Scientific Paper

Characterization of beef production of the entrepreneurial sector in southwest Holguín, Cuba

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Abstract

Objective: To characterize the beef production in the entrepreneurial sector in Southwest Holguín, from a case study.

Materials and Methods: Two workshops were conducted with the workers of the Entrepreneurial Basic Unit Carlos Sosa Ballester, from the Calixto García municipality, in Holguín, in order to identify, through brainstorming, the problems faced by beef production and their possible solutions. The restrictions were grouped according to the experts' criterion in the evaluation areas method, tools, human resources and productive environment. The percentage represented by each evaluation area with regards to the fundamental problem, from the weight of its contribution, was calculated.

Results: The prevailing criteria about the restrictions of state cattle fattening place, first, the productive environment (27,2 %) and are focused on the problem with the zootechnical flow, which does not supply the farm with animals. In order of importance, it is followed by the restrictions that are related to the application of tools (26,4 %). With regards to the method (24,4 %), the deficient feeding of herds and the bad planning of processes constitute the two restrictions found in the process. They refer, finally, to the ones linked with human resources, concerning the fluctuation of labor force, which represented 22 % of the limitations.

Conclusions: Beef production of the entrepreneurial sector in southwest Holguín is limited by the zootechnical flow, herd feeding, process planning and employee retention, which are determinant to face the adverse factors of the ecosystem.

Keywords: Rural development, innovation, animal production

Introduction

The delivery of cattle to slaughter in the period 2012-2017 had an annual growth of 0,49 % at global level. In Latin America and the Caribbean, reached 0,18 %, with weights at slaughter of 46,0 and 14,7 kg·animal^{-1}, respectively (FAO, 2019). Cuba, in the same period, according to the numbers referred to the state sector (ONEI, 2018a), had a growth of 111,9 thousand heads in the delivery of cattle to slaughter. However, the average slaughter weight was reduced in 14,0 kg animal^{-1}.

According to the description by Funes-Monzote (2008), the stabilization of these indicators requires to diversify, decentralize and promote food self-sufficiency, as pillars that emerge after the economic crisis associated with the collapse of the Soviet Union. It is known that in the period 1960-1990 intensive technologies prevailed, with monoculture in large land extensions dependent on external inputs. This type of technology, although it was productive, is inefficient and environmentally deleterious.

The change of paradigm required by the current circumstances demands integration in the technological, scientific, environmental, economic, educational and communicational management, as well as optimum utilization of the available capacities in Cuba and the recognition of productive scales. These elements are included in the agroindustrial policy for the period 2016-2021, which ascribes a protagonist function to the Cuban state agricultural enterprise (PCC, 2017).

There are opportunities to promote cattle rearing and fattening in dry environments of the tropic with adequate productive levels. The results of feeding supplementation with sugarcane (*Saccharum officinarum* L.) and king grass (*Cenchrus purpureus* Schumach & Beskr) during the dry season, and the establishment, as minimum, of 30 % of the area with legumes, can be mentioned. Regarding reproduction, the utilization of simple yards or multiple herds, mounting per season and manipulation of calf lactation can be referred (Benítez *et al*., 2009b). The use of animal husbandry agroforestry and intensive

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silvopastoral systems must be also added, because of the ecosystem services they provide (Murgueitio *et al*., 2019).

The above-mentioned practices and the support of agricultural extension services, which favor their assimilation and take into consideration the projected transformations in the sector, could contribute to the re-establishment of beef production levels in the agroecosystems of southwest Holguín. This zone of the Cauto basin, of flat relief, but of dry climate, with physical restrictions in its soils for agricultural development, is used for rearing beef cattle (Oquendo, 2011).

The identification of problems constitutes the first step for their solution. In this sense, the support of institutional innovation is essential, especially when there are practices that can be introduced and ecosystems that demand particular management. This work aims at characterizing beef production in the entrepreneurial sector in southwest Holguín, from a case study.

