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Factors related to the onset of postpartum ovarian activity in dual purpose cattle in the tropics

Factores relacionados con la actividad ovárica postparto en ganado de doble propósito en los trópicos

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Abstract

In order to determine the factors related with the reproductive performance (days to first progesterone rise, to first oestrus, to conception and services per conception) and milk yields with pasture attributes (standing forage biomass and crude protein content), blood metabolites (total protein, albumin, urea, beta-hydroxybutyrate and globulin) and body condition changes, a total of 165 cross-bred cows *Bos indicus x Bos taurus* that calved within the period of study were used on 12 small farmers located within north-central region of the state of Veracruz, México. Each farm was visited every month. Milk samples were collected twice a week for progesterone analysis. Blood samples and body condition score were taken once a month. ANOVA was used to detect the effect of farm, season and their interaction upon all response variables. Regression and correlation procedures were used to quantify those relationships. Neither changes in body condition score or pasture attributes were sensitive enough to predict either milk yield or reproductive performance. Blood metabolite profiles were not consistently related to productive or reproductive variables either. On the other hand, the effects of farm and season were significant (P<0.05) on almost all response variables.

Key words: Reproductive performance, ovarian activity, dual purpose, tropics.

Resumen

Para determinar los factores relacionados con el desempeño reproductivo (días al primer incremento de progesterona, al primer estro, a la concepción y servicios por concepción) y producciones de leche con atributos de la pastura (biomasa forrajera y contenido de proteína cruda), metabolitos sanguíneos (proteína total, albúmina, urea, betahidroxibutirato y globulina) y cambios en la condición

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corporal, un total de 165 vacas mestizas (*Bos indicus* x *Bos taurus*) que concibieron dentro del periodo de estudio fueron usados con 12 pequeños productores localizados en la región norcentral del estado de Veracruz, México. Cada finca fue visitada mensualmente. Muestras de leche fueron colectadas dos veces por semana para analizar progesterona. Muestras de sangre y condición corporal fueron tomadas una vez por mes. Fue utilizado un análisis de varianza para detectar el efecto de granja, estación y su interacción sobre todas las variables respuestas. Fueron usados procedimientos de regresión y correlación para cuantificar dichas relaciones. Ni los cambios en condición corporal ni los atributos de la pastura fueron lo suficientemente sensitivas para predecir producción de leche o desempeño reproductivo. Los perfiles de metabolitos sanguíneos no estuvieron consistentemente relacionados a las variables productivas o reproductivas. Por otro lado, los efectos de finca y estación fueron significativos (P<0,05) sobre muchas de las variables respuestas.

Palabras clave: Desempeño reproductivo, actividad ovárica, doble propósito, trópicos.

Introduction

Most tropical areas of the world rely on dual purpose cows to fill their needs on milk production. These animals are mostly popular among small and medium size farmers, which have a system generally based on grazing and hand-milking with the calf at foot.

However, they vary widely in technology implementation, particularly with regard to the relative importance of pasture management, supplementary feeding, health control and overall management. Types of cattle utilized under this system are crosses between European *Bos taurus* and Zebu *Bos indicus* breeds. Production in these regions is low and variable. Calving rates of 43-65%, calf mortality of 4.8-26% and stocking rates that rarely exceed one animal per hectare are common figures. In case of Mexico, seventy five percent of the milk produced in the north-central region of the State of Veracruz, Mexico, comes from dual purpose farms, where average daily milk production is 3.1 kg/cow/day (1).

A prolonged postpartum anoestrus period (>150 days) is a characteristic of cows in the tropical regions of Mexico and is recognized as a major constraint to reach the ideal goal of a 12 month calving interval. This is dependent upon the re-establishment of ovarian cycle after parturition, which in turn depends on body condition, suckling policies, milk yield and diseases (5).

Even though there has been an increase in the utilization of agricultural by products in these regions in the past few years, the most important constraints in this system is still the inadequate nutritional management. Therefore, it is of great interest in tropical countries, to monitor the body condition and energy balance in the animal based on the nutrients available in the diet in relation to those required for optimal production.

Nutrients are transported to the sites of metabolism mainly in blood, Thus, monitoring changes in blood levels of metabolites may provide indicators of dynamic changes in nutritional status. Blood analysis is useful when combined with feed analysis, diet evaluation, health tests and careful management monitoring of the farm (6).

