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# BEHAVIOR OF THE PRODUCTIVE, REPRODUCTIVE AND METABOLIC PARAMETERS OF MEAT COWS WITH AN ORGANIC MANAGEMENT. TECHNICAL NOTE

## Comportamiento de los Parámetros Productivos, Reproductivos y Metabólicos de Vacas en un Sistema de Producción de Carne con un Manejo Orgánico. Nota Técnica

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### ABSTRACT

The current study describes productive, reproductive and metabolic performances reached by beef cattle under organic and conventional management. The experiment was carried out in two farms in La Araucanía Region, Chile. Both farms provided six cows and one bull for copulation. The feeding offered to conventional animals was based on a grassland of *Lolium perenne* with *Avena sativa* supplemented with hay and oat silage; feed produced with synthetic fertilizers. In addition, the animals are handled in a conventional way, that is, with the periosic application of antiparasitic agents, vaccines, vitamins and traditional veterinary drugs. The organic animals were offered natural organic grasslands with *Lolium perenne*, *Trifolium repens*, *Holcus lanatus*, *Paspalum dilatatum*, *Lotus pedunculatus*, *Dactylis glomerata* and were supplemented with hay of the same composition; feed produced without addition of any agrochemicals and fertilized only with manure. In addition, the animals were handled without the application of any traditional veterinary drug, using only phytotherapy and homeopathy as treatments of choice in case of pathologies.. The study period started one w before calving and finished on the eighth w postpartum. Blood samples and weight measurements were taken once a week (w). After the third w postpartum, the bull returned to the herd and cows had an echography each w to determine the return to their estrous cycle. At the beginning, organic cows body condition and weight scores increased throughout the experiment reaching an average weight of  $408 \pm 44.6$  kg, and weighing  $481 \pm 58.8$  kg at the end. Whereas, conventional cows did not exhibit the same tendency at the beginning, throughout the study they lost weight due to low food offering (966 kg dry matter (DM/ha) v/s 1670 kg DM/ha). This is a strategy used by conventional farmers to recover body condition score faster, which when combined with a Negative Energetic Balance (NEB) in the peripartum period, lead to a decrease in livestock weight. When conventional cows gave birth, non esterified fatty acids (NEFAS) and  $\beta$  hidroxy butyrate ( $\beta$ HB) concentrations in blood increased greatly, showing significant differences ( $P < 0.05$ ) compared to organic cows, even in the first w, which presented lower concentration levels during the experiment. However, these levels decreased in the conventional group, when food offer increased (1417 Kg DM/ha),

almost matching the two groups on the same level. In regards to reproductive aspects, significant differences were found in luteal tissue apparition between both groups ( $P < 0.05$ ) in postpartum anestrus. On average, organic cows returned to cyclicity 1 w before conventional cows. In conclusion, the differences observed between both farms are not attributed to a difference in organic or conventional management but rather to feeding management differences.

**Key words:** Cattle; conventional cows; organic cows; transition period.

### RESUMEN

El presente estudio describe los resultados productivos, reproductivos y metabólicos alcanzados por dos planteles de carne vacuna bajo manejo orgánico y convencional. El experimento se llevó a cabo en dos predios de la región de La Araucanía, en Chile. En ambos planteles se trabajó con seis vacas y un toro. El manejo de los animales convencionales se basó en la administración de una pradera de *Lolium perenne* con *Avena sativa* y suplementadas con heno y ensilaje de avena; alimentos producidos con fertilización con productos sintéticos además, los animales son manejados de forma convencional, es decir, con aplicación periódica de antiparasitarios, vacunas, vitaminas y fármacos veterinarios tradicionales. Los animales orgánicos se les ofreció praderas naturales certificadas orgánicas con *Lolium perenne*, *Trifolium repens*, *Holcus lanatus*, *Paspalum dilatatum*, *Lotus pedunculatus*, *Dactylis glomerata* y se suplementaron con heno de la misma composición, alimentos producidos sin adición de ningún agroquímico y fertilizados solamente con guano. Además, los animales fueron manejados sin la aplicación de ningún fármaco tradicional veterinario, usando solamente fitoterapia y homeopatía como tratamientos de elección en caso de patologías. El período de estudio comenzó una semana (sem) antes del parto y terminó en la octava sem después del parto. Se tomaron muestras de sangre y se tomaron mediciones de peso una vez por sem, y después de la tercera sem posparto, junto con el ingreso del toro al rebaño, se les realizó una ecografía sem a cada vaca para determinar el retorno a la ciclicidad. La condición corporal y el peso de las vacas bajo un sistema



