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Review

Advances in Knowledge of the Dairy Cow During the Transition Period in Uruguay: a Multidisciplinary Approach

Avances en el conocimiento de la vaca lechera durante el período de transición en Uruguay: un enfoque multidisciplinario

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Abstract

The transition from pregnant non lactating condition to non pregnant lactating status is a period of dramatic changes for the cow, which has to adapt its metabolism to the strong requirements for milk production. From the equilibrium that the cow resolves this period will depend the capacity to maximize milk production and quality, to evade metabolic diseases and ensure the following pregnancy. The nutritional improvement, genetic selection and animal management have increase milk production in the last decades and this is associated with a decrease in the reproductive performance and in the increase of health diseases. This review summarizes the studies performed in the last years in Uruguay, with emphasis in nutritional management, ingestive behaviour, endocrine and molecular mechanisms of nutrient partitioning and its relation with fertility in dairy cows. Studies that investigate the productive efficiency of different dairy biotypes and breeds are reported. Studies in the cow´s health that identify the transition period as a risk factor for metabolic, infections and traumatic diseases are included. We conclude that studies that integrate problems of national relevance are the appropriate methodology to investigate complex biological systems as is the dairy cow during the transition period under grazing conditions.

Keywords: dairy cows, transition period, grazing

Resumen

La transición del estado preñada no lactante al no preñado lactante es un período de cambios drásticos para la vaca, la cual debe adaptar su metabolismo a las fuertes exigencias que le demanda la producción. Del equilibrio con que la vaca resuelva este proceso dependerá la capacidad de maximizar la producción y la calidad de la leche, de evitar enfermedades metabólicas y asegurar la siguiente preñez. La mejora nutricional, la selección genética y el manejo animal han aumentado la producción de leche en las últimas décadas, y esto se asocia a una disminución del desempeño reproductivo y al aumento de problemas sanitarios. Esta revisión resume trabajos realizados en los últimos años en Uruguay, enfatizando en el manejo diferencial de nutrientes, la respuesta en comportamiento ingestivo, los mecanismos endocrino-moleculares de la partición de nutrientes y su relación con la fertilidad en vacas lecheras. Se reportan experimentos que estudian la eficiencia productiva de diferentes biotipos lecheros y razas. Se describen trabajos en salud que identifican el período de transición como período de riesgo a enfermedades metabólicas, infecto-contagiosas y traumáticas. Se concluye que los estudios integrados en problemas de relevancia nacional es la respuesta necesaria a sistemas biológicos complejos como lo es la vaca lechera durante el período de transición en pastoreo.

Palabras clave: vaca lechera, período transición, pastoreo

Milk production in Uruguay

In Uruguay, milk production has increased in the last 30 years; however, the number of producers has decreased significantly, with more than 2000 producers disappearing in the last 20 years, concomitantly with an increase in the scale of dairy farms in terms of the number of milking cows (DIEA, 2011). Dairy product exports are close to 70% of the total available volume, mainly milk powder and cheese, so the solid content of milk becomes relevant. As a result, industries have promoted the payment by solids criterium. These conditions are unbeatable to lay the foundations and generate the necessary tools that allow adding value to the raw material for the elaboration of specialized commodities for our markets.

In our country, since livestock systems are based on grazing, milk production accompanies the seasonal production of pastures, giving the maximum milk production in spring (DIEA, 2011). Milk production systems exhibit a structural imbalance between nutrient supply and demand. This imbalance is attempted to correct with supplementation, forage reserves and concentrates, resulting in systems with increasing levels of operational complexity, infrastructure requirements and fundamentally precision in the management of food resources. The intensive use of pastures improved with concentrates and silage was one of the key factors that allowed a productive leap in the last two decades (DIEA, 2011). National genetic evaluations of the Holstein breed indicate that the genetics of Uruguayan dairy livestock come predominantly from North America. Genetic selection by milk production, worldwide, during the last decades - associated with the spread of high-production Holstein - has been a primary factor in international productive improvement.

Limiting aspects of the Uruguayan dairy production system

Bovine milk plays a central role in human nutrition and it is consumed globally, in different forms and destinations. The main lines of research in the international dairy industry focus on the valorization and innovation of products through the properties of some dairy components, promoting the healthy and therapeutic aspects of milk (Bauman and others, 2006).

