Review paper

Reflections about the adoption and extension of a seasonal milk production model in Camagüey, Cuba

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Abstract

In order to reflect on general criteria for the adoption and extension of a seasonal milk production model in the Camagüey province, considerations are presented related to the possibilities and potentialities of seasonal milk production based on climate conditions, characteristic of cattle production ecosystems and on the more efficient use of available resources. Topics are approached linked to the rational management of the pastureland, closely related to an adequate strategy in reproduction and parturition, whose higher concentration (70-80 %) should coincide with the period of higher pasture production, taking into consideration the limited use of additional resources, the bio-economic response, its possible repercussions on the need to assimilate new conceptions and action methods at the different levels, as well as on the primary production-industry-trade-consumer chain. It is indicated that the implementation of a seasonal milk production model adapted to the conditions of Camagüey, Cuba, can mean a significant response to the need of the country to increase productive yields on sustainable bases.

Keywords: food chain, ecosystem, animal production, reproduction

Introduction

Prices in the international market have a remarkable effect on the acquisition of milk and its derivatives. In such situation, milk production is highly important in pastoral systems dedicated to this purpose, where the achievement of good bio-economic efficiency is essential and an adjusted relation between the needs of dry matter to be consumed by the herd, to achieve adequate yields, and the pasture growth rate per season, is imperative (Soto *et al*., 2014a).

The economic, political and food insecurity situations that prevails throughout the world makes essential the need to increase the productive and efficiency values, particularly in the farming sector (Soto *et al*., 2010a).

Under these circumstances, the promotion of those activities that ensure incomes and substitute imports, as well as food production, will be privileged, in order to progressively reduce the existing dependence on the external market in this subject. Cuba cannot afford to incur in expenses that can be substituted by the national production, goal that must be proposed in the long term. The development of agriculture constitutes a matter of national security (Castro, 2009).

Considering the above-explained facts, the milk production based on pasturelands has in the synchronization of the nutritional requirements of the herd and the growth curve of pastures, its main food supply strategy or, in other words, maximum accommodation of the lactation curve of the herd to the grass growth curve; the greatest concern is not to obtain high pasture volumes, but to have them available to be grazed when the cows are producing (Brancato, 2007). For such reason, the key to harvest and transform more pasture into milk depends on the ability of the implemented system to capture the accumulated biomass, before its quality decreases and part of it is lost (García and Rossi, 2006).

The efficiency of the systems is related to the procedures that are performed in cattle production processes and to the performance of the actors that lead them, who decide the alternatives that are

applied and the way of managing the productive systems (Vargas *et al*., 2015). This criterion is an essential part of the fundamental basis on which seasonal milk production models are supported and which has been the key to success in countries from different latitudes where it has been applied (Brancato, 2007).

In the particular case of New Zealand, a forage-based diet is given priority. This has allowed milkings higher than 3 300 kg milk/lactation and 3 000 kg of milk solids/hectare (FEDEGAN, 2013). Similarly, fertility and parturitions are managed through a seasonal system, where 95 % of the parturitions occur in the spring and, thus, the cows are dried in the autumn. This way the cows are selected regarding their fertility, and the ones which do not become pregnant in that season are culled. This, along with the technological innovations and the genotypic development of the breed has allowed the milk production in New Zealand to be done with the lowest production costs recorded in developed countries (Jaramillo, 2014).

In general, the prevailing agro-climate conditions in the tropical regions determine, in most cases, the profitability of the exploitations (Domínguez *et al*., 2015). Taking into consideration the marked seasonality of the climate in Cuba and, particularly, in the Camagüey province, where cattle feeding is based on pastures and whose growth curve mostly responds to the changes in temperature, radiation and rainfall, it is necessary to concentrate parturitions, so that the lactation curve is accompanied by the grass productivity curve, which allows more correct use of the stocking rate and a more efficient production per area unit. The objective of this work is to reflect on general criteria for the adoption and extension of a seasonal milk production model in the Camagüey province.

I. Premises that support the application of a seasonal milk production model

The productivity and efficiency of a herd are mainly determined by the management to which it is subject, including the control of a large diversity of factors, such as the quantity of inputs that are applied to the soil-plant system, its natural potentials, the potential of its animals and the supplements in terms of quality and quantity, all of it influenced by climate and decision-making (Pedraza and Justiz, 2015).

Within this variety of factors, the following are important in milk production: controlled feeding, management techniques of replacements and cows, reproductive management and organization, agricultural management of pastures and forages, organization of the operations and management of the financial and environmental resources, as well as the knowledge-information dyad; thus, it is considered a very complex activity.

In such countries as New Zealand, with a dairy industry which is evaluated from the primary producer to the market, based on a seasonal model with parturitions in the early spring, with a high stocking rate (2,5 cows/ha), high utilization of the pastureland (90 %) and low or no supplementation, good efficiency values (90-95 % birthrate) and reduced costs: 0,09-0,12 NZD (New Zealand dollar)/ kg of milk, have been achieved, with a conservationist, competitive and very high quality approach in the commercial products (Holmes, 2006).

The system with which this country achieved its competitiveness is the seasonal production, because it feeds the cows mainly with pastures, and most important is that the cost of feedstuff must be compared all the time with the price of milk to determine which is the most effective. Higher production does not always imply higher profit. The incomes and the costs of cow per kilogram of feed in all the participating items must be considered. That is the way to go (Brancato, 2007).

A large part of the success of the dairy farms in New Zealand lies on their logistics. Their management strategies are based on an assembly of sectors with common objectives and planned connections, because it is a cooperative dairy industry. From all the farms, 63 % are operated by the owners, in many cases they live on site and they do a great part of the work; this modality implies that one person who owns the cows does the work and the other provides the dairy unit and its maintenance (Holmes, 2006). Then, it is possible to infer that the application of a seasonal system in a zone or territory can, in a first stage, attenuate the deficiency of the milk in the dry season with the milk offer produced in the rainy season, conveniently preserved, and in a second stage, consider results that show a surplus that allows to reach the market and generate incomes that are reverted in the productive process (Soto *et al*., 2010b).