orgánico aumentaron a lo largo del experimento, alcanzando en un principio un peso promedio de  $408 \pm 44,6$  kg y al final  $481 \pm 58,8$  kg. Las vacas bajo un sistema convencional no mostraron la misma tendencia, perdiendo peso a lo largo del estudio debido a una baja oferta ( $966$  Kg materia seca (MS) /ha v/s  $1670$  Kg MS/ha) de alimento al inicio del estudio, que se sumó al Balance Energético Negativo (NEB) característico del periparto. Cuando las vacas bajo un sistema convencional parieron, las concentraciones de ácidos grasos no esterificados (NEFAS) y  $\beta$  hidroxibutirato ( $\beta$ HB) en sangre aumentaron considerablemente, mostrando diferencias significativas ( $P < 0.05$ ), en las primeras sem en comparación con las vacas orgánicas, que presentaron niveles de concentración más bajos durante el experimento, sin embargo, estos niveles disminuyeron cuando las vacas del sistema convencional comenzaron a recibir más oferta de alimento ( $1417$  Kg MS/ha), casi igualando los dos grupos en el mismo nivel. En cuanto a aspectos reproductivos, se encontraron diferencias significativas en la aparición del cuerpo lúteo entre ambos grupos ( $P < 0,05$ ) en el anestro posparto. En promedio, las vacas del sistema orgánico volvieron a la ciclicidad una sem antes de las vacas del sistema convencional. En conclusión, las diferencias observadas entre ambos planteles no se atribuyen a una diferencia en el sistema de producción orgánico sobre el convencional, sino más bien a las diferencias en el manejo de la oferta de alimento.

**Palabras clave:** Vacunos; sistema de producción orgánica; sistema de producción convencional; periodo de transición.

## INTRODUCTION

Organic production is an alternative system for cattle (*Bos taurus*) production based on obtaining milk and meat, considering the animal welfare, health and environmental balance, which leads to sustainable healthy products with differentiating characteristics that provide benefits to human health.

In Chile, the conventional beef production system is more common. In this system, animals are constantly treated with veterinary drugs, such as anti-parasites, antibiotics, anabolics, among others. In La Araucanía Region, production levels are variable since there are three marked groups of cattle farmers: small, medium and large farmers, where the higher the number of heads, the better the technology that they use.

Beef cattle production in La Araucanía Region is mainly based on extensive systems using dual purpose breeds, such as Rotbunte, where the main food source is grassland (a mixture of *Lolium perenne* and *Trifolium pratense*). During the winter season, hay and silage supplements cushion the grassland growth problems observed in organic production, since supplementation with non-organic food is restricted by regulatory policies. Therefore, all remaining energy for livestock in this negative energy balance (NEB) period must be provided with organic foods. These cattle could present higher incidences of ketosis or more altered metabolic profiles; however, studies indicate that organic livestock have a lower incidence of metabolic alterations, attributed mainly to a balanced and natural diet [15, 22].

There is a close relationship between herd food levels and reproductive performance. Nutritional requirements during the first third of lactation can quadruple, and if cows do not achieve these feeding levels, nutrients from body deposits mobilize during this NEB period, prioritizing dairy production over the resumption of ovarian activity [17, 38].

In other countries, observed reproductive parameters in organic cows are characterized by shorter reproductive performances than their conventional counterparts, such as reduced inter-partum periods, first delivery periods, conception periods, and a lower number of pregnancy services, leading to a higher percentage of pregnancy in the first service [19,36].

Organic livestock production in Chile is minimal. Currently, there are only 2,548 hectares (ha) of grasslands and 453 bovines certified as organic. However, there is an increasing demand by consumers for "clean, green and ethical" products [20], so it is interesting to evaluate the productive, reproductive, and metabolic characteristics shown by these animals under Chilean conditions, in order to objectively evaluate possibilities of transition to an organic system. The present study describes the productive, metabolic, and reproductive profiles of cows raised under organic and conventional conditions.

## MATERIALS AND METHODS

### Location and animals

The experiment was conducted in parallel on two farms: first, under organic management and the second under conventional management, both located in the Araucania Region of Chile, under similar agro-climatic conditions.

Cattle from the Normande breed were used in both farms. Six cows from each farm and their respective calves born during spring were used for the sample. After the third w postpartum, the bull got in with cows from each farm for the mount. Cows were randomly selected in both farms, taking precautions that the cows had between 2 and 4 calves and that the body condition scores at the beginning of the experiment for all animals was 2-3 on a scale of 1-5 according to the scoring system used by the British National Institute for Research and Dairying at the beginning of the experiment [11].

### Feeding

In the conventional system, feeding consists on an extensive grazing system supplemented with hay and water *ad libitum*, whereas the organic system consists on organic certified natural pastures, managed with an extensive system of rotational grazing, also with water *ad libitum*.

### Samples and monitoring

The experiment lasted from the (w) prior to delivery, up to 8 w postpartum where reproductive and metabolic monitoring was performed through birth records, signs of heat, heat detection patches, ultrasonographic monitoring, and blood samples.

A body condition score (BCS) measurement was performed every fifteen days (d), recorded on a scale of 1-5, where 1 is undernourished and 5 is overweight [11]. Cows were weighed with a portable electronic device Roman scale (Iconix FX1), Iconix New Zealand Ltd.