Materials and Methods

The selection of the case study was based on objective criteria (location in a basin of national interest, ecosystem degradation, productive potential, existence of basic information) and on criteria of subjective character (previous links with research institutions, willingness to participate, existence of governmental policies for food production, introduction of science and technological innovation, enhancement of the work in hydrographic basins).

Characteristics of the study area. The work was conducted at the Entrepreneurial Base Unit (UEB, for its initials in Spanish) Carlos Sosa Ballester, dedicated to cattle fattening for industrial slaughter destined to the basic food basket, national balance and tourism. This unit belongs to the animal husbandry enterprise of the Calixto García municipality, Holguín province, Cuba. It has an animal husbandry surface of 2 119,5 ha and in 2018 it produced 442,5 t of live beef.

The local, dry tropical savanna climate, with clear distinction of two seasons, historically accumulates 80,6 % of the rains from May to October. The average temperature during the year is 25,9 ºC, according to the WorldClim climate data (Fick & Hijmans, 2017). Of the soils, 85 % are vertisols, with poor to very poor drainage, fine texture, mostly vertic properties, and prevalence of the clayey fraction, rich in smectites. Its thickness is equal to or higher than 60 cm, which limits the infiltration rate and contributes to salinization due to the evaporation of the waters that flood the land (Hernández *et al*., 2015).

Procedure of the case study. Two workshops were held, in June, 2018, and February, 2019. During the workshop of problem identification and solutions, a brainstorm was carried out with the participation of the UEB staff, researchers and scholars specialized on the topics from the Agricultural Research Institute Jorge Dimitrov. For such purpose, a protocol was applied to create an environment in which participants could develop and discuss their ideas freely (Rawlinson, 2017).

The cause-effect diagram was used to extract the main problem, its causes and relations between them. In addition, the Pareto diagram was used to visualize the solutions, selected by direct and open voting. The participants copied the list of restrictions and solutions and evaluated them by the criteria on the problem: "it is a factor of the problem", "it is a direct cause", "it is a solution to the problem" and on the solution "it is feasible", "it is measurable", "it is low cost". Each one was given a weighting of one to three points, depending on the level of acceptance.

The restrictions were grouped according to the experts' criterion in the evaluation areas method, tools, human resources and productive environment. The percentage that each evaluation area represented to the fundamental problem was calculated, based on the weight of its contribution, which was obtained through the following equation:

$$AE_k = \frac{\sum_{i=1}^{m}\left(\sum_{j=1}^{6} e_j\right)}{m}$$

Where:

AE_k: Weight of the *k*-eth area of evaluation.
m: Quantity of restrictions in the area of evaluation.
e_j: Value of the evaluation criterion of the j-eth restriction.

The data were subject to a non-parametric simple variance analysis, for repeated means. This analysis allowed to obtain Kendall's concordance coefficient (W), at confidence level of 99 % through the proprietary program IBM SPSS® Statistics version 22 (*Sigma Plus Statistiek*, 2019).

Results and Discussion

The prevailing criteria regarding the restrictions of entrepreneurial cattle fattening place, first of all, the productive environment, with a contribution of 27,2 %. This restriction focuses on the

problem that the zootechnical flow does not supply animals to the farm. In order of importance, it is followed by the restrictions related to the application of tools, with 26,4 % of contribution. They are linked to the limitation of cattle stock for the production development. Regarding the restrictions referred to the method, which are in third place, with a contribution of 24,4 %, problems related to deficient herd feeding and poor planning are included. Finally, there are those linked to human resources, concerning the fluctuation of the labor force, for 22,0 % (figure 1).

In the natural environment, this area is characterized by the existence of a landscape that tends to aridity. This portion of the Cauto basin is one of the zones of Cuba with the highest percentage of areas affected by the deficit in the accumulated rainfall in the historical, dry and rainy seasonal periods (Cutié and Lapinel, 2013). It is a region that does not have large reservoirs; it only has one river on the southern watershed (ONEI, 2018b). The drainage restrictions and soil salinization, which contribute to a significant proportion of the soils being used in animal husbandry for the fattening or rearing of crossbred or Zebu cattle (Oquendo, 2011), influence the fact that the zootechnical flow, which does not supply animals to the farm, is considered the cause of the problems. However, actually, they respond to the poor organizational preparation to face this situation.