Definitively, among the key factors to achieve higher productivity with the genetic potential of the cows are: higher efficiency of the use of pastures (more production and harvest of DM/ha) and the incorporation

of complementation and supplementation strategies which are more persistent and stable in the year to minimize the climate risks as well as the eventual market risks (Gallardo, 2012).

According to Geary *et al*. (2014), the exploitations of the seasonal milk production profile result in lower costs and higher net profit of the farm, with regards to the less seasonal milk production profile. The highest costs are related to the concentrate feed, labor, silage, machinery and replacement heifers. This statement coincides with the report by Vibart *et al*. (2012), about the fact that the concentration level of births brings about higher productivity and higher incomes on the feeding costs per land unit.

II. Adoption and extension of a seasonal model in dairy farms of Camagüey, Cuba

Foundations to implement the seasonal milk production

It is considered as accepted that, in general, the climate in Cuba is tropical, seasonally humid, with sudden changes from November to April, the driest months and with the lowest temperatures. The months from May to October have a similar rain performance in most of the country, including the Camagüey province, and they show the highest annual accumulated values of rainfall in May, June and September and even October (Centro del Clima, 2016). Thus, it is possible to infer that there are adequate climate conditions for the establishment of seasonal milk production models in the territory.

To respond to the main problems of Cuban livestock production (fig. 1), and particularly of the Camagüey province, which has a structure mainly composed by (state and non-state) cooperatives and whose weight on the national balance is approximately 20 % (ONEI, 2015), it is important to aim the greatest efforts at facing in a determinant way the technological challenges related to the need not only to improve the availability and quality of the pasturelands, according to the climate seasonality, but also to search for, introduce and apply consciously forms that allow a more efficient management of pasture as fundamental and irreplaceable source in cattle feeding, so that higher productive goals are reached based on the sustainable use of resources, giving priority to the cooperative sector.

To this end, it is important to consider that cooperativism emerges from the integration of control and research sectors; thus groups of cows can be developed which are adequate for the grazing system and their own replacement can be guaranteed (Holmes, 2006). With regards to the topic, several authors think that, to achieve higher beef and milk production, it is necessary to apply new work forms

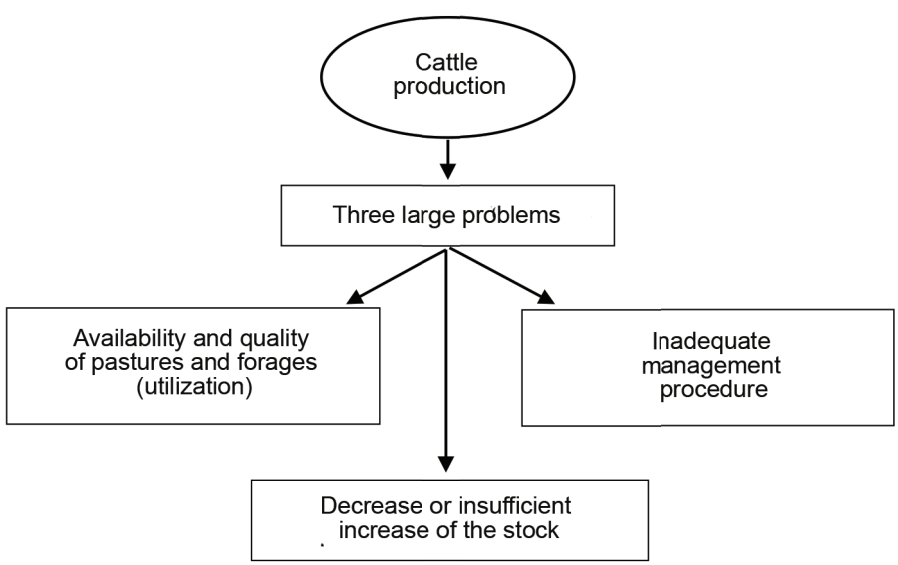

Figure 1. Main problems of Cuban cattle rearing with regards to its productions.
Source: Elaborated by the author

and use resources correctly; new criteria must be formed in Cuban cattle production (Mena *et al*., 2007).

Camagüey is the largest Cuban province and dedicates 78 % of its agricultural surface to cattle production, aspiring to reach 140 million kilograms of milk delivered to the industry (González, 2015). Nevertheless, in the studies conducted in dairy farms belonging to cooperatives of credits and services (non-state sector) of this province (Martínez *et al*., 2015), positive results were found only in those that showed better technological conditions, related to the higher land utilization, number of paddocks, as well as higher area and proportion of the farm dedicated to the establishment of cultivated pastures and forages, in correspondence with the number of animals.

In general, there is lack of implementation of milk production systems and/or models, which imply the efficient use of pastures and forages, in order to reach higher and sustainable productions. In any case, the solution to increase the pasture-based milk production is not, or will not be, in the higher use of concentrate feeds, whatever they are, because the high prices and current policies worldwide with regards to the use their raw materials such as biofuels confirm this (Soto *et al*., 2014a).

In this regard, Uña *et al*. (2014) found in a farm belonging to a state cooperative from the "Ruta Invasora" enterprise, Ciego de Ávila, a strong seasonality (more than 70 % of births) towards the rainy season, when the values of birthrate (78 %), milk production (1 393 kg/ha) and unitary cost of the product (0,86 CUP/kg) had the best results compared with the other farms, with deficient forage balance (10,4 t DM/cow/year).