### Grassland availability, production, and nutritional composition

A Jenquip® compressed height forage plate was used to determine dry matter (DM) availability per ha where the compressed height of grassland was measured once a w, and a hundred times at random places, applying measurements to the formula to calibrate results for grasslands in the Araucania Region of Chile during spring time. Results were given as kilograms (kg) DM/ hectares (ha)

Two 50 x 50 centimeter (cm) metal exclusion cages were used for grassland production measurement. One cage was used in each farm; to perform the measurement, a 50 x 50 cm square of was demarcated in a homogeneous prairie representative of the farm. Grass cuttings were taken inside the marked square

and placed in plastic bags without air and immediately weighed and frozen (Whirlpool Wha20ABDWC 2014, China) at -20 °C for posterior analysis in the laboratory. The exclusion cage was put in place from the d the grass was cut, until 28 d later, from where it was removed and the grass that grew inside the cage was cut again, obtaining samples, similar to the latter (in plastic airless bags, weighed and frozen). The process was repeated in another pasture location on the 28th d to determine prairie production from the application of the cage. The nutritional composition was determined with sample pastures cut in zigzag at the height of grazing, avoiding proximity to entrances, drinking troughs, and trees. Finally, a third sample of approximately 500 grams (g) was taken and placed in a plastic airless bag and frozen at -20 °C.

### Metabolic $\beta$ -hydroxybutyrate ( $\beta$ HB) and non-esterified fatty acids (NEFA) determination

Serum concentrations of  $\beta$ HB and NEFA were determined from blood samples drawn once a w from the last w prior to delivery up to 30 d postpartum. From this date, samples were taken every fifteen d up to 60 d postpartum. Blood samples were collected from the coccygeal vein, taking a sample volume of 5 milliliter (mL) with a vacuum tube without anticoagulant BD Diagnostics, México. Serum portions were separated into 1.5 mL Eppendorf tubes, previously labeled with the animal's identification number, and the collection date, and then frozen at -20 °C until further analysis.

All analyses were carried out using specific commercial kits to determine  $\beta$ HB (NAD-dependent enzymatic UV method; Randox®, N°1007, USA) and NEFA (colorimetric enzymatic method; Randox®, N° 115, USA). Samples were processed in an automated Shimadzu spectrophotometer, model UV mini 1240 Japan.

### Return to postpartum cyclicity and fertility

An EstroTECT® heat detector was applied to the rear end of each cow 15 d postpartum, recording when a cow entered estrus. Ultrasound monitoring began after the third w postpartum, coinciding with the bull entry to perform bio-stimulation. Ultrasound was performed transrectally using a B mode portable ultrasound (SSD500, Aloka CO, Japan). Presence of follicles and luteal bodies was observed in both ovaries, measuring the size of each ovary and recording them in the «ovarian map» of each cow.

### Statistical analysis

Data were ordered and tabulated for descriptive statistics, determining the mean, fashion, median, quartiles, standard deviation (S.D.), standard error (S.E.) and variance. Subsequently, normality was evaluated with the homoscedasticity of data obtained with Shapiro-Wilk test and Barlett test. Means were compared through a two-sample Student's t-test with a 0.05 significance. All analysis were done with a MINITAB® 16.1.0 software (2010, Minitab Inc. USA).

**Grass and hay production, availability, and composition**

Significant differences were observed in nutritional composition between farms (TABLE I); crude protein (CP) percentages in the grasslands were significantly different at the beginning of the experiment. The conventionally fertilized farm presented higher CP values and by the first month (mon) there was only an 18.4% difference, at the beginning of the experiment. This situation was then reversed, with the organically managed farm surpassing the conventional by 5.4% in this category.

DM percentages between grasslands did not present significant differences. Total ashes, metabolizable energy, and neutral and acid detergent fibers, also did not present important differences and their variations were very small over time.

During the first mon, the two farms presented significantly different soluble carbohydrate percentages. In this category, the organically fertilized grasslands practically doubled the conventionally fertilized in the first measurement, changing the situation in the second mon, where soluble carbohydrates were matched between the two farms. Exactly the same situation occurred for soluble proteins, where the percentage was double for conventional grassland when compared to organic at the beginning; however, in the second mon, the situation changed, and the organic grassland exceeded the conventional by almost 4%.

TABLE II shows significant differences in both the daily growth rates of the grasslands and their supply. A very low daily production was observed for the organic farm (OF) during the first mon of the experiment compared to the conventional farm (CF), presenting a difference of 23.9 kg DM/ha, however, organic supply practically doubled the conventional supply. In the second mon, the situation changes abruptly, with OF production increasing twice as much as the CF production, not being the case for nutrient supply, where CF showed increases and almost equally to OF supplies.

The organic farm pasture used in the present study consisted on *Lolium perenne*, *Trifolium repens*, *Paspalum dilatatum*, *Lotus*

*pedunculatus* and *Dactylis glomerate*. The only fertilization performed is the spread of manure twice a year. The conventional farm, on the other hand, was established with *Lolium perenne* and *Avena sativa*, which is fertilized with urea and a mixture of nitrogen, phosphorus and potassium twice a year.

CP levels during the first mon of the experiment in the OF were low (6%) compared to the described characteristic levels of the Araucania region during spring (23.44%). These values are expected, since in the OF the only fertilization is based on manure, in contrast with the reference values of the conventional fertilization of grasslands composed of *Lolium perenne* and *Avena sativa*, which possess higher protein percentages [8]. Protein levels presented by conventional grasslands were excessive when compared to pastures metabolizable energy levels, which were within the described average level (2.77%). It is observed that there is loss of protein utilization, since food energy levels do not allow the perfect utilization of CP present in the pastures [8,16]. With respect to the acid detergent fiber, it exceeded the recommendations for cattle by 2% in the OF, while the CF showed a percentage within the accepted range [36]. In relation to hay nutritional content offered to conventional cows (CC), it can be noted that all evaluated nutritional values are within the reference range of hay with the same characteristics [14].