For example, conjugated linoleic acid (CLA) works as an inhibitor of carcinogenesis and atherogenesis, improves the capacity of the immune system, prevents obesity and has antidiabetic effects, and improves bone mineralization (Pariza and others, 2001). There are numerous reports in this regard, however, no final conclusion has been reached regarding the safety and benefits of CLA (Benjamin and Spener, 2009). The increase in fresh pasture intake results in a 2 to 3-fold increase in the CLA content in milk (Dhiman and others, 1999) and this positions our milk production system based on grazing, advantageously, at international level. Currently, the addition of some of these elements in milk is carried out at an industrial level. National milk quality research in Uruguay regarding the maximization of nutraceutical components in a natural way has been scarce. It is, therefore, a priority that Uruguay as a "Country Brand" generates a clear, solid, intelligent, and coherent message according to that image.

On the other hand, the dry matter (DM) intake in grazing systems is usually lower than in confinement systems and could be insufficient to sustain the high milk production that could be achieved with the genetic potential (Kolver and Müller, 1998;

Chilibroste and others, 2012a). In national research, the analysis of lactation curves suggests that animals fail to express their productive potential, surely in response to the mismatch between nutrient supply-demand and the productive environment (Chilibroste and others, 2012a). The poor understanding of the ingestive behavior of the dairy cow during the transition should be added to the aforementioned complexity of the milk production system based on grazing. This is especially relevant due to the intake depression that occurs in the last weeks before calving (Grummer, 1995).

Calving at regular intervals is a prerequisite for a cost-effective lactation performance (Royal and others, 2002) and the calving to conception interval (CCI) is the limiting factor. Production increase has led to a decrease in reproductive indicators; the information consistently indicates a decrease of 20 to 30% in pregnancy rates from the 1960s to the present in different countries and an increase in reproductive and health problems (Roche and others, 2000; Lucy, 2001; Royal and others, 2002). In Uruguay, studies on 200,000 sucklings indicated that CCI increased from 131 to 150 days from 1997-2001 to 2001-2005 (Rovere and others, 2007).

This indicates that the current national situation is not different from that of Holstein, at global level, where selection pressure for milk production has affected reproductive rates. The subfertility syndrome arises from the interaction of the management system, biotype, and metabolic processes that underlie this increase in production (Gutierrez and others, 2006). As a way of lifting these restrictions, New Zealand genetics have been introduced in recent years, due to the similarity of their grazing system with ours. New Zealand exports about 90 percent of its production, so milk solids are important. Production in New Zealand prioritizes the management of pastures -90% of the diet- so most of the farms have seasonal calving, and cows are expected to be light, healthy and fertile. At national level, research in this regard is incipient. There is even less information regarding the association of genetic molecular markers (e.g., single nucleotide changes) and productive and reproductive parameters in milk, although these commercial kits exist in Uruguay and are used to predict phenotypic behaviors of interest.

The conflict between productive and reproductive performance is largely conditioned by the differential management that can be affected especially during the transition period. Apart from the high metabolic demand for milk production, the decrease (~ 30%) of prepartum intake (Grummer, 1995) promotes the mobilization of body reserves, that is, the negative energy balance (NEB). Changes occurring in this period are directly related to the adaptation **processes** of the **metabolism** and of the **digestive system** to the diet they will receive after calving. The changes in the metabolism of the tissues/organs of the body necessary to support a specific physiological function (homeorhesis, Bauman and Currie, 1980), ensure the uniformity of nutrient flow in support of lactation. This partition of nutrients is controlled by hormonal signals that together with metabolic profiles can be used as predictive tools of the herd's health status. In this physiological state, high-production dairy cows have a higher nutrient use by the mammary gland than by the rest of the body, to such an extent that Brown (1969) has suggested that the cow should be conceived as an appendage of the udder and not vice versa. This underfeeding period experienced by animals at the start of lactation not only affects the magnitude of the residual production response throughout lactation but also aggravates reproductive performance.

It is in this period that metabolic diseases or technopathies of current milk production are concentrated. The balance with which the cow overcomes this process will influence the ability to maximize milk production, avoid metabolic diseases and ensure the next pregnancy (Grummer, 1995).

The fragility of the organism is reflected in the activity of the cow's immune system which is strongly depressed around calving. A significant temporary decrease of defense cells caused by a significant passage of neutrophils into the reproductive tract has been described in postpartum. The responsive ability of lymphocytes and antibody production is also affected around calving (Kehrli and others, 1989), reporting a dramatic decrease in total serum levels of immunoglobulins G and M, in the period between prepartum week 8 and postpartum week 4 (Herr and others, 2011). The exact mechanism that determines the depression of the immune system in the peripartum is still unknown but, as generally accepted, endocrine and nutritional factors would be strongly involved (Goff and Horst, 1997; Vangroenweghe and others, 2005). These findings could explain the high incidence of infectious diseases during this period.

