Tropical and Subtropical Agroecosystems, 14 (2011): 337 - 347

SHORT NOTE [NOTA CORTA]

EFFECTS OF BODY CONDITION CHANGE OVER OESTRUS, FOLLICULAR DEVELOPMENT AND OVULATION RATE IN PELIBUEY EWES UNDER TROPICAL CONDITIONS

[EFECTO DEL CAMBIO EN LA CONDICIÓN CORPORAL, SOBRE LA ACTIVIDAD ESTRAL, EL DESARROLLO FOLICULAR Y TASA OVULATORIA EN OVEJAS PELIBUEY MANTENIDAS EN CONDICIONES DE TRÓPICO]

G. De la Isla-Herrera[1], A. Ayala-Burgos[1], R. Aké-López[1] and A. Gonzalez-Bulnes[2]

[1]Animal Reproduction Department, Faculty of Veterinary Medicine and Animal Science, Autonomous University of Yucatan, Mexico
[2]INIA Madrid España.
Email: alopez@uady.mx
**Corresponding Author*

SUMMARY

In order to study the effect of changing body condition on the oestrus, follicular development and ovulation rate, twenty two Pelibuey ewes were divided in two groups of High Body Condition (HBC>L) and Low Body Condition (LBC>H). The ewes were evaluated over an oestrus cycle at the initial body condition, and during a seven week period, the HBC>L group received a diet with half and the LBC>H with double of their maintenance energy requirements to induce a change in body condition. A second oestrus cycle was evaluated at the end of seventh week, at the final stage of change, when both groups reached a similar body condition. Before each oestrus cycle evaluated, ewes were synchronized and the oestrus detected. The oestrus length, oestrus cycle length and the follicular populations of small, medium and large follicles were estimated. Ovulation rate was determined nine days after the oestrus. There were no differences in both groups in oestrus length and oestrus cycle length (P>0.05). The maximum follicular size was similar in both groups (P>0.05). The mean number of follicles that attained a diameter $\geq$ 4 mm was higher in CCB>A ewes when gaining body condition, compared to their previous one (P<0.05), however, it was similar in CCA>B group before *vs.* during the loss of body condition. There was no difference in ovulation rate in both groups, before *vs*. during the change of body condition (P>0.05). It is concluded that Pelibuey ewes in low or high body condition, that gain or lose body condition and reach a similar body condition (medium), have no differences in oestrus length, oestrus cycle length and maximum follicular size, but showed differences in the number of large follicles reaching an ovulation size in ewes gaining body, which doesn't mean an improvement in the ovulation rate.

Keywords: Pelibuey ewe; body condition; oestrus cycle; follicular development; ovulation rate.

RESUMEN

Este trabajo evaluó el efecto del cambio en la condición corporal, sobre el desarrollo folicular y la tasa ovulatoria. Veintidós ovejas Pelibuey divididas en dos grupos de Condición Corporal Alta (CCA>B) y Baja (CCB>A), fueron evaluadas durante un ciclo estral en su condición inicial y después de un período de siete semanas donde se alimentó al grupo de CCA>B con la mitad y al de CCB>A con el doble de sus requerimientos de energía para mantenimiento, para inducir cambios de condición corporal. El segundo ciclo estral se evaluó en la etapa final de cambio de condición corporal, cuando ambos grupos alcanzaron una condición corporal similar. Antes de cada ciclo estral evaluado, las ovejas fueron sincronizadas y se detectó el estro. Se determinó la duración del estro y del ciclo estral, así como las poblaciones ováricas de folículos pequeños, medianos y grandes. Se estimó la tasa ovulatoria nueve días después de observado el estro. No se observaron diferencias en la duración del estro y del ciclo estral en los grupos (P>0.05). El diámetro folicular máximo también fue similar en ambos grupos (P>0.05). El número promedio de folículos ≥ 4 mm fue mayor en el

grupo de CCB>A al estar aumentando de condición *vs*. su condición inicial (P<0.05), sin embargo, fue igual en el grupo CCA>B antes *vs*. durante la disminución de condición corporal. No se observó diferencia en la tasa ovulatoria dentro de los grupos, antes y durante el cambio de condición (P>0.05). Se concluye que ovejas de condición corporal baja o alta, que ganan o pierden condición corporal y alcanzan una condición corporal media, no difieren en la duración del estro, del ciclo estral ni el diámetro folicular máximo, pero sí en el número de folículos grandes que alcanzan una talla ovulatoria en ovejas de baja condición y que están aumentando condición, sin que esto se refleje en una mejora de la tasa ovulatoria en ovejas de pelo.

Palabras clave: Ovejas Pelibuey, condición corporal, ciclo estral, desarrollo folicular, tasa ovulatoria.

INTRODUCTION

The ewe's prolificacy represents the highest stage of several reproductive events, influenced by genetic and environmental factors. The most studied environmental factors are the nutritional status and Body Condition (BC) related to it, which affect all the aspects of the reproductive events chain in the ewe (Scaramuzzi and Radford, 1983; West *et al.* 1991; Scaramuzzi *et al.*, 2006). Body Condition Change (BC), is a good estimator of body energy reserves (Sanson, 1993), and is associated with food seasonal variations, which are more marked in tropical regions. The effect of the body condition over reproductive performance has been studied for decades. Coop (1966), proposed there is a "static effect" of nutrition, when referring to the reproductive performance differences observed between animals with high and low body condition, besides a "dynamic effect" given by the change in body condition, like the one observed during flushing, which consists of giving ewes a higher energy diet for several weeks before the beginning and after the mating period, in order to increase the ovulation rate having thus multiple lambing deliveries. It has been proposed that only positive results are observed upon flushing when ewes have a moderate body condition (2) at the beginning, and reach a moderately good condition (2.5) at the mating period (Gunn, 1979b). Although in ewes, follicle development, and consequently follicular populations and ovulation rates are very sensitive to nutritional manipulation, the results have been variable, which makes necessary to generate information regarding hair sheep under tropical conditions, related to the dynamic effect of body condition changes over follicular development and consequently on the ovulation rate. It's worth mentioning the importance of the ovulation rate because it determines the potential of lamb production. Based on theabove information, the objective of the present work was to evaluate the effect of the Body Condition Change over the oestrus, follicular development and ovulation rates in Pelibuey ewes under tropical conditions.