Likewise, in Camagüey, it has been reported that, under feeding restriction conditions, 1 325 kg milk/ha can be obtained with more than 60 % of the parturitions concentrated in April-October (del Risco *et al*., 2009) and 1 526 kg milk/ha at a lower cost (0,59 CUP/kg) with up to 80 % of the parturitions concentrated in April-August (Soto *et al*., 2010b).

These and other studies conducted in Camagüey, in the state and non-state (Cooperatives of Credits and Services) cooperative structures, main milk production form in the territory, have been focused on the evaluation of the best period to obtain higher milk volumes, considering, among other factors: season, pasture and forage availability and quality, performance of reproductive and economic indicators, concentration level of the births and their optimum occurrence time. The above-mentioned authors, as well as Uña *et al.* (2015) coincide in general on the fact that the province shows favorable climate conditions to establish a seasonal milk production model, but that it is necessary to make corrections in the reproduction work and improve the quality, availability and management of pastures and forages, so that the indispensable requisite of achieving bioproductive increases in an efficient and sustainable way is fulfilled.

Seasonal management of the forage basis

It is essential that there is a correct balance among the stocking rate, pasture management and supplementary feeding to optimize the yield of the community in general and the profitability in the pasture-based milk production (Vibart *et al*., 2012).

In works conducted in the states of the United States Gulf coast (Macoon *et al*., 2011), where the management in pasture-based milk production systems has received little attention, it was found that in the cows fed with less supplements there was more organic matter consumption of the forage, associated with higher ingestion and milk production. The stocking rate had an important effect on the yield of pastures and animals. Thus, it was determined that during the cold season the supplementation with concentrate feeds should be planned based on the ingestion of energy, estimated from the forages, to achieve optimum milk production and ensure the maintenance of the body condition.

The most significant problem of the grazing cow feeding starts from the insufficient forage availability, in both seasons of the year as general rule; this is accentuated in the eastern half of the country due to the climate characteristics of this region, with higher restrictions in the annual rainfall. This is in addition to the predominance of native pasture species, which determine pasture areas with moderate or low quality, exploited on soils with fertility affected in a higher or lower extent. However, it is important to remember that in Cuba there are native and naturalized species, adapted to each territory, with potentialities that, expressed in productive terms, allow to obtain 5-6 kg of milk/cow/day, when they are correctly managed (Pérez-Infante, 2010), which is not in accordance with the average values obtained.

In the Mayabeque province, Cuba, Domínguez *et al*. (2015) found that the best two-month periods

of milk production were those of the rainy season, when the highest dry matter yields are produced, which allows a higher offer per animal per day and in turn allows a higher selection of the animals with regards to the dry season. Likewise, studies conducted in scenarios of Camagüey and Ciego de Ávila (Guevara *et al*., 2010; Pedraza and Justiz, 2015), showed that the effect of the season on milk production is more associated to the increase of pasture availability than to the lower environmental temperature of the dry season, when the biomass production decreases.

In correspondence with the above-explained facts, four important times in the year with regards to the pasture growth and productivity occur; the first one, from April to June, as the beginning of the period of maximum grass growth; second, from July to September, when the forage production has its period of maximum yield; third, from October to December, when the grass growth rate declines rapidly, also called end of the maximum grass growth period and fourth, from January to March, when the grass growth is minimum.

Thus, it is possible to reach a higher efficiency in milk production with those same pasture species, even under conditions of feeding restriction, concentrating the highest number of parturitions in the first period and that the highest percentage of the year is not extended beyond half the second period (Soto *et al*., 2010b).

The above-stated facts indicate that, without large investments, there is still much to do regarding the maximum utilization of the available resources and with no additional expenses, or what is a more imperative need at present, using supplementation really efficiently to increase productive limits. It is even possible to improve the forage basis, with low operational costs. In this regard, Senra (2005) in Cuba, stated that the expenses of rehabilitation activities were more feasible in cattle production areas of low pasture productivity, compared with new plantings, which are much more costly and have a useful life between 3 and 5 years.

It is not worth either to supplement strongly the cows before using the cheap pasture available; or think about another type of investments either, such as pasture irrigation, until maximizing the efficacious use of that resource. Then, the introduction of grazing or cutting cultivated grass species would correspond to a later stage for reaching a higher goal of bioproductive efficiency, whose investment would have a solid basis built upon the benefits obtained.

Thus, to reach that higher level, the introduction of improvement strategies of the forage basis is attractive with regards to seasonal parturitions on milk production, to improve the availability and quality of the offer, with recovery of the investment in a relatively short term, of 12-14 months (Soto *et al*., 2010a).

Within those strategies, the inclusion of various types of trees in cattle production allows the animals to change their diet and balance it according to their requirements and potential, which can be manifested in a higher production. This possibility of selecting does not exist in the grass monocrop. The term "nutritional ecology" is suggested to refer to this effort of providing the type or variety of forage and/or feedstuff that allows the animal in question to vary its diet by itself, responding to feedback metabolic stimuli (Domínguez *et al*., 2015).

The establishment of areas with clones of *Pennisetum purpureum* and protein banks with *Leucaena leucocephala*, are alternatives reported by some authors with possibilities of reaching 7-9 kg/cow/day, numbers close to the results of the 1990's, with similar stocking rates in associations of cultivated grasses and shrubby and herbaceous legumes (de Loyola *et al*., 2010; Soto *et al*., 2010a). An effect on the body condition of the cow is also reported, whether it is producing or not (de Loyola *et al*., 2015).

The forests designed for animal production will also gradually favor the increase of the biodiversity of wild species and animals and the recovery of the nutrients present in the original vegetation from their extraction from the subsoil (Muñoz *et al*., 2015).