Finally, the production pressure and large-scale dairy farm management have significantly increased the risk factors that trigger several of these diseases. In these circumstances, cows' adaptation period to the milking dynamics and high-production management changes, can be compromised. Therefore, animal behavior guidelines and facility design, play an important role as risk factors for disease and harm to animal welfare. One of the problems is the maintenance of roads and passage areas, as well as the long periods that cows remain on the cement of the waiting room and the long distances they travel to eat; representing great traumatic potential for the musculoskeletal system. On the other hand, feeding these metabolic machines to produce large volumes of milk involves a great nutritional challenge. Under our conditions, large variations in the availability of different types of grains and price instability conspire against proper planning of cow nutrition and expose the system to health risks. Sudden changes and imbalances in these aspects can be the origin of outbreaks of acidosis, lameness and other types of pathologies that cause great pain, damage to the animal and a decrease in herd production.

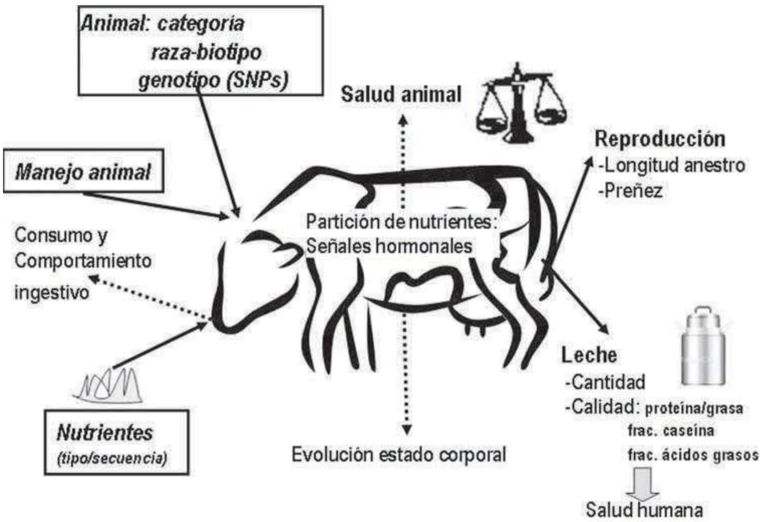
It is, therefore, the transition period where the health problems of the dairy herd are concentrated and the basis lies in the metabolic pressure involved in the high levels of potential milk production of the current dairy herd not coinciding with the required intake capacity. Individual clinic lacks preventive effects and represents an erroneous approach to health problems. When the cows get sick, the milk has already been lost and the clinical intervention – although necessary – involves a late effort that sometimes has a meager impact on controlling the economic losses represented by these pathologies (Ramos, 2007).

In addition, the good image of the grazing dairy industry associated with animal welfare and healthy products is compromised by the presence of diseases in current dairy herds. The challenge of milk production systems to which the technical advisors are exposed is not possibly achieved by a single discipline. The need for original knowledge that allows understanding the biological processes that underlie the environment-animal-product relationship is essential to maximize the company's cost-benefit ratio. This is even more relevant if considering that the research of these processes concentrates on housing systems and that South American milk production system based on grazing has particular characteristics that limit the transfer of knowledge generated in other productive systems, even grazing ones.

Conceptual way of working

Figure 1 outlines the proposed way of working to generate original knowledge in dairy. All experiments were carried out on Holstein dairy cows, with the exception of experiments where genetic lines and crossbreeds were studied, specifying each dairy biotype. The boxes indicate the studied effects or treatments (*inputs*); the emphasis has been placed on nutritional management before or after calving, referring to levels of supplementation or pasture supply and type of nutrient. We have studied aspects of animal management (grazing time, dominance) and characterized the responses according to animal category (age, number of calvings), and initiated studies regarding animal genetics (crossbreeds and dairy biotype). Economic response variables (*outputs*) involve the product (milk: quantity and quality in terms of fat/protein and casein and fatty acid fractions) or reproductive parameters that are more difficult to quantify (postpartum anestrus length, pregnancy rates).

Figure 1. Scheme of way of working with dairy cows in transition.