MATERIALS AND METHODS

The present work was performed during the months of September to December 2007, in the Animal Reproduction Department of the Veterinary Medicine and Animal Production School of the Autonomous University of Yucatan, Mexico, located at 21º 06' N and 89 º 27' W. Climate is tropical sub-humid (Aw0), with summer rains. Annual mean temperature is 25.8º C; average annual rainfall is of 983.8 mm relative humidity is between 75 and 80% (INEGI, 1994).

Animals

Twenty two Pelibuey ewes from three to five lambings were used. The ewes used were empty, without lambs and clinically healthy, which were arranged according to their Body Condition Scoring (BCS), using a scoring from 1 to 5 (emaciated to obese) proposed by Russel (1969), in one of two groups: High BCS $\geq$ 3 points (HBC>L, n=11) average body condition, 3.5 $\pm$ 0.1 and average body weight of 40.6 $\pm$ 1.7 kg; and a Low BCS $\leq$ 2.5 points (LBC>H, n=11) with average body condition of 1.8 ± 0.1 and average body weight of 30.7 ± 0.9 kg (P<0.05).

All animals had their first oestrus cycle evaluated prior to the BC change period, and a second cycle during the Body Condition Change (BC), but when body conditions were equaled to a medium level (about 2.5), three ewes were discarded for external reasons (pneumonia and ovarian adhesions) during the study: two from the LBC>H and one from the HBC>L

Feeding

A diet was designed based on *Brachiaria brizantha* hay (ground with a 0.5 in. sieve), ground corn, soybean meal, sugar cane molasses and minerals with 11.3 % CP and 9.66 MJ ME/Kg/DM (Estimated according AFRC, 1993). Individual intake was adjusted according to each ewe's live weight, offering 16.4 g DM/k live weight. The composition of the diet is shown in Table 1.

Table 1. Composition of diet for Pelibuey ewes

Ingredient	%
Ground corn	21.4
Soybean meal	18.1
Brachiaria brizantha hay	48.7
Molasses	8.6
Minerals	3.2
	100.0

Animals had a 15-day adapting period to the diet, after which they held their weight and body condition, and were evaluated along an oestrus cycle (October 8 to 28, 2007). At the end of the oestrus cycle evaluation, in order to induce a change in body weight and body condition in all animals, ewes from the HBC>L were fed with half (0.5 M) the energy requirements for maintenance, whereas ewes from the LBC>H group received (2.0 M). the maintenance requirement for energy This feeding criteria was kept for a seven week period in which at the final stage, a second oestrus cycle was evaluated (November 30 to December 21, 2007), under a body condition change situation, but at a similar body condition in both groups (Figure 1).

All ewes were confined and fed individually in pens, with access to water and provided with shading. Body condition and live weight were measured and recorded on a weekly basis during the whole length experiment.

Oestral Activity

In order to unify the oestrus cycle observations, all ewes were synchronyzed using impregnated sponges with 40 mg fluogesterone acetate (FGA) for 12 days. Oestrus was detected upon sponge withdrawal day using two rams with an apron as markers, which were exposed to ewes twice a day (7:00 a.m. and 5:00 p.m.) for half hour periods each time. A ewe was considered in oestrus when it displayed a receptive behavior to mating and allowed mounting. Ewes detected were separated from the group for the rest of the detection period and were exposed again to the marker rams in the next observation until the end of the oestrus. Oestrus duration was regarded as the period of time between the first and the last observation in which ewes were in oestrus.

Follicular Development

In order to monitor follicular development, an ultrasonographic exam was made to all ewes throughout the two evaluated oestral cycles. The exam was made through the rectum, with the ewe lying over a stretcher in dorsal decubitus position, using a real-time ultrasound equipment modo-B Aloka – 500 (Aloka Co., Ltd. Tokio, Japan), with a 7.5 MHz linear transducer. Images of the urinary bladder and the uterine horns were used as reference guides to locate the ovaries.

Along each of the two evaluated cycles, the number and diameter of all follicles ≥ 2 mm in both ovaries were counted and measured in each animal on a daily basis. Follicles were classified according to their sizes into three categories: 1) small (2.0 – 2.9 mm), 2) medium (3.0 – 3.9 mm) and large (≥ 4.0 mm), according to the classification by Contreras *et al*. (2007).

Ovulation rate

Ovulation rate was determined using ultrasound test nine days after oestrus was detected, by counting the number of corpora lutea in both ovaries. The estimation was confirmed by a laparoscopic study using a 5.0 mm and 0º Karl Storz endoscope.

Statistical analysis

Data were analyzed using SAS PROC GLM, considering as fixed effects, the body condition (high and low) and evaluated oestrus cycle (1^{st} and 2^{nd}) (SAS,1985). The analyzed variables were: oestrus duration, oestrus cycle duration, number of small, medium and large follicles, maximum follicle diameter and ovulation rate.

