of cows varies with season. In areas outside the tropics where seasonal changes in daylight hours are greater and temperatures lower, fertility is lowest in winter (Salisbury *et al.*, 1978; de Kruif and Brand, 1978). In commercial dairy herds in Tasmania the non-return to service rate was significantly lower in autumn calving herds compared with spring calving herds (55 and 72% respectively, W.J. Fulkerson, personal communication). Submission rates were also lower in the autumn calving herds.

McNatty *et al.*, 1984 observed seasonal differences in ovarian function in cows. The mean diameters of large healthy follicles (≥ 8 mm in diameter) and the dominant oestrogen secreting follicles were significantly larger in May-June than in October. In addition, corpora lutea were heavier in May-June than in October. The decreased size of follicles and corpora lutea in October was associated with higher luteinizing hormone (LH) pulse frequency. It is possible that a higher level of oestrogen biosynthesis is initiated in healthy follicles of smaller diameter in October since ranges in follicular oestradiol concentrations were similar in dominant follicles in both seasons. In winter, the pre-ovulatory LH surge was advanced relative to the onset of oestrus (Harrison *et al.*, 1982). However, there were no effects of photoperiod on the size and duration of the LH peak in heifers (Rzepkowski *et al.*, 1982).

In contrast to the above studies mean LH concentrations in ovariectomised cattle were highest during the winter months and lowest during the summer months (Critser *et al.*, 1983). Moreover, LH concentrations were higher when ovariectomised cows were given oestradiol compared with untreated ovariectomised cows. Both oestradiol (Acosta *et al.*, 1983) and progesterone (Roche *et al.*, 1981) are involved in the feedback regulation of gonadotrophin release in cattle and seasonal variation in the effects of progesterone on oestrous cycles in heifers has been reported (Lamond, 1965).

Taken together, the data suggest that season influences events during the follicular phase of the oestrous cycle and the timing of oestrus and the LH/FSH peak. Lower LH pulse frequency and altered timing of oestrus and the LH/FSH peak may be related to the reduced fertility observed in winter.

MANAGEMENT IMPLICATIONS

Reproductive performance of the New Zealand beef herd is poor with 20 to 25% of cows failing to rear calves each year (Montgomery, 1978). Furthermore, many herds begin calving in late winter and have a long spread of calving. For example, Morris (1984) analysed data from Beefplan records and observed that only 27% of Angus herds and 15% of Hereford herds had calving spreads of 80 days or less. The mean calving dates were 20 August for Angus herds and 29 August for Hereford herds. A survey of 16 beef producers in South Otago in 1977, showed that bulls were left with the herd for periods ranging from 9 to 21 weeks and half the herds began calving before mid August (A.R. Bray and G.W. Montgomery, unpublished observations).

In the last 10 years, improved beef cow productivity has been achieved through concentrated calving (Hanly and Mossman, 1977; McPhail and Mossman, 1981; Mossman, 1984; Wilson, 1984). The

objective is to have more than 80% of the herd calving in the first 42 days of the calving period so that management of the herd can be improved. The feeding management of the herd can be planned to ensure that cows are adequately fed without underfeeding or overfeeding other groups within the herd. It is easier to plan adequate feed on safe calving paddocks to ensure a high calf survival. A combination of concentrated calving and better feeding will result in a more even line of weaner calves with a higher average weaning weight. For example, it has been estimated from case histories that the application of the management required to achieve a concentrated calving with a high weaning percentage resulted in a 40% increase in total calf weaning weight and 58% increase in weaner income per cow (Wilson, 1984).

Concentrated calving can only be achieved when cows are cycling regularly at the start of mating and high conception rates are achieved. The effects of season on reproduction in temperate latitudes show that potential reproductive performance is lowest in the winter and highest in summer. Furthermore, seasonal effects are greater under conditions of poor nutrition. In the pasture based farming system in New Zealand, minimum feed supply in winter occurs at the time of lowest potential reproductive performance. Therefore, the seasonal change in feed supply and reproductive performance combine to delay puberty, reduce fertility and prolong post-partum anoestrus in late winter and early spring.

The exact timing of calving, the spread of calving and herd management will all influence the amount of feed which will be available to meet the cow requirements for pregnancy and lactation. Furthermore, cutting trials suggest that a greater frequency of defoliation decreases total pasture production (Boswell, 1977). Consequently if the herd begins calving too early, the high requirements of lactating cows may lead to severe grazing pressure, reduced pasture growth and prolonged period of underfeeding for the herd. The combined effects of season and nutrition on reproduction suggest that calving should begin later than it does in many herds. Herds calving in late winter have long post-partum anoestrous intervals and it is not possible to maintain concentrated calving combined with high weaning percentages.