Similarly, the costs of their establishment can be lowered, totally reduced and even achieve profits when short-cycle crops are integrated in that period. This last element is a frequent practice in pasture management, which obeys the need to increase the land utilization efficiency and to obtain an additional harvest of high-quality forage (Soto *et al*., 2008; Herrera, 2015).

Elements of reproduction management

As it was previously stated it is also necessary to make corrections in the reproduction work. This is essential in any farming exploitation because it defines, among others, the structure of the herd, the relative production potential that is expected of the cattle production system and the feeding program

that should be established to obtain high and stable productions (Vargas *et al*., 2015).

It is known that among the reproduction indexes, the birthrate and distribution of parturition in the year have a marked influence on the annual milk production, incomes and efficiency of the systems. Likewise, the parturition-parturition interval (PPI) of the herd, whose periodic analysis is imposed in dairy exploitations, plays a fundamental role, because it presupposes the successful continuation in time of the management practices of the pastureland and the herd.

In Camagüey, Cuba, the existence of seasonality for the presentation of the estrus has been reported (Santiesteban *et al*., 2007), related to the higher availability of pastures, with sustained trend of seasonality on the highest values of the indicator empty cow between the months from May to October, as well as the lowest number of culling of cows in reproduction. This performance can be conveniently used in the work of reproduction and the efficient use of hormonal treatments and artificial insemination, to achieve the concentration of parturitions.

Thus, in the farms of the Basic Units of Cooperative Production (UBPCs, for their initials in Spanish), Jimaguayú municipality, Uña *et al*. (2015) found seasonal behaviors in the empty cows (June and July), pregnant cows and births; as well as in the milk production, kilogram of milk per hectare and in the total expenses and incomes.

When due to an induced strategy of parturitions or at random a concentration of parturitions occurs in the months of April-August, it should have favorable effects on the lactation of these animals and on the economy of the systems, issue that needs to be accurately quantified to re-orientate a reproductive strategy of the herds towards higher bio-economic efficiency, which has been achieved for different studies in herds of the country (del Risco *et al*., 2009; Soto *et al*., 2014b).

The re-ordering of the reproductive activity implies, first, performing the highest percentage of insemination in the months from July to October, so that the confirmation of the possible pregnancies is made from October to January of the following year and a high birth percentage can be achieved in April-August (table 1).

In this case it is estimated that to establish a solid seasonal production model, it is necessary to consciously overcome a first barrier that includes improvements in the work organization, adequate technological discipline and stable availability of hormones.

The reproductive management is aimed at achieving a highly concentrated parturition pattern in order to achieve that a high proportion of cows adjusts the high demand of nutrients, mainly energy, inherent to the early lactation with the moment of higher pasture growth. Thus the production costs decrease, which allows the grassland under direct utilization to constitute the main source of nutrients for cattle (Soto *et al*., 2010b).

In the Ciego de Ávila province, Soto *et al*. (2014b), found parturition concentrations in the range 76-86 % (April-August), in dairy farms of the Livestock Production Enterprise "Ruta Invasora" with productions of 1 126 kg/ha, higher than the other studied farms, even with regards to the efficiency of the conversion of forage into milk (0,24 t of milk/t of forage), all under similar conditions of feeding restriction (less than 11 kg DM/cow/day).

In the situation of the commercial herds of Camagüey, when because of an induced reproductive strategy, a concentration of parturitions occurs at the beginning of grass growth, a favorable effect is produced on lactation and on the economy of the systems (Guevara *et al*., 2010). In this case, it has been found that when the highest concentration of parturitions occurs between April and August (more than 70 %), even under conditions of feed insufficiency, the bio-economic results can be significantly improved, and even with the possibility of intensifying, afterwards, the occurrence of parturitions towards the months of April and June (de Loyola *et al*., 2010).

The main limitation for the development and projection in time of this type of production model is the high degree of reproductive efficiency the herds must attain. In late-parturition animals the feeding conditions improve during part of the dry season, which favors their level of body reserves at the mo-

Table 1. Re-ordering of the reproductive strategy towards seasonal parturitions.

Indicator	Months											
Inseminations	7	8	9	10	11	12	1	2	3	4	5	6
Pregnancy diagnosis	10	11	12	1	2	3	4	5	6	7	8	9
Births	4	5	6	7	8	9	10	11	12	1	2	3

ment of parturition. Such reserves are essential to be used as energy source in a period characterized by showing high requirements, while the voluntary intake is highly decreased.

Management of dairy farms with regards to the seasonal parturition

One of the main causes of the low productivity of cattle is not applying some fundamental, novel and adjusted principles in a grazing method efficient in the seasonal topic, without irrigation (Senra, 2009). When parturitions occur in the early rainy season, a higher number of milking cows can be achieved and the milk production increases, due to the higher utilization, because the season directly influences the pasture availability, growth and development.

The optimum moment for the beginning of parturitions varies among the different farms, according to the prevailing agro-climate conditions. To make the herd requirements coincide it is essential that, once parturitions start, a high proportion of the cows start their lactation in the lowest possible time. Taking into consideration that the nutritional requirements are maximum around the second month of lactation, the average parturition date should precede in similar time lapse the moment of the highest pasture growth.

Under the production conditions of Cuba, where feeding depends almost exclusively on pasture, it is necessary to concentrate parturitions in the season of higher feed availability. This allows to consider the most efficient use of the stocking rate and, thus, not to seek the production per animal so much but rather a more efficient production per hectare (del Risco *et al*., 2009).

In short, milk production per hectare, measured in time, is logically one of the main indicators to evaluate the sustainable character of a dairy exploitation (Deming *et al*., 2013).

This is in addition to the conversion value of forage into milk when parturitions are concentrated in the period of higher pasture production. In terms of the meaning of conversion, the possibility of achieving 0,31 t milk/t of consumed dry matter with up to 80 % of the parturitions in April-August has been reported (Soto *et al*., 2010a) and even up to 0,59 with more than 60 % of the parturitions in April-October (del Risco *et al*., 2009). In both cases, these results were found in the farms of Camagüey under low-input conditions.

