SHORTENING THE INTERVAL TO THE RESUMPTION OF OVARIAN CYCLES IN POSTPARTUM BEEF COWS

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The work summarised in this report was carried out at Belclare and Athenry Research Centres as part of the Teagasc Beef Research Programme

Teagasc acknowledges support from the European Union 3rd Framework Programme (Contract AIR3-CT94-1124).

Project No. 4010
Beef Production Series No. 25

Teagasc,
19 Sandymount Avenue,
Ballsbridge,
Dublin 4.
February 2001.

ISBN No. 1 84170 154 8

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Acknowledgements

The authors acknowledge the skilled technical assistance of P. Joyce, W. Connolly, G. Morris, J. Nally, Ms. A. Glynn, Ms N. Hynes (UCD) and also P. Reilly, P. Creavan, G. Burke and G. McHugh for care of the animals.

1. SUMMARY

- In beef cows the interval from calving to first ovulation, or postpartum interval, is affected by nutrition and by the suckling effect of the calf.

- The suckling effect is the biggest determinant of this interval, comprising: (i) physical contact and (ii) maternal bonding between cow and calf. Restricted suckling and calf isolation induce a rapid resumption of oestrous cycles.

- Prepartum nutrition is the next most important determinant of the postpartum interval. Cows that calve in poor body condition have a longer interval than cows that calve in good body condition.

- Increasing the level of nutrition in the postpartum period has only a limited effect in shortening the postpartum interval.

- In most cows the first postpartum ovulation is silent and is succeeded by a short oestrous cycle of approximately 8-10 days. The first observed oestrus occurs prior to the second ovulation.

- When used in combination with calf isolation and restricted suckling, progesterone pre-treatment for 6 days induces oestrus in the majority of cows and eliminates the short oestrous cycle.

- The prolonged postpartum interval in beef cows is not due to failure of ovarian follicle development but to failure of successive dominant follicles to ovulate due to the inadequate frequency of LH pulses.

2. INTRODUCTION

Reproductive efficiency of beef cows is a key component determining herd productivity. Optimal efficiency occurs when the average inter-calving interval is 365 days and to achieve this cows must conceive within 85 days of calving. One of the major causes of poor reproductive efficiency in beef cows is an extended interval from calving to first ovulation, or postpartum interval. This interval is considerably longer in beef than in dairy cows and is influenced by several factors including pre- and postpartum nutrition, suckling frequency, age of cow, season and the presence of a bull. Of these nutrition and suckling are major factors that influence luteinising hormone (LH) pulse frequency and hence the interval to the resumption of ovarian cycles.

Previous work established that ovarian follicle development resumes early in the postpartum period of beef cows that calve in good body condition. Dairy cows generally ovulate the first or second postpartum dominant follicle, but the early postpartum period of beef cows is characterised by the growth and regression of several dominant follicles, resulting in a longer postpartum interval. This interval is longer in beef cows that calve in poor body condition. Little is known however of the ovarian follicle dynamics in beef cows that calve in poor body condition.

The objective of this project was to determine the effects of both nutrition and suckling on the postpartum interval of beef cows calving in poor body condition. A series of studies were conducted to determine the relative effects of pre- and postpartum nutrition and various suckling regimes on the interval from calving to first ovulation.

3. NUTRITION

a) Prepartum nutrition

The effects of body condition score at calving on the subsequent postpartum interval and on the calving to conception interval were examined in sixty spring-calving beef cows. During the last 100 days before calving cows were differentially fed to calve in a body condition score of either 1.75, 2.5 or 3.5. The mean interval from calving to first ovulation was shorter ($P<0.05$) in cows that calved in a body condition score of 3.5 than those calving in body condition scores of 1.75 or 2.5 (Table 1).

Table 1: Effect of body condition score at calving on postpartum interval and calving to conception interval (days).