Because of the longer post-partum anoestrous intervals in 2-year-old cows (Tervit *et al.*, 1977; Knight and Nicoll, 1978) it has been suggested that heifers should be mated earlier than the main herd to allow them a longer time to become pregnant in the subsequent year (McPhail and Mossman, 1981; Mossman, 1984; Wilson, 1984). However, the combined effects of season and nutrition also affect reproduction in heifers. This is most important in heifers approaching puberty since not all 15 month

heifers are cycling at joining even when fed high planes of nutrition during winter (Smeaton and Winn, 1981). In addition, the pattern of calving in 3-year-old primiparous Angus cows differed markedly following joining in either October-November or December-January (Fig. 3, G.W. Montgomery unpublished observations). The differences in the calving pattern were at least partly due to a significantly higher conception rate to first service in the late mated heifers (0.87 v 0.66 sed = 0.062). An early mating policy, particularly for cows calving at 2 years of age, will result in less pregnant heifers at the end of joining unless there are substantial improvements in the nutrition of heifers at mating. Other management advantages, such as preferential treatment for heifers at calving and compensation for lighter calf weights, must be balanced against an increase in "dry" heifers at the end of the recommended restricted joining period of 45 days.

A concentrated calving with appropriate adjustment of calving date to reduce the effects of season and improve herd nutrition can result in substantial improvements in beef production.

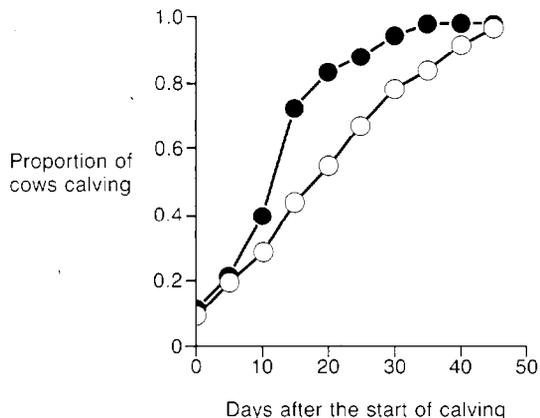


FIG. 3 The pattern of calving for Angus heifers mated from 23 October to 8 December (O - - - O Early group) and 8 December to 22 January (● - - - ● Late group).

REFERENCES

Acosta B.; Tarnavski G.K.; Platt T.E.; Hamernik D.L.; Brown J.L.; Schoenemann H.M.; Reeves J.J. 1983. Nursing enhances the negative effect of estrogen on LH release in the cow. *Journal of animal science* 57: 1530-1536.

Boswell C.C. 1977. Effects of cutting regime on pasture production. *New Zealand journal of experimental agriculture* 5: 403-408.

Bulman D.C.; Lamming G.E. 1978. Milk progesterone levels in relation to conception, repeat breeding and

factors influencing acyclicity in dairy cows. *Journal of reproduction and fertility* 54: 447-458.

Critser J.K.; Miller K.F.; Gunsett F.C.; Ginther O.J. 1983. Seasonal LH profile in ovariectomized cattle. *Theriogenology* 19: 181-191.

de Kruif A.; Brand A. 1978. Factors influencing the reproductive capacity of a dairy herd. *New Zealand veterinary journal* 26: 178-189.

Grass J.A.; Hansen P. J.; Rutledge J.J.; Hauser E.R. 1982. Genotype x environmental interactions on reproductive traits of bovine females. I. Age at puberty as influenced by breed, breed of sire, dietary regimen and season. *Journal of animal science* 55: 1441-1457.

Hanly G.J.; Mossman D.H. 1977. Commercial beef production on hill country. *New Zealand veterinary journal* 25: 3-7.

Hansen P.J.; Hauser E.R. 1983. Genotype x environmental interactions on reproductive traits of bovine females. III. Seasonal variation in post-partum reproduction as influenced by genotype, suckling and dietary regimen. *Journal of animal science* 56: 1362-1369.

Hansen P.J.; Hauser E.R. 1984. Photoperiodic alteration of post-partum reproductive function in suckled cows. *Theriogenology* 22: 1-14.

Harrison L.M.; Hansen T.R.; Randel R.D. 1982. Evidence for seasonal and nutritional modification of ovarian and pituitary function in crossbred heifers and Brahman cows. *Journal of animal science* 55: 649-656.

Hauser E.R. 1984. Seasonal effects on female reproduction in the bovine (*Bos taurus*) (European breeds). *Theriogenology* 21: 150-169.

Hawk H.W.; Tyler W.J.; Casida L.E. 1954. Some factors affecting age at puberty in Holstein-Friesian heifers. *Journal of dairy science* 37: 252-258.

Joubert D.M. 1954. The influence of high and low nutritional planes on the oestrous cycle and conception rate of heifers. *Journal of agricultural science, Cambridge* 45: 164-172.

King G.J.; Macleod G.K. 1984. Reproductive function in beef cows calving in the spring or fall. *Animal reproduction science* 6: 255-266.

King G.J.; Hurnick J.F. 1980. Proceedings of the 9th International Congress Reproduction and Artificial Insemination 3: pp.39.

Knight T.W.; Nicoll G.B. 1978. Factors influencing the interval from calving to first oestrus in beef cattle on North Island hill country. *Proceedings of the New Zealand Society of Animal Production* 38: 175-180.

Lamond D.R. 1965. Seasonal variation in the effect of progesterone on oestrous cycles in beef heifers. *Journal of reproduction and fertility* 9: 41-46.