These affectations of drought contribute to reduce herd feeding, and are the direct cause of the deterioration of pasture production. In the works conducted by Benítez *et al*. (2007), with the grass species *Brachiaria humidicola* Stapf., *Megathyrsus maximus* Jacq. and *Cynodon nlemfuensis* Vanderyst, in a rational grazing system in the Cauto valley, the climate explained 52,9 % of the variability in biomass production, with higher emphasis on maximum temperatures and rainfall.

The restrictions in the area of tools are added to this, where the inadequate reproductive process, low birth rate and inexistence of animals that allow to guarantee production in the territory, constitute a chain that restricts the growth of the cattle stock.

Inadequate practices in these agroecosystems contributed to the reduction of cattle (12,3 %) between 2015 and 2017, which is explained by variations in births (from 6754 to 4756) and by the mortality percentage (36,2 to 52,5 %) in the state sector. In the productive environment, the number of entities that develop cattle fattening grows, with

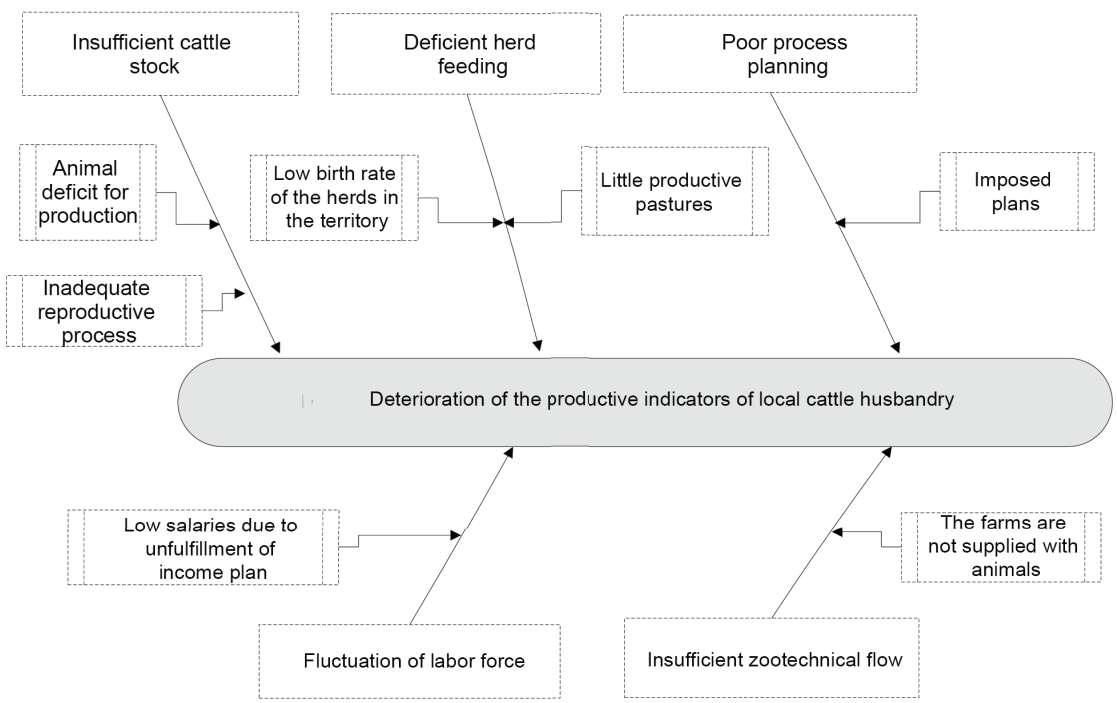

Figure 1. Cause-effect diagram of the productive indicators of entrepreneurial cattle fattening in southwest Holguín.

an increase of 34,5 % in the number of fattening cattle in the entrepreneurial sector; while in the farmer sector it grew 8,0 %, at the expense of purchase, mostly (ONEI, 2018b).