During the second mon of the experiment, grassland composition changed due to climatic variations, where the average temperature increased while rainfall decreased; allowing OF to increase up to 29% CP, which implies a loss of protein utilization, since metabolizable energy is the same as the previous mon. On the other hand, CF decreased to 24%, indicating a good use of nutrients associated with an optimal energy percentage [22].

At the beginning of the experiment, daily growth in organic pastures were quite low, influenced by a decrease in the percentage of DM present in pastures (TABLES I and II); however, the following mon, it registered a more characteristic behavior of the region, same as CF [8]. Nevertheless, grassland supplies throughout the experiment were higher in the OF, which was strongly reflected in the cows body condition scores, especially during the first mon (FIG. 1).

**TABLE I  
NUTRITIONAL COMPOSITION OF GRASS FROM BOTH FARMS DURING THE EXPERIMENT**

Farm or Group		DM	TA	CP	ME	NDF	ADF	SOCH	SP
		%	%	%	Mcal/kg	%	%	gr/kg	%
Organic	Month 1	15.49	12.62	17.33	2.60	51.39	27.11	83.10	8.91
	Month 2	14.89	11.08	29.58	2.70	42.04	20.90	77.44	13.05
Conventional	Month 1	15.14	12.99	35.73	2.61	47.20	23.13	43.58	17.24
	Month 2	17.22	10.39	24.18	2.72	44.38	22.37	81.66	9.51

DM: Dry Matter, TA: Total Ash, CP: Crude Protein, ME: Metabolizable Energy, NDF: Neutral Detergent Fiber, ADF: Acid Detergent Fiber, SOCH: Soluble Carbohydrates, SP: Soluble Proteins.

**TABLE II**  
**DAILY PRODUCTION AND SUPPLY OF GRASSLAND TO CATTLE IN BOTH FARMS DURING THE EXPERIMENT**

Farm or Group	Period	Daily Production	Food Offering
		Kg DM/ha	Kg DM/ha
Organic	Month 1	0.23	1670
			1368
	Month 2	69.44	1862
			1504
Conventional	Month 1	24.08	966
			966
	Month 2	38.87	1329
			1417
			1703

Kg DM/ha: Kilograms of dry material per hectare.

#### **Live weight and body condition score of cows in organic and conventional beef production systems**

Body weights (BW) observed at the beginning of the study did not present significant differences ( $P > 0.05$ ) between groups. CC had BW of  $472 \pm 54.9$  kg, which was significantly higher than those obtained by OC one w before calving, with a difference of 64.1 kg less for OC; however, the body condition score (BCS) observed in both groups at the same date is approximately 2.6 points, showing no significant differences (FIG. 1).

Similar weights are reached by OC and CC ( $428.3 \pm 45.9$  vs.  $428 \pm 45.3$ , respectively), from birth up to the eighth w postpartum. OC showed a progressive increase in their BW, with daily gains reaching a maximum of 2.1 kg/d during w 4 and 6 postpartum and an average gain of  $1.2 \pm 0.9$  kg/d throughout the study period. A sustained increase was observed in this period regarding postpartum bodily reserves for animals under organic management, reaching a BCS of  $4.1 \pm 0.39$  points in the eighth w postpartum and climbing on average  $1.5 \pm 0.33$  points from the beginning to the end of the experiment.

In contrast, CC presented differences in BW over the six-w postpartum period in relation to OC, showing a decrease in BW which is more pronounced between the fourth and sixth w postpartum, where the cows lost  $7.3 \pm 7.7$  kg on average. This situation changes from the seventh w until the end of the experiment and ends with the cows weighing  $443.8 \pm 38.6$  kg BW, being 29.6 kg heavier than during the sixth w postpartum. In spite of this weight gain, CC did not manage to equal OC, which at that time weighed an average of  $481.8 \pm 58.8$  kg, although there were no significant differences between the two groups at that date ( $P > 0.05$ ).

At the beginning of the experiment, the BCS of CC did not show significant differences compared to OC ( $P > 0.05$ ); however, during the course of delivery and until the fourth w postpartum, there was a marked decrease in body reserves, decreasing  $0.3 \pm 0.4$  points in BCS during that period. From the sixth w until the end of the study the situation was reversed, with an increase in BCS of  $0.5 \pm 0.2$  points, reaching an average of  $3.1 \pm 0.2$  BCS throughout the conventional cows, at the end of the experiment.

BW observed were significantly different between the two groups (FIG. 1) at the first; however, BCS were similar between both groups. This could be attributed to the body conformation of bovines under the organic system being inferior to bovines under a conventional system, inspite of being animals of the same breed. These differences can be visualized in bigger bovines, which on average reach approximately 5 cm difference in height at the withers. These differences were also observed by Aeberhard et al. [1], who observed differences of about 4 cm in the height of dairy cows, with a difference of approximately 60 kg of weight between the different heights.