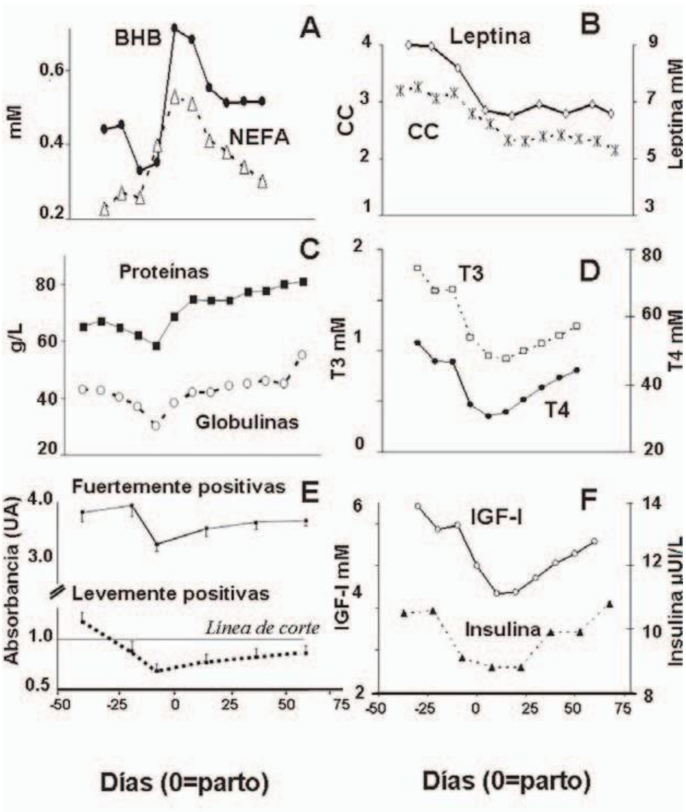


The response variables that involve determinations in the animal such as ingestive behavior, evolution of body reserves (body condition, BC), hormonal and metabolic profiles in blood and sensitivity and/or response of specific tissues allow understanding how different *inputs* (effects to be investigated) cause the *outputs*. The integrated study of the mechanisms that imply the productive response to differential animal management constitutes the path to the development of technologies to be transferred to our production environment. The research must contemplate the impact at different levels of response in order to maximize the profitability of the dairy production system, having as its primary axis the maintenance of the health and welfare of the animals.

Transition period: national data

In the experiments carried out, we have observed that the metabolic and endocrine profiles show the changes in BC during the transition period (Figure 2). The large mobilization in BC occurring in the early pre- and postpartum period is accompanied by a pronounced increase of non-esterified fatty acids (NEFA) (Meikle and others, 2004; Cavestany and others, 2005, 2009a; Adrien and others, 2012; Ruprechter and others, 2011), which were associated with an increased abundance of liver transcripts of regulatory enzymes of β-oxidation (Carriquiry and others, 2010). This increase in NEFA is frequently followed by an increase in b-hydroxybutyrate (BHB) which reflects the energy deficit (Figure 2A); although it should be recalled that there may be elevated levels of BHB of rumen origin due to the hydroxylation of rumen butyrate.

Figure 2. Metabolic and endocrine profiles, and evolution of Body Condition in the peripartum. A) Non-esterified fatty acids (NEFA, mM) and β-hydroxybutyrate (BHB, mM). B) Body Condition (BC) and leptin (nM). C) Total plasma proteins (g/l) (whole line) and globulins (g/l) (dotted line). D) Thyroxine (T4, nM) and 3,30,5-triiodothyronine (T3, nM). E) Absorbances related to the positive controls of the VMRD kit to *bovine leukosis* (absorbances greater than 1 are positive to leukosis). F) IGF-I (nM) and insulin (μUI/ml). Modifications of Meikle and others, 2004, Cavestany and others, 2005 and Rama and others, 2012.



The loss of BC is generally more abrupt in primiparous cows than in multiparous cows (Meikle and others, 2004, 2005, 2006; Adrien and others, 2012) and comes with a decrease in leptin concentrations (Figure 2B), which is consistent since it is synthesized by adipocytes and varies with changes in the percentage of fatty deposits (Delavaud and others, 2000). Dairy cows frequently lose more than 60% of their body fat during early lactation (Tamminga and others, 1997). Leptin inhibits intake and increases metabolic rate, so it is suggested that this is a strategic decrease to stimulate intake in postpartum dairy cows and to decrease the peripheral consumption of nutrients (decrease in metabolic rate). Likewise, thyroid hormones (T3, T4) drastically decrease before calving and the concentrations observed during the postpartum period do not recover compared to those of the prepartum (Meikle and others, 2004).

