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Strategic Management Elements on a Dual-Purpose Cattle Farm in Southwest Holguin Province

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ABSTRACT

Background: A country farm has purposes different from a company; however, since the former pursues an economic goal, knowing cattle management indicators could be useful.
Aim: To determine the existence of strategic management elements on a dual-purpose cattle farm in southwestern Holguin province.
Materials and Methods: A case study was conducted on a cattle farm with a dual-purpose zootechnical flow. Organizational management was characterized through a check list by means of a balanced scorecard for cattle raising.
Results: The work system was divided into purposes. The dairy herd had a strategic role, whereas the growing-fattening herd was given a tactical role. The increase of the return rate by cattle head was chosen according to the vision and strategy. The financial perspective was based on the rate of conception, which is not financial. For customer perspective, the percentage of cattle that qualifies for a particular category, with the first category covering 80% of the annual animal sale, was chosen. In the internal process perspective, unit cost was used, which in face of environmental constraints, requires innovating management. The formation and growth perspective comprised the rate of conception, which is unrelated to the skills of the work teams.
Conclusions: The farm has a number of underlying practical strategic management elements, and shows no distinct farmer rationality, which helps reflect on institutional innovation and social learning in this sector.
Key words: attitudes, farmers, agricultural economy and agricultural situation, productivity (*Source: NAL-USDA*)

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INTRODUCTION

The experience of several extensionists in Latin America shows that farmers do not manage their farms in the same way a company is run. On the contrary, their goals are focused on subsisting, and improving the living conditions of the household, rather than worrying about strict control of expenses, income, and net profits (Landini, 2011). Despite these peculiarities, along with others derived from farm size, crop diversity, and the complexity of environments in which they are located, farm production is an economic activity.

Every improvement in the productive activity requires the establishment of objectives and measurements to establish a before and an after. Sarraf and Nejad (2019) explained that the method of a balanced scorecard (BSC) permits to handle the complexity of evaluating organizational performance, particularly in environments overloaded with biased information, and the need to reach certain amount of judgment that allows for multiple perspectives and indicators to be summarized and interpreted.

Patterson and Richardson (2007) suggested the utilization of BSC in cattle raising management, based on a vision of cost-effectiveness and sustainability. The long-term productive results include: cutting down costs per animal, reducing labor dependence, minimizing the dependence on harvested and purchased foods, and increasing productivity and income per animal. This is based on four basic strategies: adjusting genotypes to the environment, producing market-oriented cattle; adjusting the production system to the environment, and considering that the overall stocking rate involves the existence of animals from several categories.

In southwestern Holguin (Cuba), a study conducted by Peña-Rueda *et al.* (2018a) showed that farmers conduct limited cattle raising due to the lack of precipitations and soils with draining limitations that tend to salinization, in which herd production, feeding, and management can determine the stability of productions. According to Peña-Rueda *et al.* (2018b), all types of farms identified in the region show structural and functional irregularities which are reflected in their productive response.

Peña-Rueda *et al.* (2019) identified that the deterioration of productive indicators is associated to the application of alternatives of production that do not fit the environment, the demand of external inputs, and insufficiencies in the adoption of technologies, and the creation of capacities to ensure herd nutrition in adverse periods of time. It requires organizational approaches that help face these restrictions.

The aim of this paper was to determine the existence of strategic management elements on a dual-purpose cattle farm in southwest Holguin, Cuba, associated to the methodology of balanced scorecard.

MATERIALS AND METHODS

A farm from Pedro Diaz Coello CCS (Cooperative of Credits and Services), at Monte Alto People's Council, municipality of Calixto Garcia, was included in the study. It is engaged in cattle raising, with a dual-purpose zootechnical flow. This study required proper farmer consent.

The premise represents the agroecosystem of southwest Holguin, located in 900-mm precipitation lines setting territorial borders on the precipitations map (Hernández-Sosa *et al*., 2018). The soils are of thin texture, most of them with vertical properties, and the prevalence of smectite-rich clay fractions, with thickness equal to or greater than 60 cm, which favors poor-very poor draining, and a tendency to salinization (Hernández Jiménez *et al.*, 2015). The grass shows anthropic degradation due to the use of resident species without seasonal and stocking rate regulations, as well as the lack of arborization (Peña-Rueda *et al*., 2018a).

Organizational management was diagnosed by means of an interview backed with a checklist made according to the proposal of Patterson and Richardson (2007), to determine vision, management strategy, financial perspectives, customers, internal processes, and formation-growth in cattle. The information from the study case was summarized in order to make generalizations about the region where the farm resides.