This is particularly important under tropical and subtropical conditions, where fluctuations in dietary quality and availability are much more severe than in others areas, hence changes in metabolite levels may prove a reliable tool in monitoring these events. It is therefore important to examine the levels of selected metabolites in blood with the aim of establishing if such measurements correlate with the benefits brought about by supplementation.

Material and methods

The study was carry out over two years (1992- 1994). A total of 165 crossbred cows *Bos indicus* × *Bos taurus* that calved within the period of study were used on 12 small farmers located within north-central region of the state of Veracruz, Mexico (20º 4' N and 97º 3' W).

There are three climatic seasons throughout the year: rainy, from July to October, presenting an increase and positive soil moisture balance and high temperatures leading to maximum pasture growth rates; "northern wind" (winter), from November to February, with adequate soil moisture balance but low minimum temperatures, around 12 ºC, which lowers the growth of C_4 tropical grasses, and "dry" season, from march to June, with a negative soil moisture balance in three out of five years and higher temperatures when compared to the other periods. On average, climate is classified as an Af(m), that is hot, humid, without a defined dry season. Average yearly rainfall is 1840 mm and average daily mean temperature is 23.4ºC, with a range between 14 and 35ºC.

The type of cattle utilized were crosses between European *Bos taurus* and Zebu *Bos indicus* breeds; like Brown Swiss and Holstein, mainly. All animals grazed on native grasses *Paspalum* spp, *Axonopus* spp, *Cynodon* spp or improved stands of mainly African Stargrass *Cynodon plectostachyus*. In ten farms, animals were supplied with extra feed based on agricultural by products (molasses, citrus pulp, discarded bananas, poultry manure) throughout the year. In two farms, cows received supplementary feeding but not on a continuos basis. Mineral mixture was offered in all farms.

Calves in ten farms were kept under the "traditional" suckling management, which consists in having the calf at foot to facilitate milk down; afterwards the calf remained tied up close to the dam until all cows were milked; then calf and cow were separated for a period of 5-6 hours to be joined again for half an hour period which the calf was allowed to suckle freely. Following this event the calf and dam were separated to be joined again on the next morning milking. Only in two farms, calves were under a 'restricted' suckling management which they were allowed to suckle two teats and the residual milk from the other two after the morning milking. Calves were weaned at 6 to 8 months of age in the 'traditional' suckling system and at 4 months in 'restricted' suckling scheme.

A record was kept on the identification of the animal, mating and calving date, weekly milk production and date of beginning and end of lactation.

Milk samples were collected twice a week by the farmer in a tube containing one sodium azide tablet as a preservative starting 15 days after calving until the cow was diagnosed pregnant by rectal palpation. Progesterone concentrations were determined by a solid phase radioinmunoassay technique using the FAO/IAEA progesterone RIA kit. The presence of ovarian structures and pregnancy diagnosis 45 days after breeding was done by rectal palpation every month. Detection of oestrous was performed by the farmer for 30 min. twice a day (AM-PM).

Body Condition (BCS) was scored monthly during each visit in all cows, from calving until diagnosed pregnant. A scale 1 to 5 (1= very thin and 5= very fat; ESCA Scoring System) was used. (3)

In order to monitor blood metabolites levels (ß-hydroxybutyrate, urea, albumin, and total protein), blood samples were taken once a month during the postpartum period (from 20-10 days prepartum until 120 days postpartum). Metabolic profiles were determined using kits provided by the FAO/IAEA. The globulin concentration was obtained by difference between total protein minus albumin.

Standing forage biomass (kg/DM/ha) was estimated at monthly intervals, obtaining 20 forage samples at random in the paddock with a 0.25 m^2. The samples were weighted fresh and then dried in the oven at 60ºC to determine dry matter content. With these measurements, the amount of DM/ha was calculated. Dried samples were ground on a Wiley mill and their crude protein (N × 6.25) content was determined using the Kjeldhal procedure. Cows grazed from 3 to 6 days on each paddock. Sampling was done whitin this grazing period.

All data (milk production, reproductive parameters and metabolic profiles) were classified according to date of calving in different seasons of year. Continuos response variables were analyzed by a linear model that included effect of farm, season and interaction farm by season. Due to a different sub-cell sizes, the method of analyses followed the least squares methodology of the PROC GLM of SAS. Blood metabolites and their relationships to milk production and reproductive performance were analyzed by regression and correlation stepwise procedures. Qualitative response variables were analyzed with two way contingency tables that use the χ^2 test to declare independence of response from the treatments.