These results can be considered remarkable according to the inputs and the quality of the pasturelands used, even higher than the ones found in trials with dairy cows on cultivated and fertilized pastures in Cuba in the 1980's, where 0,3 kg milk/kg of pasture used is considered good, as in moderate-potential cows supplemented after the fifth liter, the responses have been between 0,3 and 0,6 kg of milk/kg of concentrate feed consumed (Soto *et al*., 2010b).

In this sense, the increase of the number of parturitions over the rainy season and at the end of the dry season also contributes to higher efficiency in the production during the rainy season (Guevara *et al*., 2012).

In addition, an adequate control of the primary economic data should be guaranteed, in order to evaluate periodically livestock production systems, which should include, mainly, the following values: unitary cost, cost/peso, cost/animal/day, profit/cost, cost/feedstuff, profitability and investment recovery time (Senra, 2005).

In dairy farms, it should be expected that applying the seasonality of milk production, even where the restricted suckling rearing systems remain, calf rearing does not constitute a problem. The largest problem would be, not in the system used, but in the limitation in the number of enclosed pastures with regards to the control of parasite diseases, particularly in January and February, when their occurrence is frequent; which coincides with the lowest pasture availability.

In this regard, Ybalmea (2015) stated that the live weight gain of calves reared under restricted suckling, with weaning at 70 days, can be similar to the calves under artificial rearing, with weaning at 35 days of age, and both higher than the suckling system with nurse cows. Thus, this author also refers that in the tropic approximately 90 % of the parasite infestation of calves occurs when grazing. This problem could find an important solution with the development of forage bank and confinement, with supplementation, in the first six months of life.

In the rainy season, with the seasonal system, calves are formed ruminants already and, just like the other animals, have a great forage abundance that is intensely utilized, which can have an important repercussion on the health as well as the mean daily gain, and on the efficiency in the rearing and development stages.

In any case, in the spring the highest milk and beef volumes are achieved. The analysis of productive systems, states that the priority to achieve the success of any farm tends to minimize the utilization of the available forage by the animal (Espejo, 2007). Along with this, a high percentage of the

productivity and efficiency of a herd is concentrated on the management of the entire production system; through the policy of replacements the reproductive and productive flow of the farm is guaranteed (del Risco *et al*., 2009).

Another aspect that acquires special interest is the rationing of time and the possibility of diversifying the activities within the framework of the farm or the dairy unit and the industry. In these cases, the farmer will have the opportunity to perform, in the period of lower work intensity, maintenance chores of the farm, land preparation to increase the offer in the basic household supply and/or cattle feeding, etc. It is even possible to increase the way of life of the family environment (fig. 2).

Integration of the model in the Primary Production-Industry-Consumer chain

Independently from the tools that are used to evaluate a farm, barriers that may affect its sustainability can be revealed (Marchand *et al*., 2014). In order to implement a production system or model it is essential to take into consideration a large number of biological, technological and socioeconomic factors, but, in turn, it is very important that they act in a harmonic and proportional way, so that an efficient and sustainable production is achieved.

A general proposal of seasonal model (fig. 3), considers essentially modifying the work in the reproductive sphere considering a reordering of the occurrence of annual parturition in order to optimize the use of grass, the limited available inputs and the human resources.

In the dairy farms of the Camagüey territory, it is to be expected that applying the seasonality of milk production, even where the rearing systems by restricted suckling still remain, the calf rearing does not constitute a problem, it should rather contribute to the improvement of its body condition, as it was stated in the previous section; as well as the specialization in the maternity work and the responsibility assumed by those in charge of the activity and the personnel in general.

In a continuous way, it is important to consider the traceability of the product from the primary production to the industry, as intermediate link between the producer and the consumer. Thus, it would be important to consider the union of interests between producers and the industry, in both directions. However, a highly important issue is the strengthening of the relations among the productive chain, the industry and commercialization, with unity of objectives and interests, which would imply an important step forward to enhance the sector.

It is important to analyze, discuss and establish rules and procedures that allow the basic farmer to be identified with the results of industrial processing and the quality of the commercialized product. Likewise, but in an inverse sense, the components of industry and commerce must be fully identified in each aspect that acts relevantly on the level and quality of the product obtained.

In this sense, Brancato (2007) explained that New Zealand created a national basic production system, which is simple, stable, sustainable, low cost and closely related to the requirements of the exporting industry.

With regards to the milk industry and collection, it should be said that the Cuban society urgently

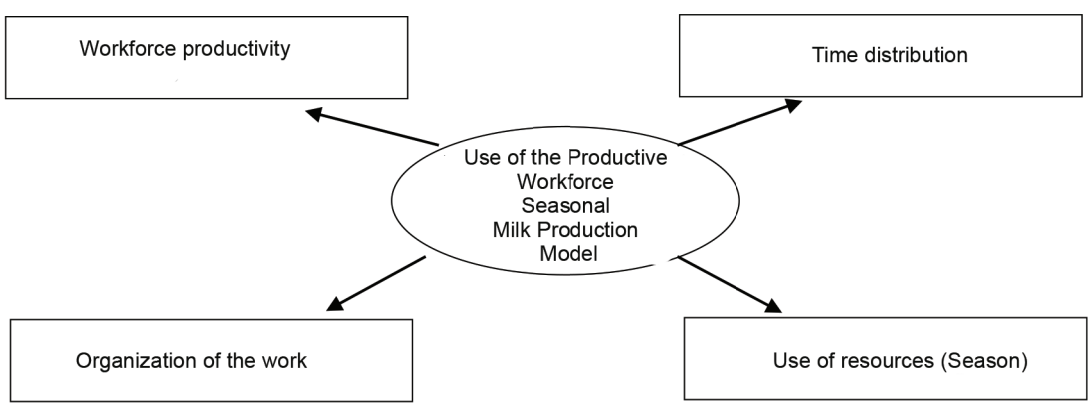

Figure 2. Implications of a seasonal production model in the use of the workforce.
Source: Elaborated by the authors