RESULTS AND DISCUSSION

The farm study comprised 67.1 ha, and a herd of 200 cattle heads. The basic mass is made of 30 breeding animals: Holstein x Zebu backcross, two Cuban Siboney bulls, and 20 replacement females, grazing in a 13.42 ha plot divided into seven subplots. In September and October, the cows and heifers were exposed to the bulls for direct mating, expecting calvings by June and July, when naturalized grass was highly available, with a peak in production reaching 26 000 liters of milk (Figure 1).

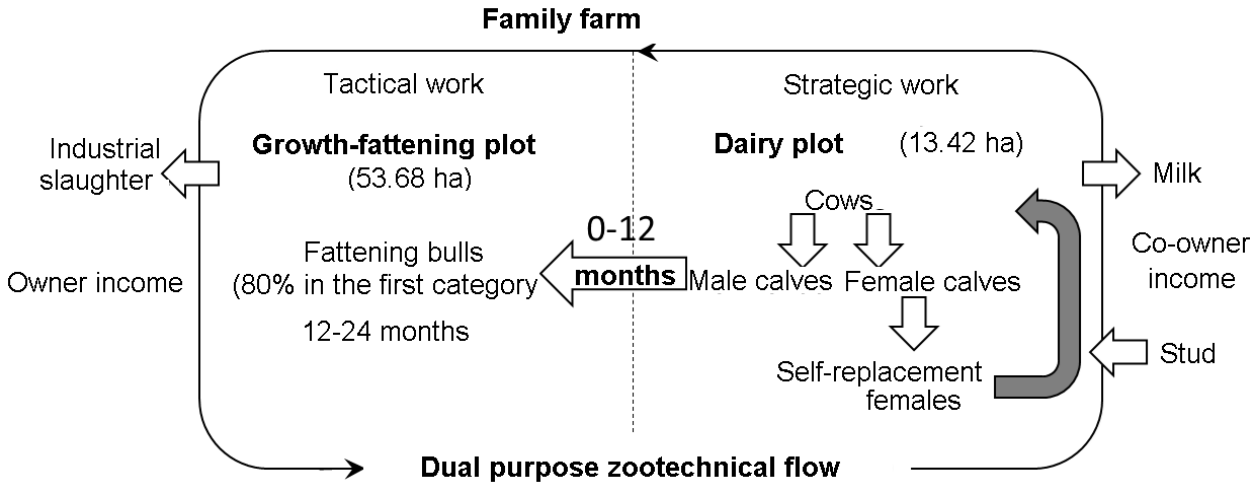

Figure 1. General functioning scheme of a dual-purpose family farm

The calves remain by the cows throughout the colostrum period, then they are fed on a milk substitute until weaning, at six months of age, and remain grazing with the group of breeding animals until they are one year old, when they are taken to a 53.68 ha plot to start fattening under grazing. During the dry period, when the animals are enclosed, and received sugar cane (*Saccharum officinarum* L.), *king-grass* (*Cenchrus purpureus* Schumach & Beskr), and molasses with 3% urea.

This family farm is run by the father and his son, using a purpose-divided work system, which is complemented throughout the year. The son manages the breeding herd, thus his income depends on milk production; he performs a strategic mission. Most of his activities are season-dependent.

The father runs the growing-fattening herd, using the calves born, closing the zootechnical flow, and preventing the sale of growing animals to the business sector, whose purchasing prices are not always attractive to farmers. Since weaning, calves spend between 12 and 24 months within the production cycle, until they are sold as bulls, for industrial slaughtering, becoming the main source of income of their owner.

In the interview, particularly in relation to long-term projection, the owner of the farm said that his vision was to achieve a high return rate per head, something that Patterson and Richardson (2007) complied, along other four reasrchers, for application in cattle raising (Table 1). The restrictions for the development of production are defined in the following order: droughts, inadequate genotypes, and insufficient area, which Peña-Rueda *et al.* (2019) coincides with.

Table 1. Elements of management vision and strategy suggested for cattle raising, and selection in the study case

Vision*	Managing strategy*	Selection
Achieving cost-effectiveness and sustainability	1) Reducing costs per head	
	2) Limiting labor use	
	3) Decreasing crop harvest and food purchases	
	4) Achieving high productivity	
	5) Increasing the return rate per head	√

***Adapted from Patterson and Richardson (2007)**

The head return rate is not a purely accounting indicator, but a relative measure of distributed income by the elements of cost. This is primary evidence that the aspects of strategic management exist in the economic activity of farmers, though there exists a different rationale (Landini, 2011). Besides, they coincide with the criteria given by Sarraf and Nejad (2019), that BSC is a multidimensional method that takes conventional management based on punctual examination of a financial structure into a balanced structure with financial and non-financial indicators, as well as short and long-term goals.