Results and discussion

Reproductive performance. The reproductive performance for each farm is shown in table 1. There were statistical differences (P <0.05) among farms for all reproductive parameters. The general average for all farms were 128, 103, 166 days and 1.48 for days to first oestrus, time between calving to first progesterone rise (DP4), days open and the number of services per conception (SPC), respectively.

Days to first oestrus were shorter (P<0.05) in cows that calved in the dry season (111 ± 8.7 days) than those that calved in winter or the rainy season (128 ± 8.7 and 145 ± 6.9 days respectively). However the DP4, open days and SPC were not statistically different between seasons (P>0.05).

Table 2 shows number of cows with ovarian activity (OA) during the experimental period. A total of 55 % were cycling and 45% were identified as anoestrus. During winter 28% of cows had OA, whereas, in dry season only 6.7% had OA (P < 0.05).

Forty three percent of the cows calved in the winter; whereas 21% and 35 % calved in the dry and rainy season respectively. There were statisti-

Table 1. Reproductive performance in dual purpose cattle, days to first oestrus, first progesterone rise (DP4), days open and service per conception (SPC) in 12 farms, in the wet tropics of Mexico.

		Postpartum interval			
Farms	N	Days to first oestrus$^{1/}$	DP4$^{1/}$	Days open$^{1/}$	SPC$^{1/}$
1.	5	211 ± 26^{a}	176 ± 33^{a}	225 ± 33^{a}	2.3 ± 0.40^{a}
2.	15	81 ± 19^{b}	53 ± 14^{b}	101 ± 24^{b}	1.6 ± 0.27^{a}
3.	30	207 ± 18^{a}	128 ± 09^{a}	229 ± 24^{a}	1.2 ± 0.28^{b}
4.	7	73 ± 21^{b}	89 ± 23^{b}	134 ± 26^{b}	1.4 ± 0.21^{b}
5.	7	190 ± 13^{a}	159 ± 14^{a}	234 ± 19^{a}	1.4 ± 0.21^{b}
6.	30	108 ± 13^{b}	104 ± 11^{c}	157 ± 20^{a}	1.3 ± 0.22^{b}
7.	4	87 ± 27^{b}	83 ± 24^{b}	183 ± 35^{a}	2.1 ± 0.39^{a}
8.	35	80 ± 11^{b}	73 ± 09^{b}	117 ± 14^{b}	1.5 ± 0.16^{b}
9.	2	132 ± 36^{a}	137 ± 47^{a}	304 ± 47^{c}	3.0 ± 0.53^{c}
10.	6	81 ± 26^{b}	120 ± 24^{a}	N.A.	N.A
11.	7	160 ± 31^{a}	106 ± 19^{ac}	161 ± 40^{a}	1.1 ± 0.45^{b}
12.	3	154 ± 36^{a}	149 ± 33^{a}	244 ± 47	1.1 ± 0.55^{b}
Average		128 ± 71	103 ± 54	166 ± 84	1.48 ± 0.8

(a, b, c) Different literal in column (P< 0.05). 1/ Average and standard error. N A/ Data not available.

Table 2. Cows with ovarian activity (OA) according calving season in dual purpose cattle in the tropics.

	Calving season			
Ovarian activity	Winter	Dry	Rainy	Total
Cycling	28.0 (46)[a]	6.7 (11)[b]	20.0 (33)[a]	55.0 (90)
Anoestrus	15.2 (25)	14.0 (24)	15.2 (25)	45.0 (74)
Total	43.0 (71)	21.3 (35)	35.4 (58)	100.0 (164)

a, b: Means statistical difference (P < 0.05)

cal differences between seasons (P < 0.05).

Milk production. The general averages for milk production during postpartum period were 183, 211, 218 and 210 kg for one, two three and four months postpartum, respectively. There were no effects on milk production according to the season that the cow calved. There were no statistical differences (P>0.05) among farms during first month postpartum; however, statistical differences (P<0.05) became apparent after the first month of lactation between farms.