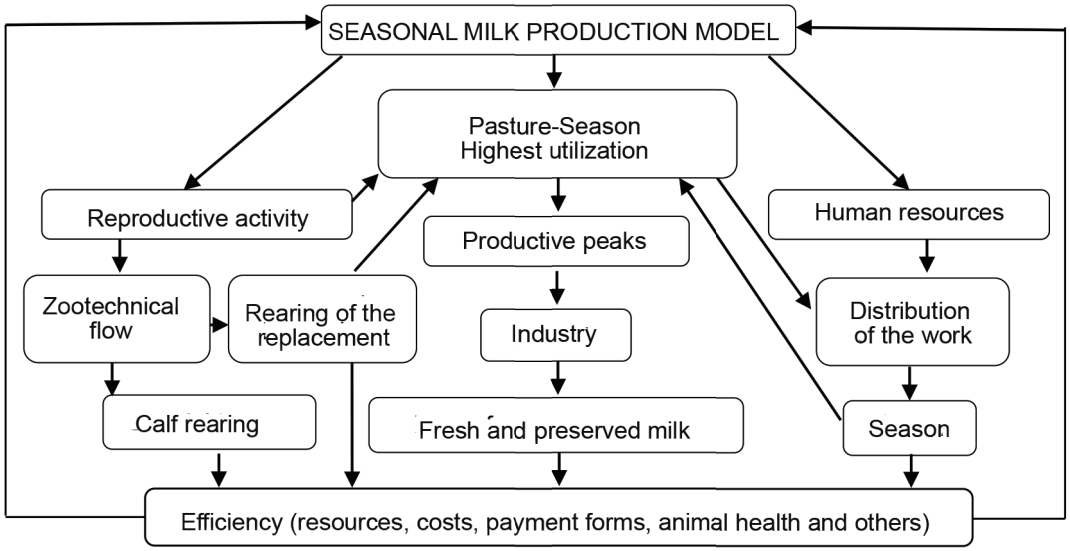

Figure 3. General diagram of the functioning of an efficient seasonal milk production system model, from the basis to the industry.
Source: Elaborated by the authors

needs the increase of the presence of animal-origin products in the basic household supply, and milk is not an exception. In Cuba there is no room for the contradiction between the industry and the farmer, due to the production relations. Moreover, the rise of the production peaks that lead to change old precepts about the adoption of technologies and, also, determine changes in the industry, with such alternative as Leche Larga Vida (Long Life Milk) or Powdered Milk, is necessary, as well as investments in roads.

The first steps have been taken towards the increase of capacities for the collection and cooling of milk, through the development of small facilities located in zones of higher contribution of the product (e.g. Jimaguayú) and establishment of industries for the elaboration of powdered milk (Camagüey); however, this could be only a partial solution taking into consideration the internal demands and productive potentialities, because the transportation networks and the necessary equipment to face productive peaks need capital investment, whose value is estimated to be higher than that required for the productive process itself, which can represent the main economic limitation.

III. Introduction of the seasonal production model

Enterprises show contrasts in other socioeconomic aspects, in the exploited areas, the total of cows in reproduction and the breeds, which brings about significant differences and, thus, in the productivity indicators, which are determinant to achieve adequate efficiency (Gallardo, 2012).

It is very important in the possible introduction of a seasonal milk production model to perform a serious and detailed work, particularly according to the characteristics of the national productive environment. It is essential to make important and urgent decisions, based on casuistic studies in each territory and particularly in the Camagüey province, in order to implement in this way alternatives that respond to the food and economic needs of the country, following a progressive sequence in their application (fig. 4).

To make decisions in order to carry this process out in certain scenarios it is essential to previously evaluate, in each case, some demographic and productive, biophysical and socioeconomic variables, such as:

1. Diagnosis of the bio-economic feasibility of the application of technological proposals and scientific results at different impact scales:

a. Formation of expert commissions, with production professionals and researchers at provincial level.
b. Identifying the fundamental aspects of the livestock production issues in each territory (ecosystem components and zootechnical management).
c. Evaluation of the main results reached in research in the province about milk production models (e.g. seasonal models).
d. Alternatives for the improvement of the feeding basis (pastures and forages).

e. Economic possibilities to face changes at different scales and terms (local development strategy).

2. Re-structuration of the form of entrepreneurial management of cattle production.

a. Determining the most efficient cooperative milk production form and extending it to the entire territory.

b. Territorial state structure for technical assistance and service provision (rural, commercial extension, animal health, reproduction, machinery, agricultural management and rearing farms).

c. Revision of the agreements with the farmers and cooperatives according to the potentialities, needs and development perspectives of the country.

3. Establishment of a monitoring and systematic control system of the performance of the sustainability indexes of the applied technology or production model.

General considerations

In cattle production systems, the adequate management of available resources with regards to the population demand, the market problems and the milk production levels are highly important criteria, to put into practice rational approaches of entrepreneurial management in this sector, implementation of technologies and productive decisions.

Taking into consideration the real possibilities of Cuban cattle production systems, it can turn out that the concentration of parturitions (70-80 %) in the period of higher grass growth increases the bio-economic efficiency of milk production, with limited dependence on external inputs.

A reproductive strategy that determines concentrated parturitions, allows to arrange the zootechnical flow of the farm, improve the growth rate of the replacements and concentrate all the efforts and possible resources in a more favorable season of the year; this allows to increase efficiency in the primary production-industry-commerce-consumer chain.