	Body condition score at calving		
	1.75	**2.50**	**3.50**
Postpartum interval	58^a	56^a	49^b
Calving to conception interval	81^a	76^a	68^b

Within row, treatments with different superscripts are significantly different ($P<0.05$).

b) Postpartum nutrition

The effect of postpartum feeding level on the postpartum interval of cows calving in poor body condition was then determined. The effects of postpartum nutrition were studied during two consecutive years. In the first year, cows calved in a mean body condition score of 2.3 and were fed a grass silage and concentrate diet providing either 80 or 120 MJ ME/cow/day from calving to first ovulation. A feeding level of 80 MJ ME/cow/day is close to the calculated recommendation for a 460 kg beef cow producing 8 kg milk and experiencing no change in liveweight after calving. The postpartum interval of cows fed either 80 or 120 MJ/ME/day was similar (Table 2a). In the subsequent year the effects of high-energy supplementation on the postpartum interval were determined. Cows which calved in a mean body condition score of 2.7 were fed a grass silage and concentrate diet providing 100 MJ ME/cow/day for the first 30 days. After this time cows continued to be fed 100 MJ ME/cow/day or were supplemented with 5 kg molasses which increased their daily energy intake to 150 MJ ME/cow/day.

Supplementation with molasses from 30 days postpartum brought about a slight and non-significant decrease in duration of the postpartum interval (Table 2b). The level of postpartum nutrition clearly has negligible effects in shortening the postpartum interval, even when high-energy supplements are fed.

Table 2: Effect of postpartum plane of nutrition on interval to first ovulation in a) cows fed either 80 or 120 MJ ME/d from calving until first ovulation, or b) cows fed 100 MJ ME/d for the first 30 days after calving and 100 or 150 MJ ME/d from then until the second postpartum ovulation.

	Ovulation	
	First	**Second**
a) 80 MJ ME/d	81	-
120 MJ ME/d	78	-
b) 100 MJ ME/d	63	71
150 MJ ME/d	55	67

Within each study, treatment had no effect on interval to first ovulation.

4. SUCKLING

a) Suckling frequency

The effect of suckling frequency was determined in sixty spring calving beef cows. After calving, cows were turned out to pasture and calves had full access to their dams up until day 35 postpartum, at which time they were allocated to one of three suckling treatments, viz., 1) ad lib suckling, where calves continued to have full access to cows, 2) twice daily suckling, where suckling was restricted to twice-a-day, or 3) once daily suckling, where suckling was restricted to once-a-day. Where suckling was restricted, calves were enclosed in a separate paddock at least one paddock away from their dams. These treatments continued until cows had experienced their second postpartum ovulation.

In beef cows maternal-offspring bonding is the main factor delaying onset of post-partum oestrus

When suckling was restricted to either once or twice daily there was a significant decrease in the length of the postpartum interval compared to cows suckled ad lib (Table 3). Suckling restriction had no detrimental effect on calf performance (Table 3).

Table 3: Effect of suckling frequency from 35 days postcalving on postpartum interval and calving to conception interval (days).

	Suckling frequency		
	Ad lib	**Twice daily**	**Once daily**
Postpartum interval	66^{a}	50^{b}	47^{b}
Calving to conception interval	84^{a}	74^{b}	67^{b}
Calf growth rate (kg/d)	1.11^{a}	1.09^{a}	1.06^{a}

Within row, treatments with different superscripts are significantly different ($P<0.05$).

b) Suckling and the maternal-calf bond

Having established that suckling restriction decreased the interval to the resumption of ovulation, the next aim was to determine whether this was due to the limitation of suckling, breaking of the maternal-calf bond, or both.

In order to partition the effects of suckling and the maternal-calf bond, 103 beef cows were allocated to one of three treatments at 30 days postpartum, viz., 1) ad lib suckling, where calves continued to have full access to cows, 2) restricted adjacent, where suckling was restricted to once-a-day and calves were housed in an adjacent pen, or 3) restricted isolated, where suckling was restricted to once-a-day and cows were isolated in a separate building well away from both their calves and other cows and calves. While out of sight, cows were still within the audio range of their own and other calves.

The average postpartum interval to first ovulation was 79, 62 and 51 days for cows on the ad lib, restricted adjacent and restricted isolated treatments, respectively. Calf isolation and restricted suckling (restricted isolated) led to a more rapid induction of ovulation than restricted suckling without calf isolation (restricted adjacent), which in turn was more rapid than cows suckled ad lib. Thus, at any given time in the postpartum period, a greater proportion of cows on the restricted isolated treatment resumed ovulation (see Figure 1).