Table 3 illustrates the effects of calving season on total yield and length of lactation in crossbred cows. There was no significant difference (P>0.05) between seasons. However, there was a trend to produce more milk when cows calved in rainy season. Total yield and lactation length per cow was affected by breed in the different farms. Holstein crosses were the most productive compared to Brown Swiss and undefined crosses (P < 0.05). However, lactation length was not different among crosses (average 267 days). Figure 1 shows lactation curves. Holstein crosses had an apparent peak at week six, in contrast, curves for Brown

Table 3. Milk yield in crossbred cows in dual purpose farms according to calving season and breed.

Season	N	Milk Yield (kg)	Lactation Lenght (days)
Winter	40	1549 ± 762	252 ± 091
Dry	29	1428 ± 829	268 ± 122
Rainy	14	1710 ± 892	307 ± 124
Breed			
Holstein × Zebu	59	1725 ± 826[a]	272 ± 113
Brown Swiss × Zebu	8	976 ± 423[b]	254 ± 086
Undefined crosses	16	1109 ± 555[b]	254 ± 110
Average	83	1534 ± 804	267 ± 109

a, b: Different literal in column means statistically different (P < 0.01)

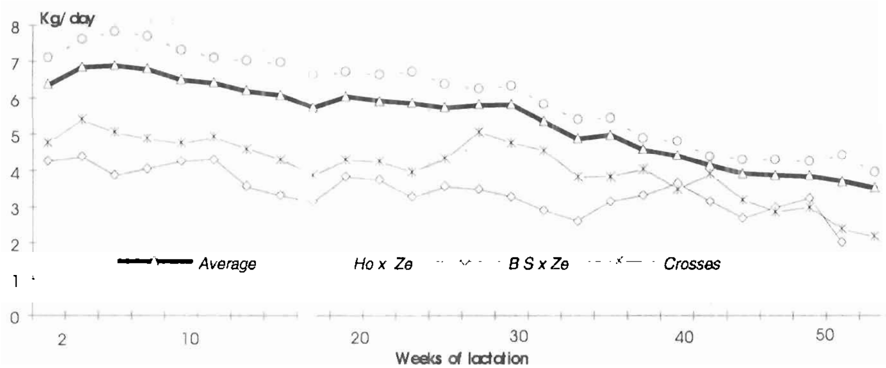

Figure 1. Lactation curves in crossbreed cows according to breed Holstein × Zebu (Ho × Ze), Brown Swiss × Zebu (BS × Ze) and undefined crosses (Crosses).

Swiss were highly variable. The average milk production per cow per day during lactation was 6.3, 3.4 and 4.3 kg, respectively.

Nutrition. The average body condition score (BC) at calving in all farms was 3.5, there was a statistical difference (P<0.05) between farms. However, during the first four months postpartum there was a decrease in BC for all farms, during this period the average was 2.6 and no significant differences (P>0.05) were recorded among farms. On the other hand, calving season affected the BC during postpartum period. The best BC was observed prior to calving in cows that calved during the rainy season (3.7) (P<0.05), while during the cold and dry seasons, scores were 3.5 and 3.3 respectively. However, after parturition, statistical differences (P<0.05) between seasons were only observed during the second month postpartum (2.7, 2.4 and 2.5 for rainy, dry and cold, respectively).

Blood metabolites. Precalving blood metabolites according to calving season are shown in table 7. Albumin was the only metabolite where statistical differences (P<0.05) between seasons were observed.

Table 4 shows blood urea levels per farm. There were statistical differences (P<0.05) between farms during the precalving and first month postpartum; the average blood urea at precalving was 6.85 mmol/L. There were no changes in blood urea with time during early postpartum at any farm. The effect of calving season on blood urea levels during pre and postpartum period was found to be not significant (P>0.05) (figure 2). Nevertheless, cows that calved during winter had higher values when compared to others.

Average globulin levels per cow per farm during the postpartum period are shown in table 5. There were statistical differences (P<0.05) between farms. However, no variation attributed to the postpartum month was observed (P>0.05). Also, there was not

Table 4. Blood urea levels (mmol/L) before and after calving in dual purpose cows in twelve farms in the wet tropic of Mexico.