With less weight the restriction produced by the imposed plans is indicated, requiring a higher number of animals to slaughter to reach the contracted tons of live beef. Miranda-Tortoló *et al*. (2016) reported that the centralized and vertical character that prevailed in the Cuban economy for years has been a factor that limited the real possibilities of actors' participation at multiple scales. The aspects studied here show that this character and its effects still persist. State and entrepreneurial managers are required to assimilate their functions and respect those of others.

The aspects analyzed so far directly influence the fluctuation of the labor force, determined by the low salaries earned by animal husbandry workers, as production plans are not fulfilled. In this sense, it is necessary to create capacities to assume the transformations of the environment and the new ways of managing enterprises and people. According to Miranda-Tortoló *et al*. (2016), these aspects could contribute to solve 80 % of the problem in which the agricultural sector is immersed, affected by decapitalization in the 1990s and by the lack of generic and specific competences of managers and specialists, regarding the adequate performance and facing of risks and changes.

The problems of deficient herd feeding, insufficient cattle stock for the production and fluctuation of the work force, obtained Kendall's concordance coefficients *W* higher than 0,5. This indicates an adequate level of agreement among the participants (Legendre, 2010), especially because they are perceived as weaknesses of the internal processes of the UEB. The poor planning of the processes and the insufficient zootechnical flow have a low concordance coefficient, and have no significance ($p > 0,05$) with regards to the statistic X^2. This is explained because, in spite of having effects on the deterioration of the productive indicators of local animal husbandry, they are indicated as threats for being the result of subordination to the enterprise decisions (table 1).

The relative contribution of the solutions is shown in table 2. In the method-related limitations, the establishment of compensation areas, rehabilitation of pasture systems, establishment of protein

Table 1. Statistical significance of the entrepreneurial cattle fattening constraints.

Parameter	Deficient herd feeding	Poor process planning	Insufficient cattle stock for production	Fluctuation of the work force	Insufficient zootechnical flow
n	20	5	5	20	5
W	0,513	0,200	0,500	0,700	0,203
X^2	51,301	5,000	12,500	70,000	5,083
gl	6	6	6	6	6
p	0,000	0,416	0,029	,000	,406

Table 2. Cumulative percentage contribution of the solutions to the reduction of restrictions in entrepreneurial cattle fattening.

Limitation	Solution	Percentage
Deficient feeding of the herds	Establishing the areas of pasture compensation.	25,8
	Rehabilitating pasture systems.	51,4
	Establishing protein banks.	76,0
	Producing seed to renovate the pasture.	100,0
Poor planning of the processes	Fulfilling the foreseen production plans.	100,0
Insufficient cattle stock for the development of production	Improving the management of animal purchase.	52,0
	Improving the herd reproduction to self-supply the farm.	100,0
Fluctuation of the labor force	Fulfilling the foreseen production plans.	100,0
Insufficient zootechnical flow	Improving animal purchase management..	100,0

banks and seed production to renovate the pasture were approached as solutions. The referred solutions were considered feasible, measurable and relatively low cost.

The response to this restriction begins with elaborating the feeding balance of the herd, which, as a work tool, allows us to find the problems, mainly the nutritional ones, propose their solutions and also makes it possible to do an integral analysis of the milk or beef production, including calves and growing cattle, in their past, present and future (Pérez-Infante, 2013).

It is also required to transform the feeding basis. In this UEB, as in most entities of the southern agroecosystem, natural pastures prevail. However, regionalization allows to recommend the grasses *Cynodon nlemfuensis* Vanderyst, *Chloris gayana* Kunth, *Urochloa brizantha* (Hochst. ex A. Rich.) R.D. Webster, *Cenchrus ciliaris* L., *Cynodon dactylon* L., *Digitaria eriantha* Steud, and the legume *Clitoria ternatea* L. (Oquendo, 2011). In addition, other forage plants identified by Oquendo *et al.* (2006), such as *Dichanthium aristatum* L. and *Megathyrsus maximus* Jacq., could be used.