Strategy 1, according to Patterson and Richardson (2007), must focus on adjusting genetics to the environment. It was evaluated by means of the conception rate on the farm studied (Table 2).

One element that stands out, which might bring confusion to the extension of BSC as a managing practice, is its preference to use the conception rate both as an indicator of perspectives and

indicator of formation. The utilization of the lowest number of indicators to reduce the complexity and uncertainty in decision-making, especially during multi-attribute processes, is practical (Qian Tan, 2017). However, the utilization of an indicator that fits better to the financial perspective, such as costs or another type of measurement related to profits and cost-effectiveness, is more prudent.

Table 2. Managing indicators suggested to determine the fit of genetic to the environment, and selection in the study case

BSC perspective	Strategy 1*	Indicators*	Selection
Financial	Fitting genetics to the environment	1) Unit cost	
		2) Cost to produce one kilogram of calf	
		3) Conception rate	√
		4) Productivity, kg weaned cow^{-1} $year^{-1}$	
		5) Breeding animals fertilized during the first 21 days of the gestation season.	
		6) Body condition of the breeding animal at confirmation	
		7) Cost of forage and supplements	

***Adapted from Patterson and Richardson (2007)**

To achieve the fit of genetics to the environment in the study case, the breeding animals should be related to the Zebu type, so they can tolerate the harshness of the environment, and Holstein, to achieve high productive levels, according to the current stabilization of the production system. These criteria are similar to Ramírez-Barboza *et al.* (2016) who noted a tendency of greater daily weight gain in phenotypes with a higher proportion of *Bos taurus* genes, in the biological performance of fattening cattle, which was linked to heterosis, and the adaptation capacity to the production environment.

The utilization of localized species and varieties is an aspect that improves the efficacy of livestocking productive management. In southwest Holguin, graminaceae are recommended, particularly *Dichanthium aristatum* L., *Megathyrsus maximus* Jacq. (Oquendo *et al.*, 2006), *C. nlemfuensis, Chloris gayana* Kunth, *Urochloa brizantha* (Hochst. ex A. Rich.) R.D. Webster, *Cenchrus ciliaris* L., *Cynodon dactylon* L., *Digitaria eriantha* Steud, and leguminosae *Clitoria ternatea* L. (Oquendo, 2011).

It is important to have individuals with Zebu traits, due to its adaptability to different environments (Rodríguez *et al.*, 2015), since precipitations are limited in the region, and the inclusion of special genotypes for production are not advised (Oquendo, 2011; Peña-Rueda *et al.*, 2018a). It coincides with Leroy *et al.* (2018), in that adaptation should be seen as an ecosystemic service offered by zoogenetic resources, which allows different breeds or species to survive and feed in areas that could not be used otherwise.

The realization of a product is not evaluated in milk, groups that close productive cycles are used, based on the strategy of producing a market-oriented animal. It is important not to sell animals for industrial slaughter if 80% of them are not first class, and the rest is within second and third classes, regardless of age and category (Table 3).

Table 3. Managing indicators suggested for the production of market-oriented animals, and selection in the study case

BSC perspective	Strategy 2*	Indicators*	Selection
Customer	Producing market-oriented animals	1) Market prizes received	
		2) Percentage of cattle that qualifies for certain category	√

***Adapted from Patterson and Richardson (2007)**

The sale of other classes is not allowed. The compliance of this indicator of the third strategy assures that the sale weight of males is not less than 400 kg. Even the rejected heifers will have a weight above the mean.

In this last aspect, rejected heifers and breeding cows are directly sent to the slaughter house at the end of the mating season, which coincides with López-Trujillo *et al.* (2016). However, the purpose for the next year is to use the efficiency shares existing in cow fattening, which can recover their body reserves lost during lactation. Research done in grazing conditions without supplementation, in Uruguay, found between 500 and 800 g/animal/day^{-1} in them (Montossi and Lagomarsino, 2017).

This adjustment to the environment of the production system (strategy No.3) is an aspect whose essence lies in production practices. On that farm, adjustment of the production system is determined by the unit cost (Table 4), but before the adversities of the environment, it would interesting to use supply days with food conserved for a year of production.