	Months postpartum means and std. dev.			
tb 1.	7.1 ± 0.7^{a}	7.8 ± 0.9^{a}	7.5 ± 0.9	6.2 ± 1.2
2.	7.0 ± 0.6^{a}	7.3 ± 0.6^{a}	7.5 ± 0.5	7.2 ± 0.3
3.	6.7 ± 0.4^{b}	6.7 ± 0.6^{b}	6.7 ± 0.7	6.8 ± 0.5
4.	8.0 ± 0.5^{a}	8.0 ± 0.4^{d}	7.9 ± 0.5	7.9 ± 0.4
5.	6.9 ± 0.2^{b}	7.0 ± 0.2^{a}	7.1 ± 0.2	6.9 ± 0.2
6.	6.5 ± 0.7^{c}	6.3 ± 0.8^{c}	6.6 ± 0.1	6.7 ± 0.8
7.	7.6 ± 0.5^{a}	7.6 ± 0.4^{a}	7.5 ± 0.4	7.5 ± 0.6
8.	6.8 ± 0.6^{b}	6.9 ± 0.5^{b}	6.9 ± 0.5	7.0 ± 0.5
9.	7.3 ± 0.3^{a}	7.2 ± 0.2^{c}	7.3 ± 0.07	7.2 ± 0.1
10.	5.9 ± 1.1^{c}	6.5 ± 1.1^{c}	6.8 ± 1.6	5.4 ± 1.5
11.	6.5 ± 0.5^{c}	6.9 ± 0.05^{c}	7.1 ± 0.07	7.0 ± 0.2
Average	6.8 ± 0.7	6.9 ± 0.7	7.0 ± 0.7	6.9 ± 0.7

a, b, c: Different literal in column means statistical difference ($P<0.01$).

statistical difference ($P>0.05$) between seasons (figure 2). However, cows that calved in the rainy season showed a tendency to have higher levels at calving than cows whose parturition occurred in other seasons. On the other hand, cows that calved during winter had higher levels in the first and se-

Table 5. Blood globulin levels (g/L) in dual purpose cows during postpartum period in twelve farms in the wet tropic of Mexico.

		Months postpartum		
Farm	precalving	1	2	3
1	44.7	39.8	43.5	46.5
2	43.9	45.9	42.9	44.6
3	45.0	44.8	44.7	42.6
4	48.5	48.4	48.5	50.5
5	41.1	41.8	41.0	40.3
6	46.0	47.2	47.6	46.1
7	38.1	39.1	39.9	36.9
8	42.3	42.1	42.1	41.8
9	43.8	44.8	43.8	43.7
10	50.4	49.9	57.0	50.2
11	48.9	48.7	48.6	47.8
Average	44.27 ± 6.32	44.64 ± 6.48	44.74 ± 7.51	42.96 ± 5.91

Difference not significant ($P > 0.05$)

cond postpartum months. Albumin levels during the postpartum period were similar between months (table 6). However, there were statistical differences (P<0.05) between farms. Albumin levels during this period were 33.4, 33.3 and 33.7 g/L for first, second and third month respectively. Figure 2 shows albumin levels according to calving season. There was no a statistical (P>0.05) effect due to season. Cows calving in the dry season had higher albumin levels than cows in others seasons. On the other hand, in winter calving cows albumin levels tended to increase during the first month, but in general, albumin levels decreased after calving.

Table 7 shows blood b-hydroxybutyrate (b-OH) levels during postpartum period. There were statistical differences (P<0.05) between farms. Average b -OH at calving was 0.336 mmol/L. No change was observed in the following months (P>0.05), averages were 0.339, 0.308 and 0.282 mmol/L for first, second and third month respectively. Changes of blood b -OH levels during postpartum period for different calving season are shown in figure 2. There was not statistical difference (P>0.05) between seasons, but cows that calved during winter had higher levels than cows that calved in other seasons.

Pastures. Figure 3 illustrates the average of standing forage biomass (SFB) throughout the year in all farms. There was a high variability among farms. In general, the maximum SFB was obtained from may to September. Some farms like farm 12 (Vicente) always presented low forage quantities (634 kg DM ha) the whole