The strengthening of the varietal composition with regionalized species, especially those of C_4 photosynthetic path, allows the increase of grazing intensity with the accumulation of organic carbon in the soil, due to its ability to adapt and compensate the effect of grazing practices (Abdalla *et al*., 2018). Species diversity and meta-community dynamics constitute complex mechanisms that provide strong resilience, and which cannot be measured by the sum of the resilience traits of each species (van Looy *et al*., 2016). Therefore, the existence of natural pastures is an element that enhances the criterion that describes unproductive pasturelands as fragile ecosystems.

The results of several studies, analyzed by Rodríguez-Acosta (2015), recommend the introduction of pasture and forage species resistant to prolonged agricultural droughts. Under conditions like these, sugarcane (*S. officinarum* L.) and king grass (*C. purpureus* Schumach & Beskr) constitute the main route for energy supplementation, and should cover 50 % of the dry matter ingested by cattle. Protein supplementation could be done through legumes, which must cover at least 30 % of the area, with the association with creeping species. It would be even better, by the tree stratum through silvopastoral systems, which in addition to increasing biomass production, generate environmental carbon capture services and biodiversity (Murgueitio *et al*., 2019).

There are some shrubs and trees as resident species in the southern agroecosystem, with potentialities for their inclusion in silvopastoral systems. Among them are: *Albizia lebbeck* (L.) Benth., *Aeschynomene americana* L., *Pithecellobium dulce* (Roxb.) Benth., *Rhynchosia minima* (L.) DC., *Samanea saman* (Jacq.) Merrill, *Sesbania sesban* (L.) Merrill and *Cordia collococca* L., besides *Leucaena leucocephala* (Lam.) de Wit. and *Gliricidia sepium* (Jacq.) Kunth (Oquendo *et al*., 2006).

The forage plants *A. lebbeck* and *L. leucocephala* are plants of common use in animal husbandry, acknowledged in semiarid regions of Asia for their nutritional value, dry matter digestibility and ruminal degradability of their leaves (Habib *et al*., 2016).

S. saman and *L. leucocephala* in Latin America showed favorable effects in the feeding of growing females, with remarkable reduction of methane emissions in diets with low-quality pastures (Piñeiro-Vázquez *et al*., 2017). Particularly, *L. leucocephala* showed increases in the populations of fiber-degrading microorganisms and in the depressing effect of protozoans in fattening bulls, which propitiates higher productive responses (Galindo-Blanco *et al*., 2018).

On the other hand, the exacerbation of the annual drought stops the live weight gain of the animals and even pushes back the advances made at the beginning of fattening. However, this effect can be counteracted by using the grazing areas closest to the UEB for animals near slaughter. In this way, damage to pasture and soil due to overgrazing is avoided, and water consumption and transportation are reduced (Derner *et al*., 2017). In addition, this would allow energy supplementation through sugarcane (*S. officinarum*) and king grass (*C. purpureus*), final molasses or other byproducts, from the sugar industries located in the surrounding municipalities.

For finishing fattening in this period, protein supplementation is also necessary, which can be carried out with the use of non-protein nitrogen through urea and chicken manure (Rodríguez-Acosta, 2015) and the use of forage from widely-distributed and accepted plants, especially in dry regions. These are species that are recognized in the literature, such as *Moringa oleifera* Lam. (Liu *et al*., 2018), *Morus alba* L. (Peña-Borrego *et al*., 2019) and *Tithonia diversifolia* (Hemsl.) A. Gray (Tagne *et al*., 2018).