Table 4. Managing indicators suggested for adjusting the production system to the environment, and study case selection

BSC perspective	Strategy 3*	Indicators*	Selection
Internal processes	Adjusting the production system to the environment	1) Costs of foods harvested/purchased	
		2) Days with supply of food conserved for a year of production	
		3) Unit cost	√
		4) Cow/man relation	

***Adapted from Patterson and Richardson (2007)**

Sarraf and Nejad (2019) explained that this perspective is linked to the use of technology and residual reduction, productivity, post-sale service, and innovation, as activities of the value chain that will contribute to the satisfaction of customer and stakeholders's expectations and demands.

Innovation is an internal process that ensures stability of farm operation in southwest Holguin, where limited water supply is a problem to implement milk production systems. However, these are developed by the farmer sector (Peña-Rueda *et al.*, 2018a). Zootechnical flow in dairy cattle must reduce the cow/man^{-1} relation, especially during milking.

Usually, a dual-purpose zootechnical flow is not thought to be possible in the area, since, according to López and Ribas (1993), Cuban Siboney possesses good milk production traits, climatic adaptation, and can be a good source of beef.

A dual-purpose zootechnical flow contributes to the second strategy, as the market demands milk for vulnerable groups, and beef for the entire population. It also contributes to the third strategy, by concentrating milk production activities in the season with the highest grass availability (de Loyola *et al.*, 2012), and calves (Diskin and Kenny, 2016), which favors the development of the offspring, thus conditioning the reduction of short-term unit cost in the rainy season.

Also, at the beginning of the rainy season, fattened animals, which are not part of production, and those which ended their production lives, can be sold, which favors long-term economic results, and reduces the stocking rate in the moment with the highest environmental adversity (Hánke and Barkmann, 2017).

The way in which feeding takes place helps limit the number of days with feeds conserved over a production year. On this farm, grazing takes place in a continuous manner, and efficacy could increase with intensive rational grazing that permits to utilize the plant when the optimum amount of nutrients has been stored in relation to the stocking rate capacity (Milera-Rodríguez *et al.*, 2019).

In critical periods, supplementation is done with sugar cane (*S. officinarum*) or king grass (*Cenchrus purpureus*). Cultivation to preserve these forages is an energy supplementation practice. According to Peña-Rueda *et al.* (2019), when referring to studies on the Cauto River Basin, noted that, at least 30% of the cattle area is required to meet 50% of the ingestion capacity.

Protein supplementation is limited. The performance of this farm could be higher if Moringa oleifera Lam (Liu *et al.*, 2018), *Morus alba* L (Peña-Borrego *et al.*, 2019), and *Tithonia diversifolia* (Hemsl.) were included. A. Gray (Tagne *et al.*, 2018). Additionally, forest-grazing systems can produce protein biomass, besides providing shade, capturing carbon, and increasing biodiversity (Murgueitio *et al.*, 2019).

The perspective of formation and growth is the hardest to measure, since, methodologically, it focuses on culturing and the skills of the working team, also linked to their satisfaction and growth (Sarraf and Nejad, 2019). However, Patterson and Richardson (2007) focus on economic-productive growth of the herd, which was studied as such in this research, especially on the rate of conception (Table 5).

One reason not to consider formation and growth might be given by the fact that this is the almost inevitable mode of interpretation by those who lack categories and forms of understanding that provide meaning to the behavior of small farmers (Landini, 2011), and have little estimation for rural extension practices, as core elements of several programs and projects of rural development directed to them (Landini and Murtagh, 2011).

Table 5. Managing indicators suggested for assessment of the overall stocking rate include animals of various categories, and selection, in the study case

BSC perspective	Strategy 4*	Indicators*	Selection
Formation and Growth	Overall stocking rate includes animals of several categories	1) Uniformity and percentage of heifers	
		2) Mean daily gain	
		3) Conception rate	√
		4) Gross income per rejected cow	

***Adapted from Patterson and Richardson (2007)**

Research done by Peña-Rueda *et al.* (2018a) raised flags on that quite a few systems of rural farms in the region do not follow a pre-existing pattern. When development is promoted in these communities, innovation and entrepreneurial spirit of farmers are likely to encourage a higher number of farms for diversification, with decisions depending largely on the regional and institutional environment (Weltin *et al.*, 2017).