RESULTS

Body weight and condition

The nutritional management was effective to induce the change in body condition and live weight in ewes. At the end of the experiment, the body condition was 2.4 ± 0.4 and 3.0 ± 0.4 for HBC>L and LBC>H groups respectively, which mean tan average loss of 1.1 points in the HBC>L, and a gain of 1.2 points in the LBC>H group. The average final weight was of 32.1 ± 1.3 k for the HBC>L, which accounted for an average loss of 8.5 k, whereas the LBC>H group gained about 5.9 k, averaging 36.4 ± 1.2 k at the end of the experiment (figure 2). This weight loss represented about 26% of their body weight, an important loss considering that ideally, ewes lose from 5 to 10% of their body weight during lactancy, which represents 0.5 – 1.0 points in the body condition score (Sheep Production Handbook, 2002).

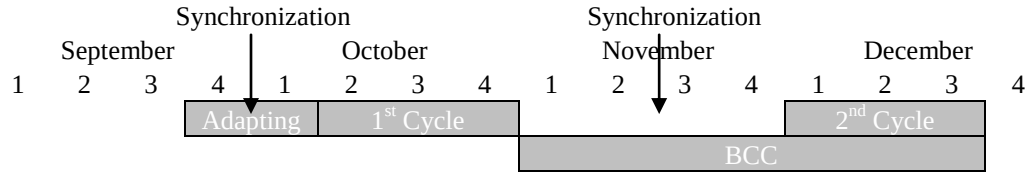

Figure 1. Experimental protocol schematic (September-December 2007). Oestral activity and ovaric measurements were recorded on the 1st and 2nd cycles.

Oestrus and oestrus cycle duration

Ewes with higher body condition showed longer oestrus during the oestrus cycle evaluated prior to the decrease in their body condition score, but with no significant differences, whereas the low body condition ewes had shorter oestrus with less differences between the two evaluated cycles (P>0.05) (Figure 3).

There were no differences between groups during the oestrus cycle (P>0.05). The HBC>L had oestrus cycles of 17.1 ± 0.2 and 17.8 ± 0.2 (mean ± s.e.) days, before and during the body condition decrease respectively, and the LBC>H was of 17.2 ± 0.2 and 16.9 ± 0.2 (mean ± s.e.) days, before and during the body condition increase. Three abnormally long oestrus cycles (more than 22 days) in the HBC>L group; two on the first and one on the second, were not considered for the data analysis.

Follicular development

A decrease in the average total number of follicles ≥ 2 mm was observed in the HBC>L sheep when decreasing their body condition, whereas the LBC>H group had an increase from day 8 (Figures 4 and 5). The HBC>L ewes showed a decrease in their follicular population, especially the small follicles, at the moment of losing body condition, whereas the medium and large follicles remained unchanged throughout the cycle (Figures 6, 7 and 8). On the other hand, the LBC>H ewes showed a higher amount of medium and large follicles during the cycle they increased in body condition (Figures 9, 10 and 11).

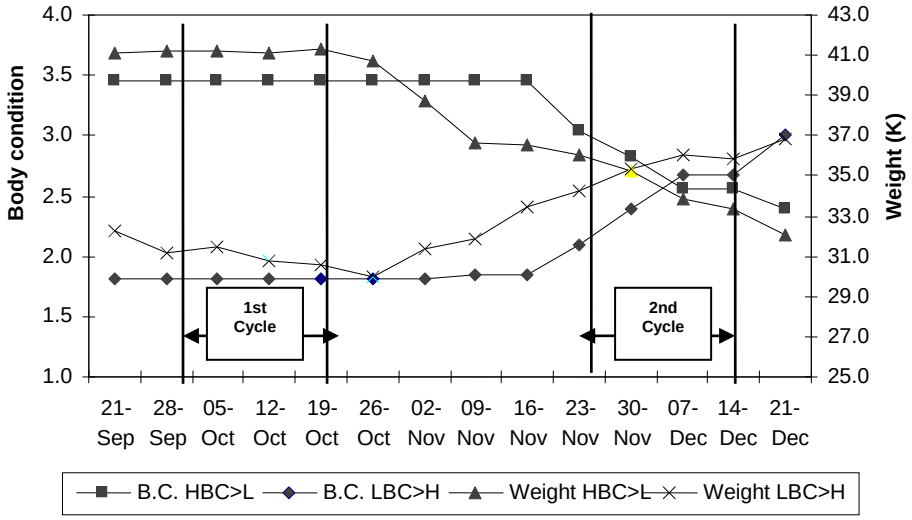

Figure 2. Body Condition (B.C.) and weight of ewes classified with high body condition (HBC>L) and low (LBC>H), before and during the body condition change.

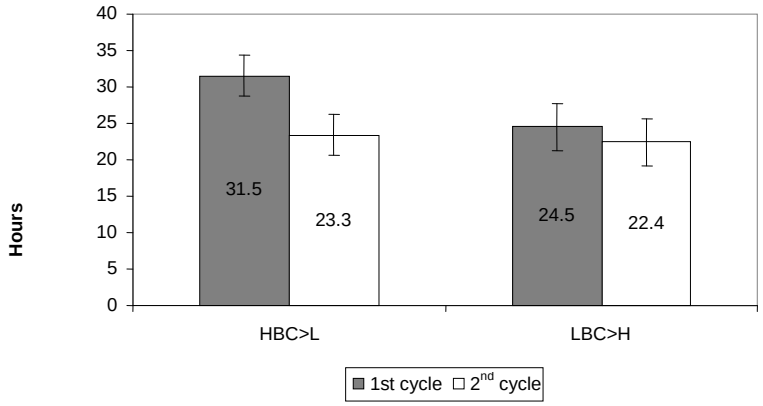

Figure 3. Oestrusduration in ewes with decreasing high body condition (HBC>L), and of increasing low body condition (LBC>H), before (1st Cycle) and during (2nd Cycle) body condition change (mean ± s.e.) (P>0.05).