The implementation of the seasonal milk production model implies the casuistic evaluation of the productive factors that compose the milk production system and the systematic monitoring of the efficiency indicators.

Bibliographic references

Brancato, A. *El modelo de Nueva Zelanda y la lechería uruguaya*. Argentina: TodoAgro. http://nuevo.todoagro.com.ar/noticias/nota.asp?nid=6194. [18/08/2008], 2007.

Castro, R. Discurso pronunciado en la clausura del IV Período Ordinario de sesiones de la VIII Legislatura de la Asamblea Nacional del Poder Popular. Granma. http://www.granma.cu/cuba/2014-12-20/discurso-integro-de-raul-en-la-clausura-del-iv-periodo-ordinario-de-sesiones-de-la-viii-legislatura-de-la-asamblea-nacional. [08/08/2014], 2009.

Centro del Clima. *El clima de Cuba. Características generales.* La Habana: Instituto de Meteorología. http://www.met.inf.cu/asp/genesis.asp?TB0=PLANTILLAS&TB1=CLIMAC&TB2=/clima/ClimaCuba.htm. [31/03/2016]., 2016.

De Loyola, C.; Guevara, R. V.; Guevara, G. F.; Curbelo, L. M. & Soto, S. A. Intensificación simulada de la parición al inicio del período lluvioso con base forrajera mejorada. Eficiencia bioeconómica. *Revista de Producción Animal*. 22 (2):14-20, 2010.

De Loyola, C.; Guevara, R. V.; Soto, S. A.; Garay, Magaly & Ramírez, J. A. Momento óptimo para intensificar la parición a partir de indicadores de la producción láctea de rebaños bovinos comerciales en Camagüey. *Revista de Producción Animal*. 27 (3), 2015.

Del Risco, S.; Guevara, R. V.; Guevara, G.; Soto, S.; Lapinet, A. & Botyfoll, D. Evaluación de la eficiencia bioeconómica de una empresa ganadera con arreglo a la estrategia de parición anual y el plano alimentario. *Revista de Producción Animal*. 21 (2):105-110, 2009.

Deming, J. A.; Bergeron, R.; Leslie, K. E. & DeVries, T. J. Associations of housing, management, milking activity, and standing and lying behavior of dairy cows milked in automatic systems. *J. Dairy Sci*. 96 (1):344-351, 2013.

Domínguez, A. M.; Morales, Y. & Sánchez, J. A. Influencia del índice temperatura-humedad sobre la producción de leche por época del año en vacas. *Memorias de V Congreso de Producción Animal Tropical*. Mayabeque, Cuba: Instituto de Ciencia Animal. [CD-ROM], 2015.

Espejo, L. G. *Producción eficiente con bovinos en pastoreo.* http://www.milkproduction.com/Library/Articles/.2007. [04/04/2009], 2007.

FEDEGAN. *FEDEGAN.* Colombia. http://www.fedegan.org.co/modelos-eficientes-de-exportacion-gira-tecnica-australia-y-ueva-zelanda. [08/08/2014], 2013.

Gallardo, M. *Factores nutricionales que afectan la producción y composición de la leche.* Facultad de Ciencias Agronómicas, Universidad de Chile. http://www.engormix.com/producir19o26sarticulos538GDL.htm. [31/07/2011], 2012.

Geary, U.; Lopez-Villalobos, N.; Garrick, D. J. & Shalloo, L. Spring calving versus split calving: effects on farm, processor and industry profitability for the Irish dairy industry. *J. Agr. Sci-Cambridge*. 152 (3):448-463, 2014.

González, Ivet. Cuba busca el esquivo despegue de la producción lechera. Inter Press Service (IPS).

http://www.ipsnoticias.net/2015/06/cuba-busca-el-esquivo-despegue-de-la-produccion-lechera/, 2015.

Guevara, R.; Soto, S.; Curbelo, L.; De Loyola, C.; Guevara, G.; Bertot, J. A. *et al.* Factores que pueden afectar la eficiencia bioeconómica y ambiental en sistemas estacionales cubanos de producción de leche. *Revista de Producción Animal*. 22 (2):87-95, 2010.

Guevara, R.; Spencer, M.; Soto, S.; Guevara, G.; Curbelo, L.; De Loyola, C. *et al.* Influencia de la estrategia de pariciones anuales en la eficiencia bioeconómica de microvaquerías en una empresa pecuaria. I. Concentración de partos en lluvia y seca. *Revista de Producción Animal*. 24 (1):1-6, 2012.

Herrera, R. S. El Instituto de Ciencia Animal, cincuenta años de experiencia en la evaluación de gramíneas de importancia económica para la ganadería. *Rev. cubana de Cienc. agríc*. 49 (2):221-232, 2015.

Holmes, C. W. Nueva Zelanda. Claves del tambo pastoril. *Seminario en la FAUBA*http://www.engormix.com/nueva_zelanda_claves_tambo_s_articulos_649_GDL.htm. [17/08/2008], 2006.

Jaramillo, T. *El modelo lácteo de Nueva Zelanda*. http://agronegocios.uniandes.edu.co/index.php/ tematicas/gestionyterritorio/198-el-modelo-lacteo-de-nueva-zelanda. [15/04/2015], 2014.

Macoon, B.; Sollenberger, L. E.; Staples, C. R.; Portier, K. M; Fike, J. H. & Moore, J. E. Grazing management and supplementation effects on forage and dairy cow performance on cool-season pastures in the southeastern United States. *J. Dairy Sci*. 94 (8):3949-3959, 2011.