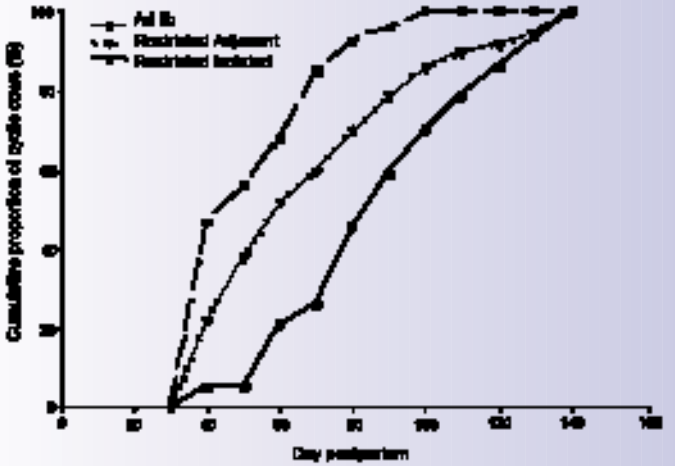

Figure 1: Cumulative percentage of beef cows that had resumed ovulation during the postpartum period following continuous access to calves (ad lib), once daily suckling with calves in an adjacent pen (restricted adjacent) or once daily suckling with calves isolated (restricted isolated) from 30 days postpartum.

5. NUTRITION AND SUCKLING INTERACTION

The interactive effects of nutrition and suckling on the postpartum interval of beef cows were also determined. The first two studies determined the relationship between postpartum nutrition and suckling frequency (Table 4). The third study determined the relationship between body condition at calving, postpartum nutrition and suckling frequency. The suckling effect was the major factor preventing the early resumption of cyclity, followed by body condition at calving (Table 5). Increasing the level of postpartum nutrition had the least impact.

Table 4: Effect of postpartum plane of nutrition and suckling frequency on interval to first ovulation in a) cows fed either 80 or 120 MJ ME/d from calving to first ovulation, or b) cows fed 100 MJ ME/d for the first 30 days after calving and 100 or 150 MJ ME/d from then until first ovulation.

		Suckling frequency from day 30		
		Ad lib	Once daily (adjacent)	Once daily (isolated)
a)	80 MJ ME/d	81	58	52
	120 MJ ME/d	78	65	51
b)	100 MJ ME/d	63	-	41
	150 MJ ME/d	55	-	35

Table 5: Effects of body condition at calving, postpartum nutrition and suckling frequency on interval to first ovulation in beef cows.

Body condition at calving:	**Low**		**Moderate**	
Postpartum nutrition:	**Low**	**High**	**Low**	**High**
Suckling frequency:				
Ad lib	68	64	63	54
Once daily	50	47	39	36

Having beef cows in a moderate to good body condition score at calving will ensure that the post-partum interval is minimised and that a 365-day calving interval can be achieved.

6. PHYSIOLOGY OF THE POSTPARTUM PERIOD

Daily ovarian ultrasound scanning established that the postpartum anoestrous period is characterised by the sequential development and regression of successive dominant follicles that fail to ovulate (Figure 2). Hence, the problem of prolonged postpartum anoestrus in beef cows calving in poor body condition is due to failure of ovulation of successive dominant follicles, rather than to a lack of follicle development.

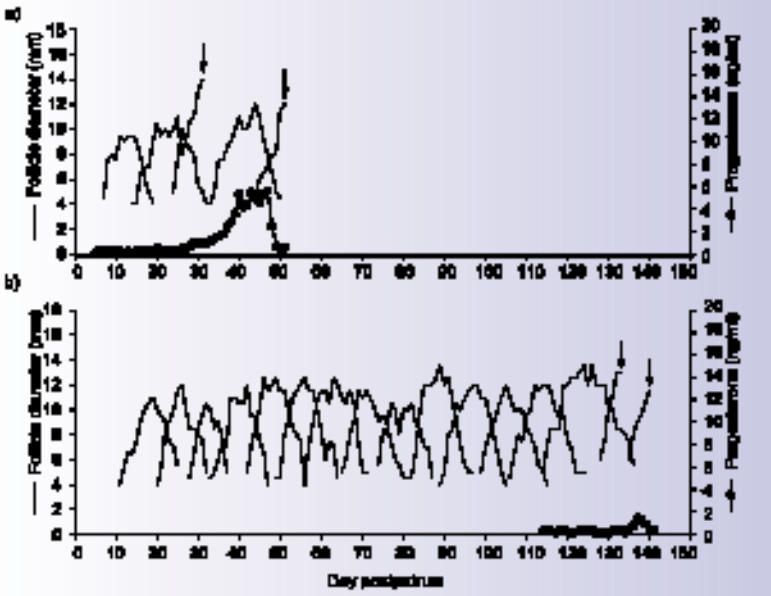

Figure 2: Pattern of growth and regression of dominant follicles from calving to second ovulation in, a) a beef cow with two anovulatory follicle waves prior to first ovulation and, b) a beef cow with 14 non-ovulatory follicle waves prior to first ovulation. Arrows indicate ovulation.