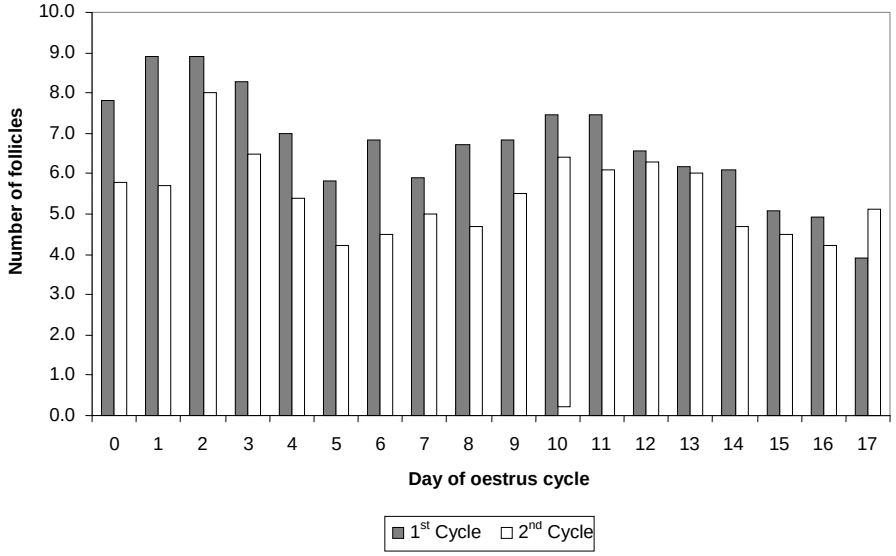

Figure 4. Total follicles ≥ 2mm in high body condition ewes (HBC>L), before (1st Cycle) and during (2nd Cycle) body condition change

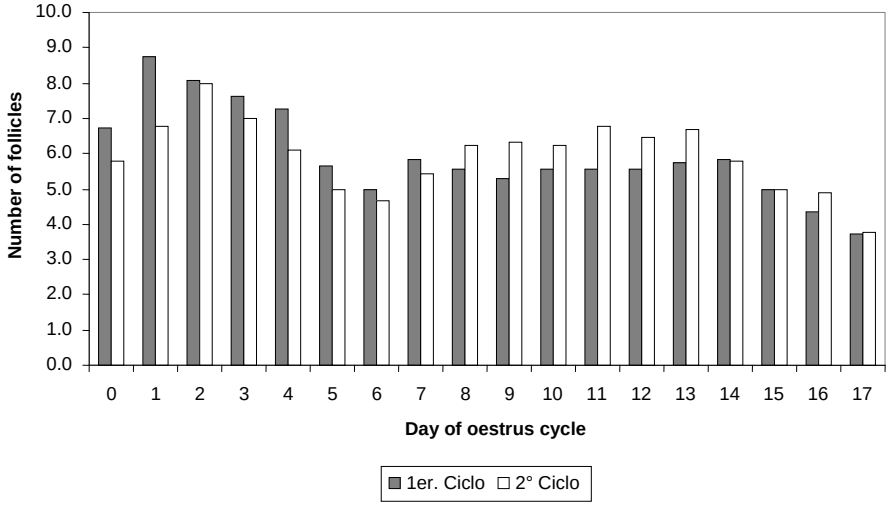

Figure 5. Average total number of follicles ≥ 2mm in low body condition ewes (LBC>H), before (1st Cycle) and during (2nd Cycle) body condition change.

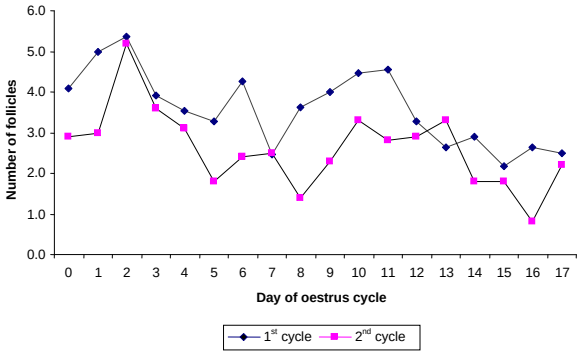

Figure 6. Small follicles (2.0-2.9 mm) in high body condition ewes (HBC>L), before (1st Cycle) and during (2nd cycle) body condition decrease.

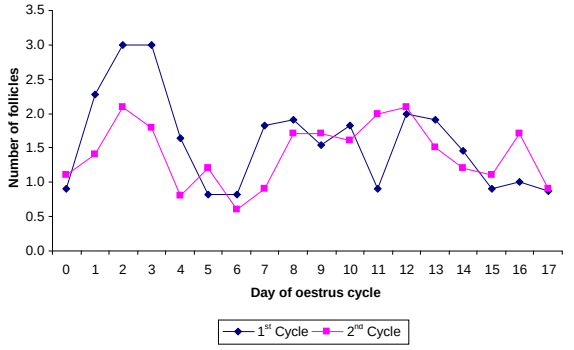

Figure 7. Medium follicles (3.0-3.9 mm) in high body condition ewes (HBC>L), before (1st Cycle) and during (2nd cycle) body condition decrease.