OC showed increases in body weight postpartum with a weight gain of up to 31.6 kg between the fourth and sixth postpartum w, unlike the CC that during the same period continued reducing their BW, although these losses are less pronounced than between birth and the fourth w after. These differences can be explained by the uneven feeding offered in both groups from the beginning of the experiment. Although OC had higher instantaneous animal load, these animals had an average supply during the first mon of 1,519 kg DM/ha, increasing during the second mon to 1,694 kg DM/ha, and in the case of the CC they were offered 966 kg DM/ha during the first mon and 1,483 kg DM/ha during the last mon of the experiment. CC management presented a more consistent curve compared with that of Doepel et al. [9] during the transition

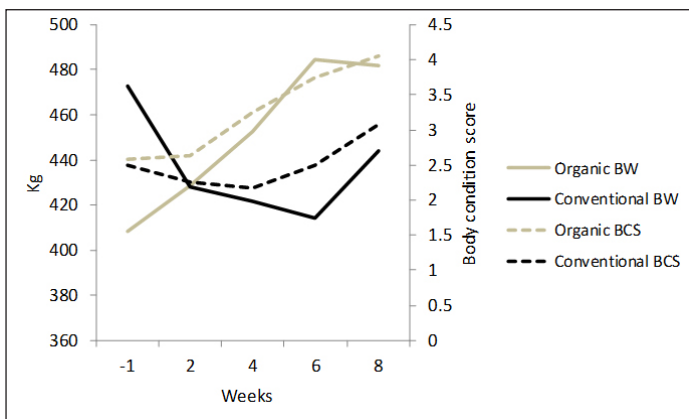


period, where they observed a significant decrease in BW during the first four w postpartum due to the characteristic NEB during this physiological stage and that subsequently cows reverted during the second mon of lactation [3].

With regards to BCS, the same pattern was observed for cows under organic management, increasing their body reserves from birth to the end of the experiment by 1.5 points and showing a close and positive correlation ( $r = 0.6$ ) between BW and BCS. The group of cows under conventional management shows a similar trend to that of BW, falling from the beginning of the experiment to the fourth w postpartum and rebounding after this period, until the end of the experiment. However, this increase does not allow this group to reach the conditions presented by OC.

Variations in BCS were 1.5 points more for the organic cows and in the case of CC, the strongest decrease was -0.33 points. Schulz et al. [33] describe that a point in BCS on a scale of 1 to 5, is approximately 55.2 kg of BW, which coincides with BW modifications observed during the experiment (+76 kg for OC and -58.4 kg for CC).

Another explanation for the drop in BW and BCS shown by the CC is that these animals were subjected to NEB during the postpartum period showing a decrease in BCS and BW, which is characteristic of this species and breed. Königsson et al. [17] describe that the physiological process of lactation implies an increase in nutritional requirements of up to 40% with respect to maintenance. In addition, bovines are not able to supply this high nutritional requirement, therefore there is a strong mobilization of body reserves [3, 31].

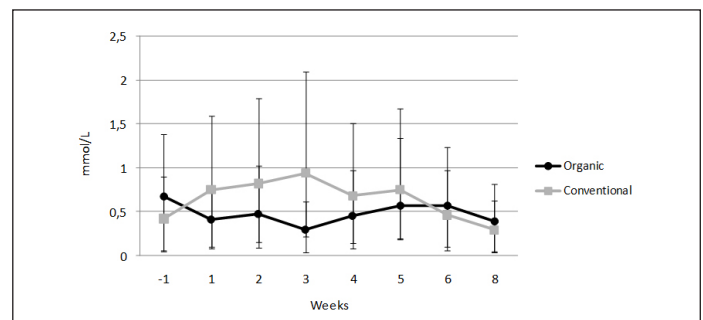


**FIGURE 1: BOVINES LIVE WEIGHT AND BODY CONDITION IN ORGANIC AND CONVENTIONAL MEAT PRODUCTION SYSTEMS POSTPARTUM**

Organic BW: body weight of bovines under organic management during the experiment; Conventional BW: body weight of bovines under conventional management during the experiment; Organic BCS: body condition score of bovines under organic management during the experiment; Conventional BCS: body condition score of bovines under conventional management during the experiment.

**Non-esterified fatty acids (NEFA) and  $\beta$  hydroxybutyrate ( $\beta$ HB) metabolic profile determination**

NEFA concentrations showed significant differences ( $P < 0.05$ ) the first 5 w of the experiment (FIG. 2), which at the beginning of the study (1 w before calving) cows under conventional management had lower NEFA concentrations than cows under organic management. This situation was reversed at birth, where OC showed a decrease in blood levels of this metabolite by 38.8%, while CC increased their concentrations by 44.6% until the fourth w postpartum. The third postpartum w shows the most pronounced difference between the two systems, with concentrations of  $0.29 \pm 0.09$  mmol/L for OC and  $0.94 \pm 0.52$  mmol/L for CC. However, after the fourth postpartum w, these differences disappear, matching the levels between the two, with both systems showing a tendency to decrease over time.



**FIGURE 2. NEFA BLOOD CONCENTRATIONS (MEAN  $\pm$  S.D) IN BOTH FARMS DURING THE TRANSITION PERIOD.**

Organic: blood concentrations of NEFA in cows under organic management during the experiment; Conventional: blood concentrations of NEFA in cows under conventional management during the experiment; mmol/L: number of moles per liter.