Final maturation and ovulation of a dominant follicle is dependent on regular pulses of luteinising hormone (LH) secreted from the anterior pituitary gland. During the postpartum period the mean concentration of LH and frequency of LH pulses increase linearly for up to several successive anovulatory follicle waves until eventual ovulation (Figure 3). The low frequency of LH pulse in postpartum beef cows, particularly those calving in poor body condition, is responsible for the failure of ovulation of successive dominant follicles and consequently the prolonged postpartum interval.

7. CHARACTERISTICS OF FIRST OVULATION AND FIRST OESTROUS CYCLE

The resumption of cyclicity in postpartum beef cows is characterised by the absence of oestrous activity preceding first ovulation. This is succeeded by a short oestrous cycle of approximately 7 to 10 days duration in 80 to 90% of cows, giving rise to the short interval between first and second ovulation [Table 2 and Figure 2(b)]. This project has established that the short cycle is due to premature regression of the corpus luteum formed following the first ovulation. During a normal oestrous cycle cows generally have two anovulatory follicle waves and the dominant follicle from the third wave ovulates. However, following the first postpartum ovulation, early regression of the corpus luteum occurs allowing the subsequent dominant follicle to ovulate. This causes the short cycle [Figure 2(b)]. Progesterone production by the short-lived corpus luteum is thought to prime the cow for expression of oestrous activity prior to the second ovulation.

8. INDUCTION OF SYNCHRONOUS OESTRUS FOLLOWING RESUMPTION OF CYCLICITY

As the resumption of ovulation is characterised by the absence of oestrous activity and a short cycle in beef cows, exogenous progesterone was administered to mimic the short luteal phase. Fifty-two beef cows calving in an average body condition score of 2.75 were allocated to one of four treatments at 30 days postpartum, viz., 1) ad lib suckling - ad libitum access of cows to calves, 2) CI/RS - calf isolation/restricted suckling, where suckling was restricted to once daily, 3) CI/RS+P_4 - as CI/RS but cows received a 6-day intravaginal progesterone releasing device at start of treatment, and 4) CI/RS+P_4+E_2 - as CI/RS+P_4 but the progesterone device had a 10mg oestradiol capsule attached. Calf isolation and restricted suckling was used to increase the frequency of LH pulses and advance the interval to first ovulation, while the exogenous progesterone (an intravaginal Contolled Internal Drug Releasing (CIDR) device) was administered to induce oestrus at first ovulation. In the fourth treatment, the oestradiol capsule was used to help synchronise follicle wave development.

Calf isolation and restricted suckling resulted in a rapid resumption of ovulation and caused a significant reduction in the length of the postpartum interval, irrespective of whether cows were simultaneously treated with exogenous progesterone and oestradiol exogenous progesterone and oestradiol or not (Table 6). The administration of a progesterone-releasing device for six days from the start of suckling mimicked the short lived corpus luteum which normally forms following a silent first ovulation. Calf isolation and restricted suckling provided the appropriate stimulus for resumption of cyclicity (Figure 4) and withdrawal of the progesterone device induced oestrous activity and ovulation 3 to 5 days later. The insertion of an oestradiol capsule was ineffective in synchronising follicle wave development and may have adverse effects on fertility, should cows have been inseminated at first ovulation. This is due to the oestradiol capsule causing the persistence of existing dominant follicles.

Table 6: Effect of ad lib suckling (control), calf isolation and restricted suckling (CI/RS), or CI/RS in combination with a 6-d progesterone (CI/RS+P4) or progesterone and oestradiol capsule treatment (CI/RS+P4+E2) on postpartum reproductive parameters relating to first ovulation and first oestrous cycle.