Nitrogenous metabolites decrease around calving and are linked to diet (Cavestany and others, 2005, 2009 a; Meikle and others, 2004, 2006; Pereira and others, 2010 b; Adrien and others, 2012). Cows with low-protein diets partly compensate for the deficit through the mobilization of their body reserves and the decrease in renal elimination of urea, which is reflected in weight loss, BC and decreased milk production. On the other hand, the increase in plasma protein during postpartum is positively correlated with the DM intake that gradually increases in postpartum (Figure 2C). Concentrations of insulin and insulin-like factor I (IGF-I) decrease around calving (Figure 2F, Meikle and others, 2004; Cavestany and others 2009a; Pereira and others, 2010 b; Adrien and others, 2012; Astessiano and others, 2012), consistent with the intake and NEB reduction that characterizes this period. These data are consistent with the knowledge generated regarding the nutrient partitioning of the transition period of the dairy cow. Growth hormone (GH) is the best homeorhetic or teleophoretic hormone, which promotes the udder using these nutrients since it "turns off" the use of essential fuel (glucose) by peripheral tissues and promotes the mobilization of body reserves. One of the strategies used by the high-production dairy cow is to decouple the somatotrophic axis, that is, hepatic desensitization to GH (lower concentrations of GH receptor, GHR) which results in lower concentrations of its mediator, IGF-I, (Kobayashi and others, 1999).

National results (Astessiano and others, 2012) show that hepatic expression of GHR-variant 1A and IGF-I transcripts decreased from pre to postpartum in grazing dairy cows, but to a lesser extent in cows fed totally mixed rations (TMR). The decoupling of the GH-IGF-I axis affects several organs and tissues, but the lack of negative feedback on GH is highlighted, since it promotes a higher circulating concentration of this hormone, and therefore a greater teleophoretic action. Likewise, lower concentrations of IGF-I and insulin (Figure 2F) favor peripheral catabolism that supports lactation.

On the other hand, insulin and IGF-I are the same hormones that stimulate follicular development and the resumption of ovarian cyclicality after calving. We have shown that better BC at calving (>3) is associated with higher IGF-I concentrations and shorter postpartum anestrus (Meikle and others, 2004). The insulin/GH/IGF-I ratio and the day of the nadir of energy balance influence follicular growth and first postpartum ovulation (Beam and Butler, 1999). The re-establishment of NEB is reflected in the increase of insulin and IGF-I, (Figure 2F) and is associated with the beginning of the increase in intake and with the end of the disengagement of the somatotrophic axis.

Primiparous cows present greater difficulty in recovering from NEB, reflecting this through the more imbalanced metabolic and endocrine profile and worse reproductive indices than multiparous cows (Meikle and others, 2004, 2005; Cavestany and others 2009a; Adrien and others, 2012), a process probably aggravated by the stress involved in their first lactation. This may be the result of these animals being in development, although the dominance effect of food availability is also present under grazing conditions (Grant and Albright, 2001). In addition, low grazing activity during access to pastures has been observed and very low biting rates were observed in newly calved primiparous cows (Chilibroste and others, 2012b).

The immunodeficiency that characterizes the transition period can be observed in the marked decrease in globulins (Figure 2E) and is associated with the sharp increase of reproductive, udder, foot, or other infectious pathologies (Blowey, 2005; de Torres, 2010). There is international agreement on the incidence of mastitis being higher during the first 70 days of lactation (Seegers and others, 2003), which is consistent with national studies (de Torres, 2010), which found that the cell count per quarter is significantly higher in the first third of lactation than in the second (odd ratio: 1.58).

In a recent study, Rama and others (2012) report that leukosis-positive cows - that is, with optical densities above the positive controls included in the kits - presented a decrease in these titers representing between 40-60% of the initial prepartum levels (Figure 2E). False negatives were demonstrated from day -20 to +60, indicating that samples should be avoided for serological diagnosis of infectious diseases in this period, at least for bovine leukosis. Apart from the diagnostic considerations, the immunosuppression of this period could modify the load of possible pathogens present in the mother during the peripartum, that is, the animal could lose the ability to control them, reactivating the infection and causing an increase in its load with the obvious consequences in the animal and the herd.

Other pathologies are exacerbated by the NEB suffered by dairy cows during the transition period. Ramos (2012) has shown that for productive conditions in Uruguay, lameness is more likely to occur at mid-lactation (60- 120 days postpartum, dpi) than in early (<60 days) or late (>120 dpi) lactation. This is consistent with studies that show that the body condition of cows is positively correlated with the thickness of its digital cushion, which decreases from the first month of lactation and reaches its nadir at 120 days postpartum. The decrease in the digital cushion– a structure composed mainly of adipose tissue that buffers mechanical pressures in the foot - is associated with the increase in the prevalence of various foot diseases (Bicalho and others, 2009).