Marchand, Fleur; Debruyne, L.; Triste, Laure; Gerrard, Catherine; Padel, Susanne & Lauwers, L. Key characteristics for tool choice in indicator-based sustainability assessment at farm level. *Ecol. Soc*. 19 (3):46. http://dx.doi.org/10.5751/ES-06876-190346. [28/04/2015], 2014.

Martínez, J.; Torres, Verena; Jordán, H.; Guevara, G. & Hernández, N. Clasificación de fincas lecheras pertenecientes a cooperativas de créditos y servicios. *Revista de Producción Animal*. 27 (1), 2015.

Mena, M.; Bertot, J. A.; Avilés, R. G.; Guevara, R.; Guevara, G. & Vázquez, R. . Estacionalidad en la producción de leche en un rebaño bovino. *Revista de Producción Animal*. 19 (1):9-12, 2007.

Muñoz, D.; Ponce, M.; Pereda, J.; Muñoz, D.; Muñoz, L.; Rivero, L. E. *et al.* Los árboles en los sistemas productivos pecuarios del municipio Jimaguayú. *Memorias de V Congreso de Producción Animal Tropical*. Mayabeque, Cuba: Instituto de Ciencia Animal. [CD-ROM], 2015.

ONEI. *Panorama Territorial. Cuba 2014*. La Habana: Oficina Nacional de Estadística e Información. http://www.one.cu/publicaciones/08informacion/panoramaterritorial2014/0000%20Completa.pdf. [02/02/2016], 2015.

Pedraza, R. & Justiz, Y. Efecto de la época y la empresa en indicadores de producción de leche vacuna en Ciego de Ávila. *Revista de Producción Animal*. 27 (2), 2015.

Pérez-Infante, F. *Ganadería eficiente. Bases fundamentales*. Ed. Nieve C. Cardice, MINAGRI. La Habana. 2010.

Rossi, J. L. & García, S. C. ¿Cuál es el «piso» de la producción pastoril? Buenos Aires. http://www.engormix.com/MA-ganaderia-leche/articulos/cual-piso-produccion-pastoril-t1241/p0.htm. [30/04/2009], 2007.

Santiesteban, Dayami; Bertot, J. A.; Vázquez, R.; De Loyola, C.; Garay, Magaly; de Armas, R. *et al.* Tendencia y estacionalidad de la presentación de estros en vacas lecheras en Camagüey. *Revista de Producción Animal*. 19 (1):73-77, 2007.

Senra, A. Impacto del manejo del ecosistema del pastizal en la fertilidad natural y sostenibilidad de los suelos. *Rev. AIA*. 13 (2):3-15, 2009.

Senra, A. Índices para controlar la eficiencia y sostenibilidad del ecosistema del pastizal en la explotación bovina. *Rev. cubana Cienc. agríc*. 39 (1):13-21, 2005.

Soto, S. A.; Curbelo, L. M.; Guevara, R. V.; Mena, Madeline; De Loyola, C.; Uña-Izquierdo, F. *et al.* Efecto de patrones de concentración de parición en el periodo abril-agosto en vaquerías comerciales. I. Eficiencia bio-productiva. *Revista de Producción Animal*. 26 (2), 2014b.

Soto, S. A.; Guevara, R.; Estévez, J. & Guevara, G. . Análisis del efecto bioeconómico de la inclusión de cultivos de ciclo corto como integración al sistema de producción lechera. *Revista de Producción Animal*. 20 (2):115-123, 2008.

Soto, S. A.; Guevara, V. R.; Senra, P. A.; Guevara, V. G.; Otero, A. & Curbelo, R. L. Influencia de la distribución de parición anual y el aprovechamiento del pasto en los resultados alcanzados en vaquerías de la cuenca de Jimaguayú, Camagüey. I. Indicadores productivos y reproductivos. *Revista de Producción Animal*. 22 (2):37-44, 2010b.

Soto, S. A.; Guevara, V. R.; Senra, P. A.; Guevara, V. G.; Otero, A. & Curbelo, R. L. Simulación-validación del efecto bioeconómico de estrategias de mejora de la base forrajera en función de la producción estacional de leche en vaquerías. *Revista de Producción Animal*. 22 (2):51-60, 2010a.

Soto, S. A.; Uña, F.; Curbelo, L. M.; De Loyola, C.; Rodríguez, Evelyn & Estévez, J. Indicadores bio-economicos de la producción de leche. *Revista de Producción Animal*. 26 (2), 2014a.

Uña, F.; Soto, S. A.; Curbelo, L. M.; De Loyola, C.; Rodríguez, Evelyn & Estévez, J. Comportamiento anual de indicadores bio-económicos de la producción

de leche en vaquerías de la empresa pecuaria Ruta Invasora, Ciego de Ávila. II. Vaquería caso. *Revista de Producción Animal*. 26 (3), 2014.

Uña, F.; Soto, S. A. & Yordi, Idania. Comportamiento estacional de indicadores bio-económicos. *Revista de Producción Animal*. 27 (1), 2015.

Vargas, J. C.; Benítez, D. G.; Torres, V.; Ríos, S. & Soria, S. Factores que determinan la eficiencia de la producción de leche en sistemas de doble propósito en la provincia de Pastaza, Ecuador. *Rev. cubana Cienc. agríc*. 49 (1):17-19, 2015.

Vibart, R. E.; Washburn, S. P.; Green, J. T. Jr.; Benson, G. A.; Williams, C. M.; Pacheco, D. & Lopez-Villalobos, N. Effects of feeding strategy on milk production, reproduction, pasture utilization, and economics of autumn-calving dairy cows in eastern North Carolina. *J. Dairy Sci.* 95 (2):997-1010, 2012.

Ybalmea, R. Alimentación y manejo del ternero, objeto de investigación en el Instituto de Ciencia Animal. *Rev. cubana Cienc. agríc*. 49 (2):141-146, 2015.

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