$\beta$ HB blood concentrations were not significantly different ( $P > 0.05$ ) between both groups. Nevertheless, in the third w postpartum, organic cows showed an increase of 59.7% which was maintained subsequently in around 0.5 mmol/L. With respect to the same w, these OC reached 53.8% more  $\beta$ HB blood concentration than cows under conventional management ( $P = 0.05$ ; FIG. 3). During postpartum w 4 and 5 these differences equated between the two groups and were differentiated again by the sixth w. This time it was exhibited by an increased  $\beta$ HB blood concentration for the conventional (68.6%;  $P = 0.07$ ).  $\beta$ HB blood concentrations throughout the study for the OC were maintained at approximately 0.6 mmol/L for seven w, and a single w showed values above 1 mmol/L, while the CC presented three (w-1, 6 and 8), with values above 0.8 mmol/L.

Blood concentrations of NEFA during the postpartum period should be less than 0.6 mmol/L [4, 6]. Therefore, both groups had high blood concentrations at some point of the study period. Considering this CC were higher, exceeding these concentrations in 5 out of the 9 w that were studied between the first and fifth w

postpartum. However, this situation was observed only one w prior birth in the OC. This shows that CC were more weeks in NEB during postpartum due to a restricted supply of grassland (966 vs. 1,670 kg DM/ha). As described by Cooper-Prado et al. [7] the nutritional requirements for keeping a calf during the first mon of calving are 11 kg DM/d (40% higher than an adult bovine). Therefore, these requirements were not covered, catalyzing a process of triglycerides degradation [5, 13].

The curve of NEFA concentrations observed in CC shows a similar shape to those characterized for dairy cows, although the curve of the CC is delayed by two w compared to the one described in the literature [9], where a peak during the first w postpartum are observed, along with subsequent decreases until reaching physiological parameters around the fourth w postpartum. The difference in both studies could be related to the fact that bovines in the conventional farm had a peak of NEFA in two w, where the highest concentration of this metabolite is found in conventional cows in the third w postpartum [9, 27, 35].

A completely different situation was observed in the OC, which presented a sustained decrease during the first postpartum w, and showed concentrations above the physiological ranges in only one week (FIG. 2), which coincides with the peak described for dairy cows. This NEFA concentration curve observed for OC can be explained by the greater availability of food offered and its nutritional composition, which in the second mon showed increased CP levels by 12.3%, stimulating lipid mobilization which was reflected in a small increase in NEFA during the second mon of the experiment [9]. The same process occurred in the CC, during the first mon of study, since the pasture offered to bovines was scarce and with 35.73% of CP, which according to Doepel et al. [9] stimulates the production of NEFA achieving higher concentration peaks. In one of the few studies where metabolic profiles between organic and conventional systems in dairy cows was compared [25], there were no significant differences in NEFA blood levels between the two production systems.

Acceptable  $\beta$ HB blood concentrations for cows in early lactation are  $< 0.6$  mmol/L to  $< 0.8$  mmol/L and higher than these values is considered subclinical ketosis [40]. Therefore, it can be concluded that both groups had subclinical ketosis, with an excess of energy reserve mobilization that the organism could not absorb, therefore increasing ketone bodies concentrations in the blood, although there were no significant differences between the two groups [6, 9, 35]. However, it should be noted that OC only presented subclinical ketosis in one w (w 3), unlike CC that underwent three (w -1, 6 and 8). Therefore, recovery of NEB by OC seems to be more efficient, as it decreases NEFA and  $\beta$ HB blood levels earlier than the CC [22]. These results are similar to those described by Richert et al. [29] who reported that CC presented higher incidence rates of subclinical and clinical ketosis than OC.

BCS of cows in the transition period was equivalent at first. However, as the experiment progressed, CC strongly decreased their BCS and BW, reflecting an increase in NEFA and  $\beta$ HB blood

concentrations, showing that there was a high rate of fat mobilization and a deficiency of carbohydrates, thus increasing the production of ketone bodies as an alternative energy source [22,37].

During the third w postpartum, cows under the organic system increased  $\beta$ HB concentrations, achieving a maximum of  $1.26 \pm 0.46$  mmol/L. This increase can be explained by a process of negative energy balance which was the case during this period [37]. However, considering the weight gain, bovine BCS and low NEFA concentrations observed during the same w, this theory is discarded. Therefore, ketosis type II is more likely to have occurred, which happens due to excess supplementation in the peri-partum period, causing an increase in  $\beta$ HB concentrations associated to hyperinsulinemia [24].

There is a dependence and positive correlation reported between animal BCS and fat mobilization, where livestock with high BCS ( $> 4$ ), mobilize more NEFA than livestock with medium BCS (3.5) under a period of food restriction, and in turn, there is a dependence and positive relationship between the levels of NEFA and  $\beta$ HB, to where  $\beta$ HB blood levels increase for both groups. At the end of the experiment these levels are strongly related to increases in BW and BCS at that stage [24, 35].