Nutrients: emphasis on metabolic memory and differential nutritional management in the peripartum

The effects of nutritional management on milk production (quantity and quality) and reproductive parameters have been exhaustively reported worldwide. However, results are variable and often contradictory. Designs differ in the degree of body reserves at calving (metabolic memory), energy/protein level and dietary source, the inclusion of specific nutrients, magnitude and duration of NEB, in addition to other experimental factors such as breed, age, moments in which nutritional treatments are applied with respect to the transition period and the observation records.

This makes it difficult to compare results and obtain practical management conclusions and is especially relevant in controlled grazing studies since most of the information comes from milk production systems under stabling conditions.

All our experiments have shown that cows with higher BC mobilize more reserves and present higher concentrations of NEFA than cows with poor BC at prepartum or at calving (Meikle and others, 2004; Adrien and others, 2012). Figure 3 shows the evolution of primiparous (L1) and multiparous (L2) cows with low or high BC, induced nutritionally from -100 to -30 days prepartum (Adrien and others, 2012); three weeks after calving, no differences in BC were found between groups.

This increased supply of energy reserves was seen through higher productions of fat-corrected milk and polyunsaturated fatty acids (PUFAs), such as omega 3 (4.8 vs 2.7 mg/g fatty acid for high and low BC, respectively) and CLA (10.3 vs 7.3 mg/g fatty acid for high and low BC, respectively) known for their beneficial role in human health. Grazing diets have a high proportion of PUFAs (50 -75%) of total fatty acids (Dewhurst and others, 2001), and therefore, we have suggested that cows with high BC have higher grazing intake that would not only result in higher contents of ingested PUFAs (Figure 3C, 3D), but in a higher passage rate that limits ruminal hydrogenation (Artegoitia and others, 2012).

IGF-I concentrations were higher during peripartum and early lactation in multiparous cows with higher nutritionally induced BC (Adrien and others, 2012). IGF-I concentrations were, in turn, associated with a shorter resumption of postpartum cyclicality; anestrus in cows with high BC was 15 days shorter than in those with low BC (Figure 3E, 3F, Adrien and others, 2012). The resumption of ovarian cyclicality drastically affects reproductive indicators of economic interest. A population study with milk progesterone, twice a week during the first 90 days postpartum in approximately 900 dairy cows, determined that if an animal does not resume ovarian cyclicality in the first 60 days postpartum it lengthens the calving-first service interval to 67 days (unpublished data).

In our country, numerous pre- and postpartum supplementation studies have been carried out, but relatively few studies included the determination of anestrus and endocrine profiles.

Differential forage supply (7.5, 15 and 30 kg dry matter (DM)/cow /day) and TMR provided *ad libitum* caused milk production and BC levels according to nutrient supply (Figure 4A, E, Chilibroste and others, 2012b).

Two different experiments showed that the production of TMR cows was higher than the grazing groups and this was consistent with a higher nutrient density (Meikle and others, 2012; Fajardo and others, 2012), reflected in higher concentrations of insulin and IGF-I (Figure 4B, 4D; Meikle and others, 2012). No differences were found in milk production between cows with high (HA) and medium (MA) forage supply (30 and 15 kg DM/cow/day, respectively), but these were greater than cows with low (LA) forage supply (7.5 kg DM/cow/day).

Grazing probability increased linearly in HA (0.39 min/100 min/day) and MA (0.44 min/100 min/day) cows at a higher rate than LA cows (0.22 min/100 min/day) (Chilibroste and others, 2012 b). The biting rate was higher in HA and MA cows compared to LA. The low forage supply modified the ingestive behavior since they grazed less time and at lower bite rates. This was reflected from the second week after calving, in milk production, which was lower than in the other groups (Figure 4A). However, the medium supply (MA) group maintained a milk production comparable with the high (HA) group, and observing the endocrine-metabolic profile (Figure 4B, 4D) it can be suggested that they compensated this production with a greater mobilization of reserves (Figure 4E).

Figure 3. A/B) Evolution of body condition. C/D) Milk corrected by 4% fat. E/F) First ovulation in primiparous (L1) and multiparous (L2) cows with high and low body condition one month before calving. Graphic inserts: omega-3 (n-3) fatty acids and conjugated linoleic acid (CLA). Asterisks P<0.05 a vs b P< 0.05. Adrien and others, 2012 and Artegoitia and others, 2012.