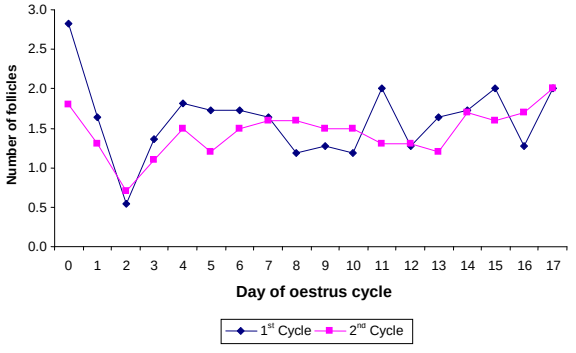

Figure 8. Large follicles (≥ 4 mm) in high body condition ewes (HBC>L), before (1st Cycle) and during (2nd cycle) body condition decrease

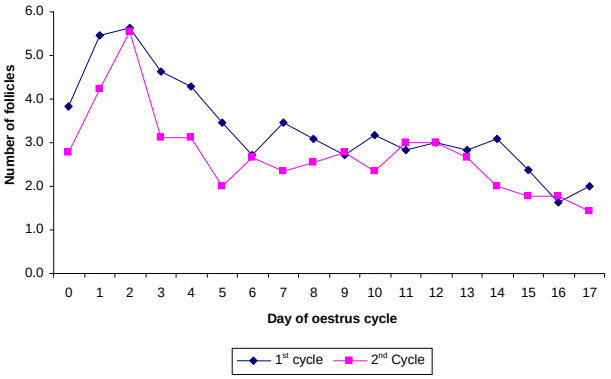

Figure9. Small follicles (2.0-2.9 mm) in low body condition ewes (LBC>H), before (1st Cycle) and during (2nd cycle) body condition increase.

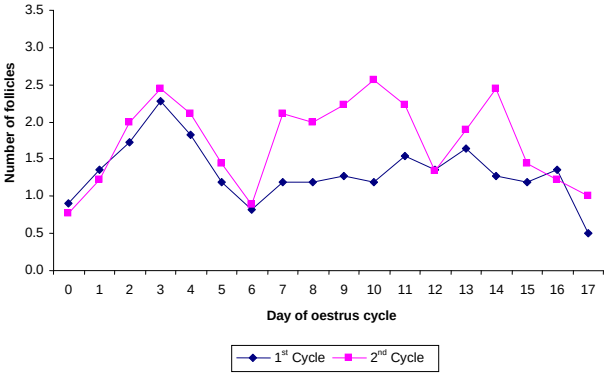

Figure 10. Medium follicles (3.0-3.9 mm) in low body condition ewes (LBC>H), before (1st Cycle) and during (2nd cycle) body condition increase.

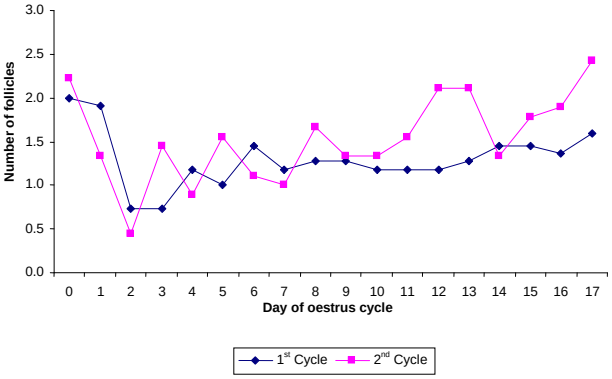

Figure 11. Large follicles (≥ 4 mm) in low body condition ewes (LBC>H), before (1st Cycle) and during (2nd cycle) body condition increase.

Maximum follicle diameter

The maximum follicle diameter was similar (P>0.05) among groups in both evaluated cycles (figure 12). However, the number of follicles that reached a size equal or more than 4 mm were significantly higher in LBC>H ewes during the increase in body condition, than at the beginning of the experiment (1.6 ± 0.1 vs. 2.3 ± 0.2; mean ± s.e.) (P<0.05), whereas the HBC>L ewes showed no differences before and during the decrease in body condition (1.7 ± 0.2 vs. 2.0 ± 0.3; mean ± s.e.) (P>0.05).

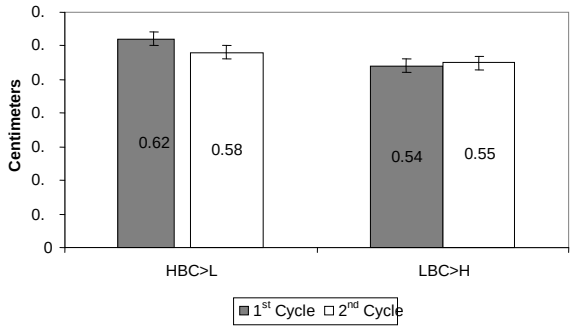

Figure 12. Maximum follicle diameter in high body condition ewes (HBC>L) and low (LBC>H), before and during the body condition change (mean ± s.e.).

Ovulation rate

The ultrasound's sensitivity to determine the presence of corpora lutea was of 100%, confirmed by endoscopy. Although no significant differences were observed among groups (P>0.05), in the two evaluated cycles, the HBC>L ewes showed an increase in 6% of their ovulation rate as their body condition score decreased by a point, whereas the LBC>H, as they increased their body condition, tended to increase their ovulation rate (P = 0.1) improving it by 27%.

During the first cycle, there were double ovulations in 73% (8/11) of the HBC>L ewes, and 45% (6/11) of the low body condition group. Triple ovulations were only observed during the change in body condition, on the second cycle, with a very similar performance by type of ovulation (Table 3).

Table 2. Ovulation rate of ewes that gain (LBC>H) or lose (HBC>L) body condition (mean ± s.e.). (P>0.05).

	1st Cycle	2nd Cycle
HBC>L	1.7 ± 0.1	1.8 ± 0.3
LBC>H	1.5 ± 0.2	1.9 ± 0.3

DISCUSSION

Oestrus and oestrus cycle duration

The oestrus duration showed no differences in the present work, but it showed a trend (P = 0.08) to present longer oestrus in ewes with high body condition, than those who decrease theirs, as well as on those which increase the body condition.