	Ad lib	CI/RS	CI/RS+P_4	CI/RS+P_4+E_2
First ovulation:				
Ovulatory response to treatment	$3/13^a$	$11/13^b$	$11/13^b$	$11/13^b$
Standing oestrus*	$0/9^a$	$0/13^a$	$\geq 5/13^b$	$\geq 5/13^b$
Mucus/tone in reproductive tract*†	$2/9^a$	$6/13^a$	$12/13^b$	$11/13^b$
PPI to first ovulation (days)	66.3^a	40.4^b	43.5^b	44.0^b
First oestrous cycle:				
No. cows with short oestrous cycle	$7/9^a$	$11/13^a$	$2/13^b$	$2/13^b$
Interovulatory interval (days)	12.0^a	11.3^a	19.4^b	18.7^b
Interovulatory interval (foll. waves)	1.3^a	1.2^a	2.3^b	2.1^b

Within row, treatments with different superscripts are significantly different ($P < 0.05$).

* Only 9/13 cows observed for oestrus as 4 cows had not ovulated by 100 days postpartum and ascribed a postpartum interval of 100 days.

† Due to experimental constraints, observation of oestrus was not possible in all cows, so presence of vaginal mucus and uterine tone prior to first ovulation were used as indicators of oestrus.

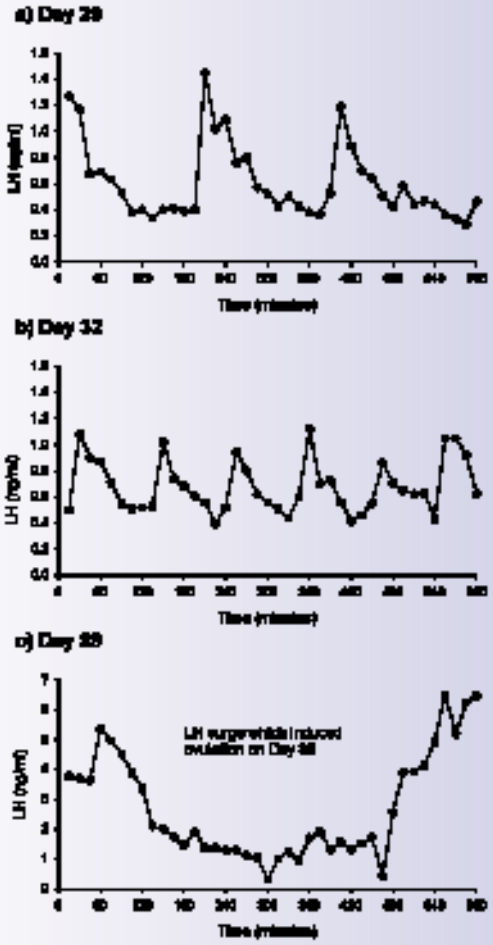

Figure 4: Effect of calf isolation and restricted suckling from 30 days postpartum on LH pulse frequency in an individual beef cow. The cow also received an intravaginal progesterone-releasing device (CIDR) for 6 days from the day restricted suckling commenced. The cow was blood-sampled at 15-minute intervals for 10 hours one day before commencement of restricted suckling (day 29) as well as two and eight days after (days 32 and 38, respectively). Ovulation occurred on day 39 postpartum and was preceded by the expression of oestrous activity.

9. CONCLUSION

The results from this project demonstrate that both nutrition and suckling have major effects on the interval from calving to first ovulation in beef cows. Prepartum nutrition, reflected in body condition at calving, is clearly the most important nutritional effect. Cows that calve in good condition have a shorter postpartum interval than those that calve in poor condition. Increasing the level of postpartum nutrition, even to very high levels, has a negligible effect on the interval to first ovulation.

The mechanism by which suckling delays the interval to first ovulation comprise two components, viz., (i) physical contact between cow and calf, and (ii) maternal bonding between cow and calf. Limiting the effect of these components through calf isolation and restricted suckling induces a rapid resumption of oestrous cycles by altering the endocrine environment.

While ovarian follicular development resumes early postpartum, the prolonged postpartum interval is due to the failure of successive dominant follicles to ovulate. This is due, in turn, to the inadequate frequency of LH pulses. Calf isolation and restricted suckling causes an increase in the frequency of LH pulses within 48 hours and induces the majority of cows to resume cyclicity. The first ovulation is, however, generally silent and succeeded by a short oestrous cycle of approximately 7 to 10 days' duration.

A short-term progesterone treatment commencing at the start of calf isolation and restricted suckling allows cows to express oestrus at first ovulation and eliminates the short oestrous cycle.