McNatty K.P.; Hudson N.; Gibb M.; Henderson K.M.; Lun S.; Heath D.; Montgomery G.W. 1984. Seasonal differences in ovarian activity in cows. *Journal of endocrinology* 102: 189-198.

McPhail C.R.; Mossman D.H. 1981. Concentrated calving on hill country. *New Zealand farmer* 102: 155-158.

Menge A.C.; Mares S.E.; Tyler W.J.; Casida L.E. 1962. Variation and association among post-partum and production characteristics in Holstein-Friesian cattle. *Journal of dairy science* 45: 233-241.

Montgomery G.W. 1978. Perinatal mortality and deaths to weaning in beef cattle. Proceedings of 8th Seminar of the Sheep and Beef Society, New Zealand Veterinary Association 31-36.

- Montgomery G.W.; Davis G.H.; Hurrell G.A. 1980. Interval from calving to first oestrus in autumn- and spring-calving herds in the same locality. *Proceedings of the New Zealand Society of Animal Production* **40**: 280-284.
- Montgomery G.W.; Scott I.C.; Hudson N. 1984. An interaction between season of calving and nutrition on the resumption of ovarian cycles in post-partum beef cattle. *Journal of reproduction and fertility* **73**: 45-50.
- Morris C.A. 1984. Calving dates and subsequent inter-calving intervals in New Zealand beef herds. *Animal production* **39**: 51-57.
- Morris S.T.; Pleasants A.B.; Barton R.A. 1978. Post-partum oestrous interval of single-suckled Angus beef cows. *New Zealand journal of agricultural research* **21**: 577-582.
- Mossman D.H. 1984. Management of beef cows for optimum reproduction. In *Beef cattle reproduction*. Ed. G.K. Barrell, Lincoln College, Canterbury, New Zealand. pp 71-81.
- Nicoll G.B.; Smeaton D.C.; McGuire K.R. 1984. Effect of herbage allowance on the performance of pregnant beef heifers. *Proceedings of the New Zealand Society of Animal Production* **44**: 173-175.
- Peters A.R. 1984. Reproductive activity of the cow in the post-partum period. I. Factors affecting the length of the post-partum acyclic period. *British veterinary journal* **140**: 76-84.
- Peters A.R.; Riley G.M. 1982. Milk progesterone profiles and factors affecting post-partum ovarian activity in beef cows. *Animal production* **34**: 145-153.
- Randel R.D. 1984. Seasonal effects on female reproductive functions in the bovine (Indian breeds). *Theriogenology* **21**: 170-185.
- Roche J.F.; Ireland J.; Mawhinney S. 1981. Control and induction of ovulation in cattle. *Journal of reproduction and fertility* Supplement **30**: 211-222.
- Roy J.H.B.; Gillies C.M.; Perfit M.W.; Stobo I.J.F. 1980. Effect of season of the year and phase of the moon on puberty and on the occurrence of oestrus and conception in dairy heifers reared on high planes of nutrition. *Animal production* **31**: 13-26.
- Rzepakowski R.A.; Ireland J.J.; Fogwell R.L.; Chapin L.T.; Tucker H.A. 1982. Serum luteinizing hormone, follicle stimulating hormone and prolactin response to photoperiod during the estrous cycle of Holstein heifers. *Journal of animal science* **55**: 1125-1131.
- Salisbury G.W.; VanDenmark N.L.; Lodge J.R. 1978. *Physiology of reproduction and artificial insemination of cattle*. Second Edition, W.H. Freeman and Co. San Francisco.
- Schillo K.K.; Hansen P.J.; Kamwanja L.A.; Dierschke D.J.; Hauser E.R. 1983. Influence of season on sexual development in heifers: Age at puberty as related to growth and serum concentrations of gonadotropins, prolactin, thyroxin and progesterone. *Biology of reproduction* **28**: 329-341.
- Smeaton D.C.; Winn G.W. 1981. Nutrition of weaner beef heifers; growth, puberty and yearling mating on hill country. *Proceedings of the New Zealand Society of Animal Production* **41**: 267-272.
- Terqui M.; Chupin D.; Gauthier D.; Perez N.; Pelot J.; Mauleon P. 1982. Influence of management and nutrition on post-partum endocrine function and ovarian activity in cows. In *Factors influencing fertility in the post-partum cow*. Eds H. Karg and E. Schallenberger, Martinus Nijhoff, The Hague, Netherlands. pp. 384-408.
- Tervit H.R.; Smith J.F.; Kaltenback C.C. 1977. Post-partum anoestrus in beef cattle: A review. *Proceedings of the New Zealand Society of Animal Production* **37**: 109-119.
- Thibault C.; Courot M.; Martinet L.; Mauleon P.; du Mesnil du Buisson F.; Ortavant R.; Pelletier J.; Signoret J.P. 1966. Regulation of breeding season and estrous cycles by light and external stimuli in some mammals. *Journal of animal science supplement* **25**: 119-142.
- Wilson B. 1984. Breeding cow efficiency: Quiet revolution in Wairoa. *New Zealand farmer* **105**: 83-86.