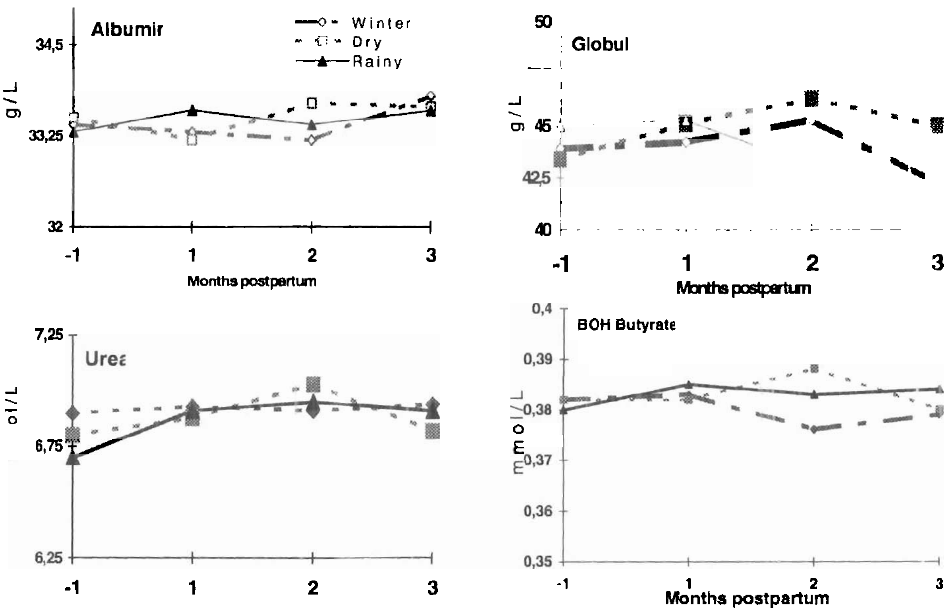

Figure 2. Blood metabolites levels in cows that calved in the winter, dry and rainy season.

Table 6. Blood albumin levels (g / L) in dual purpose cows during postpartum period in farms in twelve farms in the wet tropic of Mexico.

Farm	Precalving Means and std. dev /	Months postpartum Means and std. dev		
		1	2	3
1	34.8 ± 1.9^{b}	38.7 ± 4.4^{a}	39.0 ± 5.0^{c}	36.8 ± 6.0^{b}
2	32.0 ± 1.6^{a}	33.2 ± 3.9^{b}	32.2 ± 2.8^{a}	29.8 ± 0.6^{a}
3	35.8 ± 3.0^{c}	35.9 ± 2.8^{a}	35.4 ± 3.5^{b}	35.2 ± 3.9^{b}
4	33.0 ± 2.2^{b}	32.7 ± 2.0^{b}	32.8 ± 2.4^{b}	31.4 ± 1.3^{a}
5	31.2 ± 1.9^{a}	31.6 ± 3.0^{b}	31.5 ± 2.0^{b}	33.3 ± 3.1^{b}
6	32.6 ± 3.8^{b}	32.0 ± 3.6^{b}	32.0 ± 4.0^{b}	32.8 ± 3.6^{b}
7	31.8 ± 2.1^{b}	31.5 ± 2.61^{b}	30.8 ± 0.9^{b}	33.3 ± 2.2
8	33.9 ± 3.3^{b}	34.0 ± 1.8^{a}	34.3 ± 3.4^{b}	34.6 ± 3.1^{b}
9	32.8 ± 2.4^{b}	32.3 ± 2.3^{b}	33.5 ± 1.5^{b}	32.6 ± 0.9^{a}
10	32.8 ± 2.6^{b}	33.7 ± 4.2^{b}	30.6 ± 1.4^{a}	30.9 ± 1.1^{a}
11	30.4 ± 1.0^{a}	31.0 ± 1.5^{b}	30.8 ± 0.5^{b}	32.5 ± 4.3^{b}
Average	33.5 ± 3.23	33.4 ± 3.64	33.34 ± 3.56	33.77 ± 3.44

a, b, c: Different literal in column means statistically different ($P<0.05$).

year, while others like farm 7 (Hugo) and farm 4 (Clara) produced highest amounts (2756 and 5316 kg/DM/ha, respectively). Those differences indicated a high variation in grazing management, mainly different stocking rates that lead probably to different degrees of pasture utilization. In spite of the variation in forage quantity, the quality was not very different among farms; the maximum crude protein (CP) content was 10.9 % and the minimum 6.0 %, with an average contents of 8.3 ± 0.53 %. The best value of protein contents was obtained in April and June (9.0 and 9.3 % respectively). On the other hand, December and January were the worst (7.4 and 7.6 % respectively).