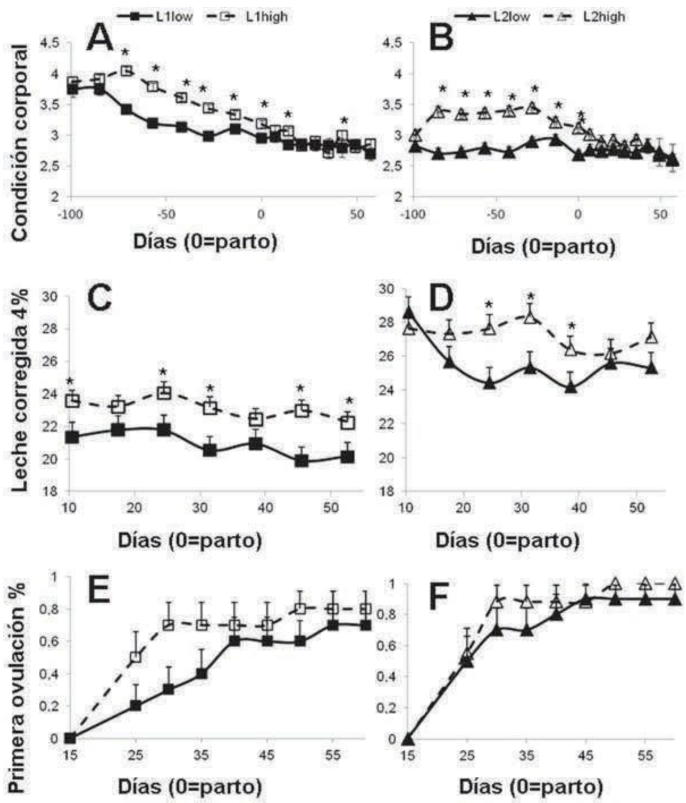
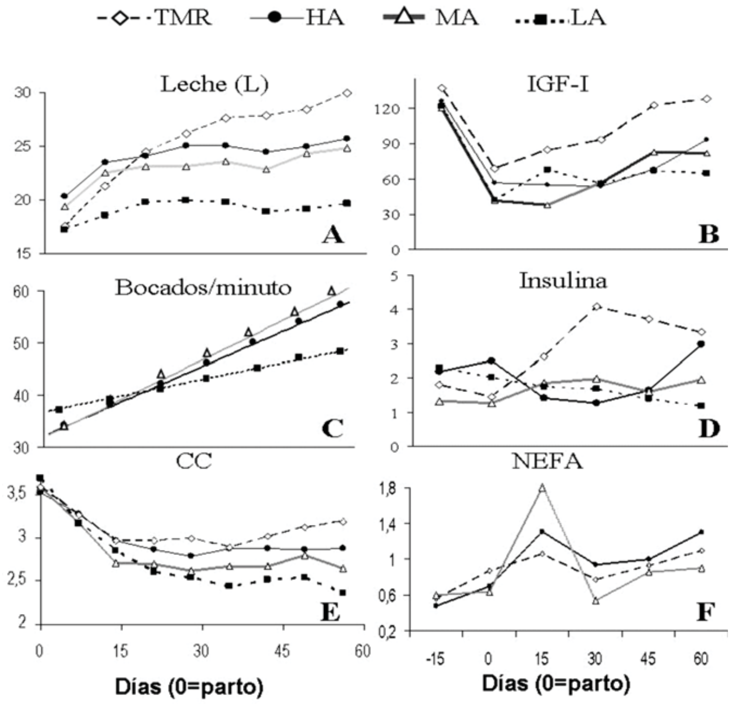


Figure 4. A) Milk production (l), B) IGF-I (ng/ml), C) bitings/minute, D) insulin (µUI/ml), E) body condition, F) unesterified fatty acids (mM) in cows fed *ad libitum* with totally mixed ration (TMR), or high (HA), medium (MA) or low (LA) forage supply (30 kg, 15 or 7.5 DM/day/cow respectively). Adapted from Chilibroste and others, 2012b, Meikle and others, 2012.



Higher concentrations of NEFA (Figure 4F) and lower concentrations of urea (data not shown) in the MA group compared to TMR and HA cows during the first month postpartum were consistent with the resumption of delayed postpartum ovarian cyclicality in MA cows (data not shown).