Results show a similar trend to that reported in literature, where blood concentrations were significantly higher ( $P < 0.01$ ) in conventional cows when compared to OC ( $989.5 \pm 61.7$  vs.  $813.8 \pm 24.6$   $\mu$ mol/L), which would eventually be attributed to an unsatisfied animal welfare state with a balanced diet that allows NEB not to be as pronounced as in CC [25].

In the United Kingdom, subclinical ketosis was more frequently reported for cows under organic management. However, these authors concluded that animals managed under an organic system have a greater capacity to adapt to poor dietary levels, a situation that can be observed in this study [32], where OC around partum presented higher values of metabolites, indicative of energy metabolism, but these values were not extreme, as observed in blood concentrations reached for CC (FIG. 3).

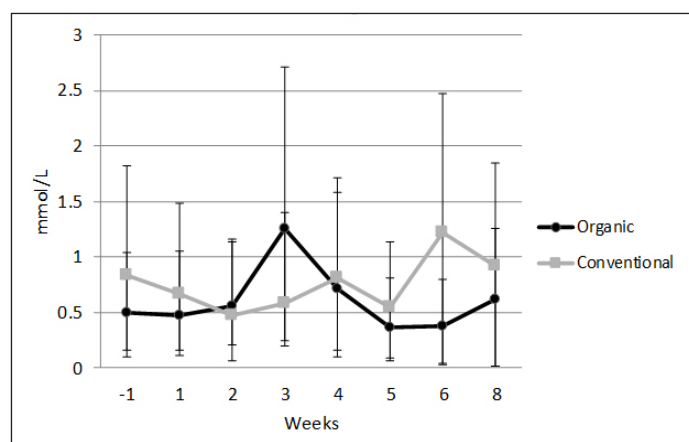


FIGURE 3. BLOOD CONCENTRATIONS OF BHB (MEAN  $\pm$  S.D) IN BOTH FARMS DURING THE TRANSITION PERIOD.



Organic: blood concentrations of  $\beta$ HB for bovines under organic management; Conventional: blood concentrations of  $\beta$ HB in bovines under conventional management; mmol/L: number of moles per liter.

### Return to postpartum cyclicity

Estrus behavior in both groups did not present significant differences ( $P > 0.05$ ), with the organic cows returning to cyclicity 4 d earlier (TABLE III). However, luteal tissue presence was different ( $P < 0.05$ ) between the two groups, where there was a corpus luteum present at d 43 in the OC versus d 52 in the CC.

It can be observed that both groups presented similar sizes regarding follicular dynamics at three w early postpartum. However, the follicular size of OC exceeds 8 milimeter (mm) in diameter in the fourth w, while CC maintained at 5 mm, presenting significant differences between both groups ( $P < 0.05$ ), with CC exceeding 8 mm only after the sixth postpartum w. During that same w, OC continued follicular growth, surpassing 10 mm diameter.

Follicular dynamics monitored from the third w postpartum allowed us to observe a difference in follicular size presented by the ovary, as seen in FIG. 4, where only small follicles were found for both groups in the third w. During the fourth w, the organic cows showed a change with a good number of medium sized follicles, contrary to the CC which had only small follicles (50% of organic animals with medium follicles vs. 100% small follicles in the conventional group). In w six, 3 cows from a total of 6 already had pre-ovulatory follicle sizes, unlike CC where only 1 out of 6 had follicles of that size (FIG).

4). Postpartum cyclicity was not affected by the productive system (TABLE III); however, OC showed an advance in luteal

tissue presentation compared to the CC ( $P < 0.05$ ). This earlier appearance of the corpus luteum (CL) in OC, even before the first observed estrus, indicates the exit of the postpartum anestrus, presenting a silent ovulation without estrus. This characteristic is described by Pinzón and Grajales [26], where cows during the postpartum period travel through a silent estrus, which although not visually observed, it could be detected by ultrasound through the appearance of the CL.

In contrast to dairy cattle, beef cattle are characterized by restarting cyclicity later (30 d vs. 15 d when there is no marked NEB) [23]. This is the reason why organic livestock are ideal for beef production. However, Stagg et al. [34] describe that beef bovines, which cycle through postpartum dietary stress where their nutritional requirements cannot be covered by the food offer, strongly delay the restart of cyclicity, achieving ovulation for the first time 70-100 d postpartum. This data is in agreement with the CC, which delayed the restart of cyclicity due to the NEB that took place during the first mon of calving, and quickly reverted this by increasing the food supply, allowing an increase in BW and BCS, which stimulated the release of gonadotropins, increasing follicles to ovulatory size [2, 21].

Follicular development was also influenced by feeding, since grassland supply was higher in the organic cows (TABLE II), they developed pre-ovulatory follicles more prematurely [16]. This has been associated to cows with NEB that increased their levels of NEFA and  $\beta$ HB, but reduce insulin, glucose, and IGF-1 concentrations [12]. The decrease in IGF-1 concentrations causes a negative feedback in the follicular development, since this factor stimulates growth and maturation of the follicle, allowing the follicle to increase estrogen release, which promotes positive increases in LH pulses triggering ovulation [17].

OC showed an increase in follicular size compared to CC (FIG).