In the present work, three (7.3%) of the forty one evaluated cycles, high body condition ewes before and during the body condition decrease, showed irregular cycles with durations between 22.4 and 25.6 days, which is similar to that reported by Cruz *et al.* (1994), who observed in pelibuey ewes, without pointing out the body condition, oestral cycles that averaging 17.8 ± 0.9 days in 83.2% of detected ewes throughout the year, and of 20 or more days in the remaining animals. Results indicate that the duration of the oestrus cycle is not affected by the body condition *per se*, or by its changes, either gains or losses. The later constitutes an important element to consider when programming the mating periods, given the fact that there will be ewes with longer oestrus cycles, that could have less chance of being detected in oestrus and thus be mated by the ram.

Table 3. Type of ovulation in high body condition ewes (HBC>L) and low (LBC>H), before (1st Cycle) and during (2nd cycle) body condition increase.

Period	CC	Ovulated ewes	No of corpora lutea	Single ovulation (%)	Double ovulation (%)	Triple ovulation (%)
HBC>L	1st Cycle	11	19	27.3	72.7	0.0
	2nd Cycle	10	18	40.0	50.0	10.0
LBC>H	1st Cycle	11	16	54.5	45.5	0.0
	2nd Cycle	9	17	33.3	44.4	22.2

Follicular development

It has been observed that feeding sheep with a sub-maintenance diet can alter the follicular size distribution in the ovary (Allen y Lamming, 1961), since ewes under flushing increased the number of follicles <2 mm and 2-3 mm diam. compared to ewes fed with a diet under the maintenance needs. In the same way, Haresign (1981) reported at the time of oestrus a similar number of follicles 1-2 and >3 mm diam. in ovaries of both groups, and a larger number of follicles 2-3 and >3 mm diam. in ewes fed with twice the maintenance requirements, as well as O'Callaghan *et al.* (2000), which demonstrates the influence of the body condition change over the final stages of follicular development, preventing athresia of follicles > 2 mm (Haresing, 1981) allowing availability of more healthy follicles ≥ 2 mm diam. at the moment of luteolysis (Xu *et al.* 1989). On the contrary, Rhind y McNeilly (1998) didn't find differences in the amount of follicles larger than 2.5 mm diam. among groups fed on high and low nutritional regimes.

Maximum follicle size

The maximum follicle size observed in the present work, in ewes of high and low body condition prior to a change, is similar to that reported by Viñoles *et. al.* (2002) in Polwarth ewes, where larger follicle diameters were observed on high body condition sheep. In ewes losing body condition, it becomes more evident the decrease in follicle diameter, however, ewes increasing body condition showed no differences, which means that the recovery from a very low body condition may require a several week period.

Although no differences in maximum follicle diameter were observed between cycles within the group that increased in body condition, there was an ovulation rate increase in the second cycle, which leads to conclude that the size the ovulatory follicle reaches is not of great importance. What needs to be explained is the absence of differences in the ovulation rate among groups in the first cycle, which could have been due to a very high average body condition within the HBC>L ewes at the beginning of the study.

Ovulation rate

There were no differences in the ovulation rate found among the HBC>L and LBC>H groups in the two evaluation cycles. These results differ from those previously reported by De la Isla *et al.*, (2004), who found during the month of May significant differences between high and low body condition animals (2.1 *vs.* 1.2). The differences in the results could have been because of the different time of the year in which the study took place, since the ovulation rate of high body condition ewes observed in the present study was similar to that observed by González *et al.* (1992) during the months of November (1.8) and December (1.67), and by Cruz *et al.* (1994) during October (2.0), in Pelibuey ewes under tropical conditions.

In the present work, ewes that started with a high body condition, held their ovulation capacity even in a marked body weight loss and body condition situation. The similar reproductive performance that kept during the two evaluation cycles could be partly explained by the high body condition that 64% of ewes (7/11) had, with scores equal or higher than 3.5, at the beginning of the experiment. This body condition level allowed them to use their body reserves to face a sudden decrease both in weight and body condition. It was also observed that the final body condition reached by this group (2.4 scores), was not enough to affect the follicular development processes and consequently, the ovulation rate. In this sense, it has been reported that dry Pelibuey ewes with a body condition between 2 and 3, become less affected in their protein and

energy metabolism than those that are below this limit (Cruz *et al.*, 1999 and Caldeira *et al.*, 2007).

Bramley *et al.* (1976), made Masham ewes with a body condition of 2.5, to lose 0.9 points or gain 1.3, which yielded at the end of the work, a gain of 50 lambs for every 100 ewes exposed to the ram, by each unit of body condition. This meant that ewes with a moderate body condition (2.5) can respond to supplementary feeding. In the present study, the low body condition ewes started with a 2 point score, which probably was not low enough to obtain a significant response.

The low body condition group had a 27% increase in the ovulation rate by improving their body condition, which means a better possibility to increase prolificacy by almost half lamb per ewe. These results agree with other author's, who report a higher ovulation rate in animals increasing body condition, in relation to those decreasing it (Ducker and Boyd, 1977). The same authors did not find significant differences in the ovulation rate between small or large ewes maintained with a body condition of 2 - 2.5 (1.84), but found differences when small ewes increased body condition from 2.0 to 3.5 (2.08), and large ones decreased to 1 – 2.5 (1.64). Results obtained by several authors, have lead to consider that body condition *per se* at the moment of the mating period is more important than if ewe is increasing or decreasing its condition. (Gunn *et al.*, 1969, 1972; Gunn and Doney, 1975), and a positive relationship is found between the ovulation rate and the nutritional level prior to the mating period in moderate body condition ewes (2.0) (Downing and Scaramuzzi, 1991; West *et al.*, 1991), but not in higher body condition ewes (Gunn *et al.*, 1984b).