The vision of Patterson and Richardson (2007) is also important, though the idea that the overall stocking rate includes animals of various categories might become another variant for the dimension of internal processes, since uniformity and percentage of heifers, and mean daily gain are indicators that show supporting processes that contribute to others directly related to the satisfaction of current and future needs of customers and stakeholders (Sarraf and Nejad, 2019).

Humphreys (2009) considers that the stocking rate determines the level of performance of animals, the sustainability of grass production, and farm cost-effectiveness, which is the decision key, whose importance is over other indexes. He also found that managing schemes of the grassland will fail if they are not supported by the appreciation of the relation between the number of heads managed and their individual performance. According to Senra (2005), grazing pressure will permit to control the stocking rate, and to take necessary measures regarding the amounts and moments to supply feed throughout the year.

The stocking rate is the first indicator whose simplicity and overall performance should be mastered by farmers, depending on the periods of highest supply. When the grazing index begins, and animal conduct and performance are associated to availability, the stocking rate may vary regarding the grazing pressure, and the season. This will allow for the creation of a feeding balance for comprehensive analysis of milk or beef production (Pérez-Infante, 2013).

Senra *et al.* (2005), in dry tropical conditions, without irrigation, suggested periodic evaluation of the system's efficiency by controlling grassland and animal indexes in the short-term, including live weight and daily gain. The long-term soil indexes, which strengthen the strategic analysis of the farm with a possible greater scope than the conception rate, is a productive indicator that provides little information about the overall stocking rate.

CONCLUSIONS

An examination of a rural dual-purpose cattle farm in southwest Holguin shows the existence of strategic management elements that correspond to aspects treated in the literature.

Particularly, the vision and strategy increase the return rate by head, the customer perspective is oriented to 80% of the cattle sold as first class. In the internal process perspective, it is oriented to the reduction of unit cost.

Opposed to the perspectives: financial, formation, and development, these are focused on the conception rate, which is not financial or associated with the skills of work teams. Besides, they should not share the same indicator.

The elements dealt with indicate the existence of a need to confront the common points between farmer knowledge and professional knowledge to explain experiences, reflect on that respect, and consolidate the bases in institutional innovation and social learning, to solve productive problems in the sector.

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REFERENCES

de Loyola, C., Bertot, J. A. y Guevara, R. V. (2012). Perspectivas de la actividad reproductiva para la producción lechera estacional en rebaños de Camagüey. *Rev. prod. anim.*, *24*(2), 1-6. https://revistas.reduc.edu.cu/index.php/rpa/article/view/2830

Diskin, M. y Kenny, D. (2016). Managing the reproductive performance of beef cows. *Theriogenology*. 6(1), 379-387. https://doi.org/10.1016/j.theriogenology. 2016.04.052

Hánke, H. y Barkmann, J. (2017). Insurance Function of Livestock: Farmer's Coping Capacity with Regional Droughts in South-Western Madagascar. *World Development*, *6*, 264-275. https://doi.org/12. 10.1016/j.worlddev.2017.03.011

Hernández-Sosa, M., Planos-Gutiérrez, E. O. y Boudet-Rouco, D. (2018). Influencia de los factores físico-geográficos en la configuración espacio-temporal de la lluvia: Estudio de casos en Cuba. *Revista Cubana de Meteorología*, *24*(1), 61-74. http://rcm.insmet.cu/index.php/rcm/article/view/260/311

Hernández Jiménez, A., Pérez Jiménez, J. M., Bosch Infante, D. y Castro Speck, N. (2015). Clasificación de los suelos de Cuba 2015. San José de las Lajas, Mayabeque, Cuba: Ediciones INCA.

Humphreys, L. R. (2009). *Tropical pasture utilisation*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511525810

Landini, F. (2011). Racionalidad económica campesina. *Mundo Agrario*, *12*(23). https://www.mundoagrario.unlp.edu.ar/article/view/v12n23a14

Landini, F., Brites, W. y Mathot y Rebolé, M. I. (2017). Towards a new paradigm for rural extensionists' in-service training. *Journal of Rural Studies, 51*, 158-167. https://doi.org/10.1016/j.jrurstud.2017.02.010

Landini, F. y Murtagh, S. (2011). Prácticas de extensión rural y vínculos conflictivos entre saberes locales y conocimientos técnicos. Contribuciones desde un estudio de caso realizado en la provincia de Formosa (Argentina). *Ra Ximhai, 7*(2), 263-279. http://www.journals.unam.mx/index.php/rxm/article/view/26684/25000