**TABLE III**  
**CHARACTERIZATION OF RETURN TO CYCLICITY FOR BOVINES IN BOTH FARMS BY ESTRUS AND CORPUS LUTEUM PRESENTATION AND SIZE OF THE LARGEST FOLLICLES BY ULTRASOUND FOLLOW-UP**

Categories		Organic cows	Conventional cows	Significance
		(Mean $\pm$ S.D)	(Mean $\pm$ S.D)	
Birth day - First estrus		45.4 $\pm$ 8.6	49.5 $\pm$ 6.9	$P > 0.05$
Birth day- Corpus luteum presentation		43.0 $\pm$ 11.7	52.3 $\pm$ 6.6	$P < 0.05^*$
Follicle size (mm)	Week 3	5.0 $\pm$ 1.0	5.3 $\pm$ 1.2	$P > 0.05$
	Week 4	8.8 $\pm$ 3.5	5.6 $\pm$ 2.0	$P < 0.05^*$
	Week 6	10.5 $\pm$ 3.9	9.2 $\pm$ 3.5	$P < 0.05^*$
	Week 8	7.6 $\pm$ 2.8	10.3 $\pm$ 4.5	$P < 0.05^*$

S.D: Standard Deviation mm: millimeters \*value with significative difference

4). The frequency of pre-ovulatory follicles ( $\geq 15$  mm) was higher in CC at w 6, and follicle frequency was increased by w 8, which according to Wiltbank et al. [39], they are able to increase their levels of circulating estradiol just after that date, thus stimulating the production of LH and ovulation. OC on the other hand, showed a high frequency of small follicles ( $\leq 10$  mm) at w 8, due to the fact that these cows already ovulated on the sixth w, within the beginning of the second follicular wave in the follicular emergency stage [18, 39].

Discrepancies can be found in the literature regarding the restart of cyclicity, where it has been observed through studies of farm records that there are no significant differences in CFI (calving to first insemination) between organic and traditional livestock [14, 30]. However, Fall et al. [10] found significant differences in CFI for advanced age cows ( $> 3$  births), where CC presented a shorter period than OC, attributed to a greater longevity of the latter, allowing cows under this productive system to maintain optimal reproductive performance for more years. Although this experiment cannot state that there is greater longevity in OC, since both groups were homogeneous and similar in age Reksen et al. [28], observed in fact an extension of this parameter by organic systems that go through a winter period with a NEB, which is detrimental to reproduction.

$\leq 8$  mm: number of follicles observed by ultrasonography less than or equal to 8 mm in diameter.

9-14 mm: number of follicles observed by ultrasound with size between 9 and 14 mm in diameter.

$\geq 15$  mm: number of follicles observed by ultrasonography greater than or equal to 15 mm in diameter.

## CONCLUSIONS

The differences observed in the present study between both farms are not attributed to a difference in organic or conventional management but rather to differences in the feeding management between both farms. Nevertheless, it is important to note that an organic system has lower production costs compared to CC; therefore, it is interesting that the productive performance of cows is equated or even surpassed by the organic system with low costs making it a more economic productive system.

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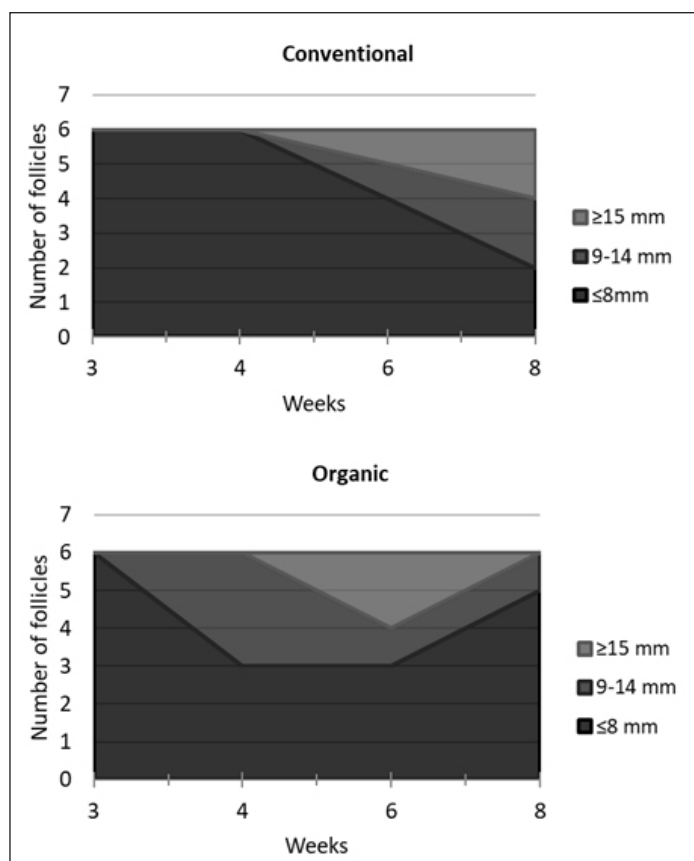


FIGURE 4: FREQUENCIES OF FOLLICULAR SIZES OBSERVED IN BOVINES FROM BOTH FARMS THROUGH ULTRASOUND FOLLOW-UP DURING THE EXPERIMENT.

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