Other national reports have used strategic supplementation to improve reproductive rates. Cavestany and others (2009a), providing a prepartum three-week energy supplementation to multiparous cows, reported higher milk production and a 12-day shorter anestrus in the supplemented group, associated with a higher prepartum concentration of IGF-I, insulin and leptin. These results were confirmed in a subsequent experiment (Cavestany and others, 2009b), where an energy supplementation for three weeks before calving reduced the length of the prepartum anestrus in multiparous cows by 15 days, although there was no effect in primiparous cows.

On the other hand, adding sunflower seeds to the diet during the first two months postpartum promoted ovulation in primiparous cows, but this was not observed in multiparous cows (Mendoza and others, 2008), confirming once again the relevance of the animal category in reproductive performance, even in response to nutritional treatments. The authors attributed these effects to a higher energy density and/or to the presence of nutraceutical components in the sunflower seed.

Genetic lines, crossbreeds and molecular markers

Based on the considerations made, regarding the production objectives defined in our country, the productive and reproductive comparative evaluation of cows of different genetic lines is of interest. We studied the performance of Uruguayan Holstein cows (HU) and crossbreed Holstein Friesian New Zealand (HU-HFNZ) selected by economic merit in the previous lactation in the same productive environment.

Cumulative production of milk, fat, protein and total solids at 305 days of lactation were not affected by the genetic line; however, HU cows produced 0.5±0.23 L/d more milk than HU-HFNZ cows in the first 240 days of lactation (Pereira and others, 2010 a). Fat and lactose percentages were higher and protein percentages tended to be higher in HU-HFNZ cows than in HU cows. HU cows were 49±3 kg heavier than HU-HFNZ and produced fewer milk solids per kg of metabolic weight. The pregnancy percentage at the first 40 days of service was higher and overall pregnancy tended to be higher in HU-HFNZ cows than in HU cows. Concentrations of unesterified fatty acids and β-hydroxybutyrate increased around calving and were higher in HU cows (Pereira and others, 2010 b). The efficiency- production of milk solids by metabolic weight - was higher in HU- HFNZ cows, mainly due to their lower live weight, as well as reproductive performance. The differences in endocrine and metabolic variables observed in both genetic lines suggest a different partition of nutrients and energy; in which HU cows use greater energy from body reserves, while HU-HFNZ would present lower maintenance energy use (Pereira and others, 2010b).

The information generated regarding dairy crossbreeds is incipient; we have studied the productive and reproductive behavior of primiparous cows with Uruguayan Holstein mothers and American Holstein fathers (HA), and of primiparous Uruguayan Holstein cows crossed with New Zealand Holstein (HNZ), Swedish Red and White (RBS) and Jersey (J) (Dutour and others, 2010a, 2010b). Milk production in the HA group (17.5±0.37 kg/day) was superior to the crossbreeds RBS and J (16.0±0.36 kg/day and 15.1±0.35 kg/day, respectively), while it did not differ significantly from the HNZ group (17.0±0.36 kg/day). However, when milk production was analyzed according to metabolic weight, no significant differences were found between the different genetic groups. Group J was significantly lighter than the rest of the genotypes, which did not vary among them. No significant differences were found between the genetic groups for several reproductive indicators, but the J-crossbreeds presented a higher proportion of pregnant cows at 21 and 42 days after the beginning of the insemination period.

Finally, and as mentioned above, although commercial kits of molecular markers are available in Uruguay and are used in some production systems, we have not found studies in this regard.

Our advances regarding molecular markers, phenotypic characters of interest and metabolic endocrinology have focused on growth hormone (GH-AluI) and its mediator, IGF-I (IGF-I-Snab I) (Ruprechter and others, 2011). These markers had no relevant effects on production parameters. However, a polymorphic site (transition T (allele A) by C (allele B) located in the promoter region of the IGF-I gene and detected by Snab I) was associated with the interval calving-first service in primiparous cows, with cows genotype BB presenting longer intervals (Ruprechter and others, 2011). These results are consistent with previous studies in which BB cows had longer anestrus (unpublished data). The most relevant findings focused on the effects found of the GH and IGF-I genotypes on endocrine and metabolic profiles, constituting the first international report to find an association in dairy cows during the transition period.

Final considerations

This document reveals the complexity of the biological system involved in dairy cows in transition and the production environment. Nutritional management and genetics are shown to have relevant impacts on metabolic endocrinology during the transition period that is associated with differential reproductive performance. It should be considered that contributing to the improvement of a production parameter does not necessarily imply the improvement of economic efficiency. Aspects that are usually not taken into account, such as reproductive variables, animal health, as well as the long-term maintenance of the forage ecosystem, are part of the existing response to man-made management in the dairy system.

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