Standing biomass and crude protein of forage during the postpartum period and its effects of season are shown in figure 3. The highest SFB was obtained during rainy season (2095 kg/DM/ha). On the other hand, the best crude protein value was 9.6 % during winter. There were statistical differences ($P<0.05$) between months postpartum within season. The general average SFB during the postpartum period was 1703 kg DM/ha per month. Crude protein in forage was 9.4 %. Those measurements were different ($P<0.05$) among months and farms.

Relationships among metabolites, milk production, reproduction body condition and pasture attributes.

It found that urea had high correlation coefficients with total protein

Table 7. Blood b-Hydroxybutyrate(b OH) levels (mmol / L) in dual purpose cows during postpartum period in twelve farms in the wet tropic of Mexico (Least squares means).

		Months postpartum 1/		
Farm	Precalving 1/	1	2	3
1	0.36 ± 0.05[a]	0.44 ± 0.05[a]	0.44 ± 0.06[b]	0.42 ± 0.07[b]
2	0.40 ± 0.03[b]	0.39 ± 0.03[b]	0.38 ± 0.05[a]	0.39 ± 0.06[a]
3	0.38 ± 0.30[c]	0.37 ± 0.03[b]	0.37 ± 0.04[a]	0.38 ± 0.04[a]
4	0.40 ± 0.01[b]	0.40 ± 0.02[a]	0.39 ± 0.06[a]	0.38 ± 0.08[a]
5	0.37 ± 0.03[c]	0.38 ± 0.02[b]	0.37 ± 0.01[a]	0.38 ± 0.01[a]
6	0.39 ± 0.02[d]	0.39 ± 0.02[b]	0.38 ± 0.02[a]	0.39 ± 0.01[a]
7	0.39 ± 0.02[b]	0.38 ± 0.02[b]	0.38 ± 0.05[a]	0.38 ± 0.01[a]
8	0.37 ± 0.04[c]	0.38 ± 0.02[b]	0.38 ± 0.03[a]	0.38 ± 0.02[a]
9	0.31 ± 0.08[a]	0.32 ± 0.07[c]	0.27 ± 0.05[c]	0.26 ± 0.03[c]
10	0.38 ± 0.05[c]	0.41 ± 0.02[a]	0.041 ± 0 .02[b]	0.41 ± 0.06[b]
11	0.37 ± 0.04[a]	0.34 ± 0.06[c]	0.37 ± 0.02	0.38 ± 0.01[a]
Average	0.38 ± 0.04	0.34 ± 0.03	0.38 ± 0.03	0.38 ± 0.03

a, b, c, d: Different literal in column means statistical difference ($P<0.05$). 1/ Means and standard error

(r=0.79), albumin (r=0.77) and b hydroxybutyrate (r=0.81) at precalving, that reached the highly significant level ($P<0.001$). There were not correlation among blood metabolites, body condition score, reproduction parameters and milk production for the precalving period. Changes in body condition, either precalving or from calving to first month postpartum were not correlated ($P>0.05$) with reproductive parameters, milk production and blood metabolites.

Similarly, neither SFB or its CP content were statistically ($P>0.05$) correlated to blood metabolites during the first month postpartum. On the other hand, in the second month postpartum SFB was highly significant ($P<0.01$) correlated to total protein (r=-0.22) and globulin (r=0.28), respectively. In this same month, the CP content was not related ($P>0.05$) to any metabolite. By contrary during the third postpartum month, CP content significantly ($P<0.05$) correlated to total protein (-0.21) and globulin (-0.24), whereas the SFB was not correlated ($P>0.05$) to any metabolite. On fourth postpartum month, there were not any significant ($P>0.05$) correlation among SFB or its CP content, with metabolites.