10. PUBLICATIONS ARISING FROM THIS PROJECT

Diskin, M.G., Grealy, M. and Sreenan, J. 1992. Effect of body condition score at calving and suckling frequency on postpartum interval in suckler cows. *Animal Production* **54:** 466 (Abstr.).

Diskin, M.G., Stagg, K., Roche, J.F. and Sreenan, J.M. 1995. Suckling and cow-calf interactions delay postpartum resumption of cyclicity in suckler cows. *Irish Journal of Agricultural and Food Research* **34:** 103-104 (Abstr.).

Diskin, M.G., Stagg, K. and Sreenan, J.M. 1995. Suckling and cow-calf interactions prolong postpartum interval in beef cows. *Journal of Reproduction and Fertilty* Abstract Series No. **15:** 66 (Abstr.).

Diskin, M.G., Mackey, D.R., Sanz, A., Marongiu, L., Quintans, G., Roche, J.F., Revilla, R. and Branca, A. 1999. Effects of body condition at calving, postpartum nutrition and calf access on the interval from calving to first ovulation in beef cows: Ovarian folliculogenesis and gonadotrophin secretion. *Proceedings of the British Society of Animal Science,* p5 (Abstr.).

Mackey, D.R. 1999. The effect of acute nutrition and suckling on follicular growth and gonadotrophins in cattle. Ph.D. Thesis, National University of Ireland, Dublin.

Mackey, D.R., Diskin, M.G., Sreenan, J.M. and Roche, J.F. 1996. Effects of postpartum energy intake and calf isolation on follicles dynamics and postpartum interval of beef cows. *Animal Production* **62:** 657 (Abstr.).

Mackey, D.R., Diskin, M.G., Sreenan, J.M. and Roche, J.F. 1997. Will treatment with progesterone, either alone or with oestradiol result in behavioural oestrus and a normal length luteal phase in postpartum beef suckler cows induced to ovulate by calf isolation and once-a-day suckling? *Proceedings of the British Society of Animal Science,* p36 (Abstr.).

Mackey, D.R., Sreenan, J.M., Roche, J.F. and Diskin, M.G. 1997. The effects of calf isolation and restricted suckling, either alone or with progesterone/oestradiol treatment on LH secretion and interval to first ovulation in beef suckler cows. *Irish Journal of Agricultural and Food Research* **36:** 96 (Abstr.).

Mackey, D.R., Roche, J.F., Sreenan, J.M. and Diskin, M.G. 1999. Effect of calf isolation and restricted suckling on LH secretion in postpartum suckler cows. *Proceedings of the British Society of Animal Science,* p59 (Abstr.).

Mackey, D.R., Sreenan, J.M., Roche, J.F. and Diskin, M.G. 2000. The effect of progesterone alone or in combination with estradiol on follicular dynamics, gonadotropin profiles and estrus in beef cows following calf isolation and restricted suckling. *Journal of Animal Science.*

Sinclair, K.D., Molle, G., Revilla, R., Roche, J.F., Quintans, G., San Juan, L., Sanz, A., Mackey, D.R. and Diskin, M.G. 1999. Effects of body condition at calving, postpartum nutrition and calf access on the interval from calving to first ovulation: Cow performance and metabolism. *Proceedings of the British Society of Animal Science,* p4 (Abstr.).

Stagg, K. 1999. Anoestrous in the postpartum suckled beef cow and in the nutritionally restricted heifer. Ph.D. Thesis, National University of Ireland, Dublin.

Stagg, K., Diskin, M.G., Sreenan, J.M. and Roche, J.F. 1993. Follicular growth patterns during postpartum anoestrous in suckler cows. *Irish Journal of Agricultural and Food Research* **32:** 106-107 (Abstr.).

Stagg, K., Diskin, M.G., Sreenan, J.M. and Roche, J.F. 1995. Follicular development in long-term anoestrous suckler beef cows fed two levels of energy postpartum. *Animal Reproduction Science* **38:** 49-61.

Stagg, K., Spicer, L.J., Sreenan, J.M., Roche, J.F. and Diskin, M.G. 1998. Effect of calf isolation on follicular wave dynamics, gonadotrophin and metabolic hormone changes, and interval to first ovulation in beef cows fed either of two energy levels postpartum. *Biology of Reproduction* **59:** 777-783.

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