This way to finish fattening during the dry season requires a sugarcane area, whose size allows to

supply enough quantity to cover 50 % of the dry matter demand, and also needs an open access protein bank, which is not used as compensation (Benítez *et al*., 2009b). The solution of these elements contributes directly to the fulfillment of the foreseen plans, and to solve the second restriction, because according to Pérez-Infante (2013) the breakdown of the balance between pasture and animal is very seriously reflected on the economy of the system.

Regarding the tool-related limitations, improving purchase management would contribute to reducing by half the restriction of insufficient cattle stock for production development. At present, the UEB buys yearlings that do not have the necessary weight in correspondence with age. They are animals that come from dairy farms in the territory and from other municipalities in the province, as well as from the cooperative and farmer sector. However, the potential that exists in animals of other categories, such as cows that end their reproductive life, is not valued.

According to the researchers' criterion, it is reasonable to adopt simple yards instead of multiple herds, especially for the individual control of fertility of cows and the sire, as well as for the paternity record of the offspring, which contributes decisively to increasing the birth rate, increasing the productive efficiency of the system, as well as obtaining more profits, by increasing the amount of calves. In addition, it is efficacious when conducted according to the standardized procedures and all the sanitary control rules of the reproductive process are fulfilled (Benítez *et al*., 2009b).

The adoption of the practices proposed by Benítez *et al*. (2009a,c) would allow to reach a birth rate higher than 80 %, reduce the age of incorporation into reproduction by more than four months, and between 8 and 10 months the age at first parturition, which could achieve a stable semi-open zootechnical flow. This would eliminate the restrictions of method and productive environment, and foster favorable economic conditions to turn the UEB into a stable source of employment for the community, with satisfactory economic results.

In spite of the above-stated facts, for the application of all the apparently simple practices described in this work to generate an increase in production or the workers' income, the development of a new rationality in the personnel of the entrepreneurial sector is required because innovation management is not a linear process that researchers could transmit to the company. On the contrary, it is an interactive and complex process, on which the entrepreneurial experience has enormous influence, which seeks the technologies close to its knowledge pool (Miranda-Tortoló *et al*., 2016).

The implications of this rationality should be valued based on innovation, as a process of business management, which leads to sustainable changes based on collective learning, focused on strengthening the capacity to find solutions and adapting to the different conditions of local actors (Rodríguez *et al*., 2009). This strategy demands the institutionalization of multiactoral collaboration mechanisms and the creation of spaces for productive innovation, adequate management of natural resources and institutional innovation (Schut *et al*., 2016).

Conclusions

The main problems in the animal husbandry of the entrepreneurial sector in southwest Holguín are related to the insufficiency of the zootechnical flow to carry out production, as well as to the poor feeding of the herd. However, the aspects that are related to the productive planning and worker retention restrict managerial performance and are determinant for facing adverse ecosystem factors.

It is necessary to increase institutional innovation, as a collective form of learning, from a cohesive work between the higher levels of enterprise management and scientific institutions.

Therefore, it is necessary to design and apply technical assistance services, training and agricultural extension to efficiently assimilate new technologies, so that they contribute to the better organization of labor, ensure increased productivity and consider the transformations that occur and are projected in the sector.

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Authors' contribution

- Yuri Freddy Peña-Rueda. Carried out the revision, development of key concepts, formulation of objectives and establishment of the work methods. Conducted the workshops and the data collection. In addition, worked on the data statistical processing, manuscript writing and approved its final version.

- Diocles Guillermo-Benítez. Carried out the revision, development of key concepts, formulation of objectives and establishment of the work methods. Conducted the workshops and the data collection. In addition, worked on the data statistical processing, manuscript writing and approved its final version.
- Nelvis Alipio Almaguer-Pérez. Participated in the workshops and data collection. Worked on the data statistical processing and carried out the grammar correction.
- Cruz Emilio Pacheco-Peña. Coordinated the conduction of the workshops at the UEB and participated in the data collection. Besides, improved the different sections

Conflict of interests

The authors declare that there is no conflict of interests.

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