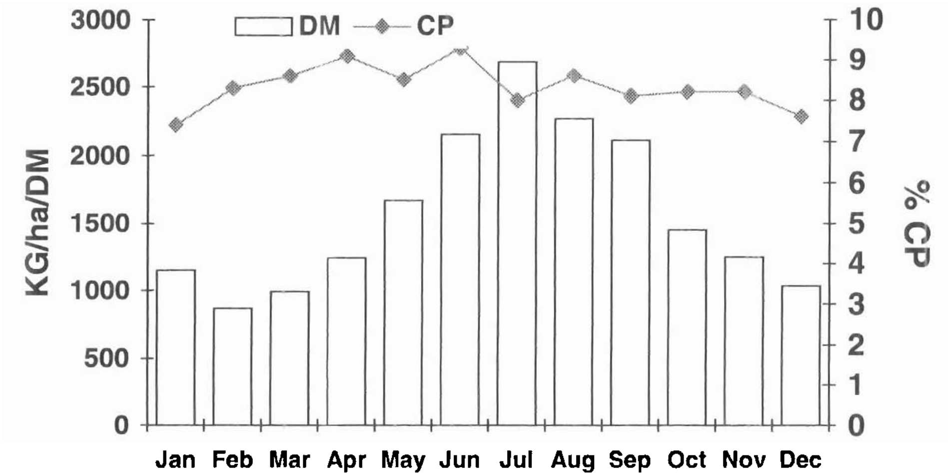

Figure 3. Average of standing forage biomass and crude protein contents troughout the year in twelve dual purpose farms.

Discussion

Late onset of ovarian activity delays the intervals to first estrous and days to conception. First progesterone rise occurred between 53 and 176 days postpartum. Fallas *et al* (4) reported that the first cycle in Holstein × Zebu cows in the tropics occurred around 93 days, depending on the type of calf rearing management. The interval from calving to conception occurred at 166 days. The values obtained are in agreement to those reported by several authors (5), indicating that open days in dual purpose cattle raised under tropical conditions ranged from 110 to 157 days. However, there was high variation between farms, which could be due to different types of calf rearing, this in turn affecting the onset of ovarian activity. This observation agrees with Vulich and Molinuevo (10), who indicated that 25% of total variance from the interval to conception is explained by differences in the management of the maternal offspring bond.

There was also a high variation between farms mostly as a consequence of different nutritional management strategies. However, a consistent feature was that Holstein cross-breds produced more milk than other crosses. Consequently average production was higher in those farms with a high proportion of Holstein crosses.

As expected, there was a decline in body condition after calving in all farms, and there were also effects of calving season during the postpartum period. Best body condition scores were found in cows that calved during the rainy season. Body condition score and reproductive parameters were not correlated in the present study.

The standing forage biomass is an indicator of the amount of dry matter available for grazing when areas are grazed at similar stocking rates, but it can also be indicative of differences in grazing intensity produced by different stocking rates on equally productive pastures. This latter situation seems to be the case for the farms studied. The use of variable supplementation policies in the different farms complicate the interpretation in the relationship between nutrition and reproductive performance when working on farm research.

Neither SFB or CP content appeared to have limited dry matter intake during the postpartum period, since the average standing biomass and CP values were close to the conventional threshold values of 1500 kg DM/ha and 7%, respectively. However, the period with higher CP values was from January to May which is the critical season with reduced pasture growth rate. The opposite happened with the remainder of the year. This is also in accordance whih normal behavior of tropical pastures dominated by C4 grasses.

Our results are at odds with reports in literature (3, 11, 12), as in our case blood metabolites did not relate statistically (P>0.05) to milk production or reproductive performance during the first five months postpartum. It is possible that blood metabolites relate well to productive performance in high producing animals of *Bos taurus* breeds which is not the case in the present study. The lack of correlation between blood metabolites and production may be due to the fact that the body reserves of cows at parturition were similar within and between farms, but these reserves were used in different ways by the various of breeds and crosses in our study, leading to similar levels of metabolites for widely different levels of milk production and reproductive performance. This might have been complicated by the different types of calf rearing, particularly with respect to suckling and weaning policies employed by the farmers.

Some studies have reported that decreases in BCS during postpartum are associated with increased postpartum intervals (9). In the present study, BCS declined from parturition to the end of the first postpartum month. However, the magnitude of this decline was not associated to any of the measurements of reproductive performance. At the present time we do not know if the typical response curve BCS-postpartum interval is of the same shape in *Bos taurus* × *Bos indicus* crosses as that found for European breeds in temperate climates. It is possible that the "optimum" BCS could be different for *Bos taurus* × *Bos indicus* since the required level of body reserves may be higher in the tropics due to increased maintenance requirements for heat stress.

Conclusions

Preliminary, it may be concluded that blood metabolites were not sensitive enough to detect or predict changes in reproductive performance and milk production. Further experiments are needed to decisively rule out the possibility of using these markers as suitable experimental tools in the tropics but of foremost considerations the development of adequate technology to help farmers increase milk production in the tropics.

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