Opposed to the above mentioned, other authors have found that feed supplementation 3-4 weeks before the mating period, does not increase the ovulation rate or prolificacy in hair sheep under tropical conditions, regardless of the year's season (White et al., 1987/88; Godfrey, 2003). Thomas *et al.* (1987), reported less corpora lutea in ewes with a body condition of 2.9 before the mating period, but a similar number of lambs produced than in ewes supplemented with corn. Rhind *et al.* (1984), concluded there is little gain in lamb production when supplementing ewes during a long period of time prior to the mating period, to obtain a body condition above 3 points.

Previous studies on ewes that reach a moderate body condition (2 points) at the moment of the mating period starting from initial scores of 1.5 or 2.5, showed no differences in the ovulation rate (Gunn *et al.* 1979a), which indicates that it is more important the body condition at the beginning of the mating period than the previous feeding regime. There seems to be a threshold where once above it the ovulation rate increases due to a high feeding level prior to the mating period (Gunn *et al.* 1979a), but there is no increment below it. This threshold seems to be within the moderate to moderately good body condition (2.0 - 2.5 points). In the present work, the low initial body condition (1.8) of the gaining group, could have contributed to the lack of response. With ewes in such poor body condition, there could have been a higher demand above the available energy supply to increase the body reserves, with less available energy for stimulating ovary activity. The practical implications mean that, in order to obtain an increase in the response, the body condition has to be increased up to a moderately good level at the moment of the mating period.

Gunn *et al.* (1991) observed different behaviors among breeds according to their body condition, which suggests that, depending on the breed, there could be different target body conditions for a successful reproductive performance. Nevertheless, the nutritional effect over the reproductive processes could be a consequence of the ewe's "net nutritional status" or global energetic budget, which considers internal sources (body reserves) as well as external (diet) sources of nutrients. This is related to the metabolic changes associated to the decrease or increase in the feed intake and the use or storage of nutrients in body reserves, which relates to the nutrient demand that the ovary's physiology requires and which will determine the initial stage of the ewe's gestation.

The feed intake of ewes which began with a high body condition, before and during the body condition decrease, accounted for a total of 18.8 k of fresh base food, which was equal to $55.60 (Mexican pesos) per animal for a seven week period. This figure, in a flock of 100 ewes, would account for an expense of about $5,560.00, which does not significantly affect the reproductive performance of the animals. The later led to consider that Pelibuey ewes do not require a body condition score higher than 2.4 at the moment of the mating period.

CONCLUSIONS

In the present work, the initial body condition and its change did not affect significantly the follicular development or the ovulation rate in ewes under a medium body condition, which suggests that flushing hair sheep for long periods at the end of the highest reproductive activity period is not required. Furthermore, animals with a very good body condition (3.5) which suffer a loss of up to a point of body condition (8.5 k live weight) in a scale of 1 to 5 are able to maintain their reproductive performance.

Note: This work is part of the Doctoral Thesis of the first author. PROMEP grant holder. Autonomous University of Queretaro.

REFERENCES

AFRC 1993. Agricultural Food and Research Council. Nutrient Requirements of Ruminant Livestock. CAB.

Allen, D.M., Lamming, G.E. 1961. Nutrition and reproducction in the ewe. Journal of Agricultural Science, Cambridge. 56:69-79.

Bramley, P.S.; Denehy, H.L.; Newton, J.E. (1976). The effect of different planes of nutrition before mating on the reproductive performance of Masham ewes. Veterinary Record. 99:294-296.

Caldeira, R.M., Belo, A.T., Santos, C.C., Vazques, M.I., Portugal, A.V. 2007. The effect of body condition score on blood metabolites and hormonal profiles in ewes. Small Ruminant Research. 68:233-241.

Contreras, S.I., Díaz, T., López, G., Caigua, A, García, H, Salvador, A. *et al*. 2007. Evaluación de la técnica de ecografía transrectal en la detección de folículos ováricos en ovejas tropicales. Archivos Latinoamericanos de Producción Animal.15:10-14.

Coop, I.E. 1966. Effect of flushing on reproductive performance of ewes. Journal of Agricultural Science. 67:305-323.

Cruz, L.C., Fernández-Baca, S., Álvarez L.J., Pérez, R.H. 1994. Variaciones estacionales en presentación de ovulación, fertilización y sobrevivencia embrionaria de ovejas Tabasco en el trópico húmedo. Revista Veterinaria México. 25:23-27.

Cruz, M.E., García, M.R., Miranda, M.G., León, A.E., Fonseca, J.Y. 1999. Relación entre el peso vivo, condición corporal e indicadores bioquímicos de la nutrición en ovejas vacías y secas de la raza Pelibuey. Archivos de Zootecnia. 48:223-226.

De la Isla, H.G., Aké, L.R., Cancino, A.G., Magaña, M.J. 2004. Efecto de la condición corporal sobre el ciclo estral, tasa ovulatoria y función del cuerpo lúteo en ovejas de pelo. Memorias de la XL Reunión Nacional de Investigación Pecuaria. Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias. Noviembre de 2004, Mérida, Yucatán, México. pp 131.

Downing, J.A., Scaramuzzi, R.J. 1991. Nutrient effects on ovulation rate, ovarian function and the secretion of gonadotrophic and metabolic hormones in sheep. Journal of Reproduction and Fertility Supplement. 43:209-227.

Ducker, M.J., Boyd, J.S. 1977. The effect of body size and body condition on the ovulation rate of ewes. Animal Production. 24:377-385.

Godfrey, R.W., Weis, A.J., Dodson, R.E. 2003. Effect of flushing hair sheep ewes during the dry and wet seasons in the U.S. Virgin Islands. Journal of Animal and Veterinary Advances. 3:184-190.

González, A., Murphy, B.D., Foote, W.C., Ortega, E. 1992. Circannual estrous variations and ovulation rate in Pelibuey ewes. Small Ruminant Research. 8:225-232.

Gunn, R.G., Doney, J.M., Russel, A.J. 1969. Fertility in Scottish Blackface ewes as influenced by nutrition and body condition at mating. Journal of agricultural Science, Cambridge. 73:289-294.

Haresign, W. 1981. The influence of nutrition on reproduction in the ewe. I. Effects on ovulation rate, follicle development and luteinizing hormone release. Animal Production. 32:197-202.

Gunn, R.G., Doney, J.M., Russel, A.J. 1972. Embryo mortality in Scottish Blackface ewes as influenced by body condition at mating and post-mating nutrition. Journal of agricultural Science, Cambridge. 79:19-25.

Gunn, R.G., Doney, J.M. 1975. The interaction of nutrition and body condition at mating on ovulation rate and early embryo mortality in

Scottish Blackface ewes. Journal of Agricultural Science, Cambridge. 85:465-470.

Gunn, R.G., Doney, J.M., Smith, W.F. 1979a. The effect of nutrition before and after mating on ovulation rate and early embryo mortality in South Country Cheviot ewes in moderately condition at mating. Animal Production. 29:25-31.

Gunn, R.G., Doney, J.M., Smith, W.F. 1979b. The effect of level of pre-mating nutrition on ovulation rate and early embryo mortality in North and South Country Cheviot ewes in moderately-good condition at mating. Animal Production. 29:17-23.

Gunn, R.G., Doney, J.M., Smith, W.F. 1984. The effect of level of pre-mating nutrition on ovulation rate in Scottish Blackface ewes in different body conditions at mating. Animal Production. 39:235-239.

Gunn, R.G., Maxwell, T.J., Sim, D.A., Jones, J.R., James, M.E. (1991). The effect of nutrition prior to mating on the reproductive performance of ewes of two Welsh breeds in different levels of body condition. Animal Production. 52:157-163.

Instituto Nacional de Estadística, Geografía e Informática (INEGI). Resultados definitivos VII Censo Agrícola-Ganadero. Tomo II. México, D.F. 1994: 625-638.

O'Callaghan, D.O., Yaakub, H., Hyttel, P., Spicer, L.J., Boland, M.P. 2000. Effect of nutrition and superovulation on oocyte morphology, follicular fluid composition and systemic hormone concentrations in ewes. Journal of Reproduction and Fertility. 118:303-313.

Rhind, S.M., McNeilly A.S. 1998. Effects of level of food intake on ovarian follicle number, size and steroidogenic capacity in the ewe. Animal Reproduction Science. 52:131-138.

Rhind, S.M., Gunn, G., Doney, J.M., Leslie, I.D. 1984. A note on the reproductive performance of greyface ewes in moderately fat and very fat condition at mating. Animal Production. 38:305.

Russell, A.J.F., Doney, J.M., Gunn, R.G. 1969. Subjective assessment of bodyfat in live sheep. The Journal of Agricultural Science. 72:451. Abstract.

Sanson, D.W., West, T.R., Tatman, W.R., Riley, M.L., Judkins, M.B., Moss, G.E. 1993. Relationship of Body Composition of Mature Ewes with Condition Score and Body Weight. Journal of animal Science. 71:1112-1116.

SAS, 1985: SAS's User Guide: Statistics. SAS, Institutes, Cary. North Carolina, USA.

Scaramuzzi, R.J., Radford, H.M. 1983. Factors regulating ovulation rate in the ewe. Journal of Reproduction and Fertility. 69:353-367.

Scaramuzzi, R.J., Campbell, B.K., Downing, J.A., Kendall, N.R., Khalid, M., Muñoz-Gutiérrez, M., Somchit, A. 2006. A review of the effects of supplementary nutrition in the ewe on the concentrations of reproductive and metabolic hormones and the mechanisms that regulate folliculogenesis and ovulation rate. Reproduction, nutrition, development. 46:339-354.

Sheep Production Handbook 2002. American Sheep Industry Association, Inc. Seventh Edition Vol. 7. pp. 732.

Thomas, D.L., Thomford, P.J., Crickman, J.G., Cobb, A.R., Dziuk, P.J. 1987. Effects of plane of nutrition and Phenobarbital during the pre-mating period on reproduction in ewes fed differentially during the summer and mated in the fall. Journal of Animal Science. 64:1144-1152.

Viñoles, C.; Forsberg, M.; Banchero, G.; Rubianes, E. (2002). Ovarian follicular dynamics and endocrine profiles in Polwarth ewes with high and low body condition. Animal Science. 74:539-545.

West, K.S., Meyer, H.H., Nawaz, M. 1991. Effects of differential ewe condition at mating and early

postmating nutrition on embryo survival. Journal of Animal Science. 69:3931-3938.

White, R.M., Álvarez, L.J.A., Zarco, Q.L. Boletín Informativo 1987/88. Centro de Investigación, Enseñanza y Extensión en Ganadería Tropical. Facultad de Medicina Veterinaria y Zootecnia. Universidad Nacional Autónoma de México. México, D.F., 1987/88.

Xu, Z., McDonald, M.F., McCutcheon 1989. The effects of nutritionally-induced liveweight differences on follicular development, ovulation rate, oestrous activity and plasma follicle-stimulating hormona levels in the ewe.

SubmittedJune 19, 2009 – Accepted September 25, 2009
Revised received October 5, 2010