Leroy, G., Baumung, R., Boettcher, P., Besbes, B., From, T. y Hoffmann, I. (2018). Animal genetic resources diversity and ecosystem services. *Global Food Security, 17*, 84–91. https://doi.org/10.1016/j.gfs.2018.04.003

Liu, Y., Wang, X., Wei, X., Gao, Z. y Han, J. (2018). Values, properties and utility of different parts of Moringa oleifera: an overview. *Chinese Herbal Medicines*. https://doi.org/10.1016/j.chmed.2018.09.002

López-Trujillo, R., García-Elizondo, R. y Ruiz-Zárate, F. (2016). Fecha del primer parto y productividad de vacas Charolais en Coahuila, México. *Agronomía Mesoamericana, 27*(2), 377-383. http://dx.doi.org/10.15517/am.v27i2.21287

López, D. y Ribas, M. (1993). Formación de nuevas razas lecheras. Resultados en Cuba. *Cuban Journal of Agricultural Science, 27*(1), 1-10.

Milera-Rodríguez, M. d. l. C., Machado-Martínez, R. L., Alonso-Amaro, O., Hernández-Chávez, M. B. y Sánchez-Cárdenas, S. (2019). Pastoreo racional intensivo como alternativa para una ganadería baja en emisiones. *Pastos y Forrajes, 42*(1), 3-12. https://payfo.ihatuey.cu/index.php?journal=pasto&page=article&op=view&path%5B%5D=2075&path%5B%5D=3870

Montossi, F. y Lagomarsino, X. (2017). Propuestas para el engorde de vacas de descarte. *Revista INIA, 2017*(Diciembre), 5-9. https://www.researchgate.net/publication/322722316_Propuestas_para_el_engorde_de_vacas_de_descarte

Murgueitio, E., Chará, J. D., Barahona, R. y Rivera, J. E. (2019). Development of sustainable cattle rearing in silvopastoral systems in Latin America. *Cuban Journal of Agricultural Science, 53*(1), 65-71. https://www.cjascience.com/index.php/CJAS/article/view/861/884

Oquendo, G. (2011). *Tecnologías para el fomento y explotación de pastos y forrajes*. La Habana: Editorial Pueblo y Educación.

Oquendo, G., Machado, R., Acosta, M., Bernal, M. A. y Cisneros, M. (2006). Identificación y colecta de plantas forrajeras en suelos de un agroecosistema ganadero afectados por la

salinidad. *Pastos y Forrajes*, *29*(2), 145-155. https://www.redalyc.org/articulo.oa?id=269121704003

Patterson, H. y Richardson, C. (2007). Utilizing the Balanced Scorecard in Ranch Management: Cattle Production Systems Perspective. *Rangelands*, *29*(2), 22-27. https://doi.org/10.2111/1551-501X(2007)29[22:UTBSIR]2.0.CO;2

Peña-Borrego, M. D., Fermoselle-Cumbá, D., Peña-Rueda, Y. y Bécquer-Granados, C. (2019). Análisis bibliométrico acerca de las investigaciones publicadas sobre *Morus alba* L. *Pastos y Forrajes*, *42*(1), 81-87. https://payfo.ihatuey.cu/index.php?journal=pasto&page=article&op=view&path%5B%5D=2095&path%5B%5D=3868

Peña-Rueda, Y., Benítez-Jiménez, D., Almaguer-Pérez, N. y Pacheco-Peña, C. (2019). Caracterización de la ganadería vacuna del sector campesino en el suroeste de Holguín. *Pastos y Forrajes*, *42*(4), 300-308. https://payfo.ihatuey.cu/index.php?journal=pasto&page=article&op=view&path%5B%5D=2108&path%5B%5D=3929

Peña-Rueda, Y. F., Benítez-Jiménez, D., Ray-Ramírez., J. V. y Fernández-Romay, Y. (2018a). Determinant factors of livestock production in a rural community in the southwest of Holguín, Cuba. *Cuban Journal of Agricultural Science*, *52*(2), 1-9. https://www.cjascience.com/index.php/CJAS/article/view/803/808

Peña-Rueda, Y. F., Benítez-Jiménez, D., Ray-Ramírez., J. V. y Fernández-Romay, Y. (2018b). Typology of cattle farms in a peasant community from southwest of Holguín, Cuba. *Cuban Journal of Agricultural Science*, *52*(3), 1-8. https://www.cjascience.com/index.php/CJAS/article/view/814/816

Pérez-Infante, F. (2013). *Ganadería eficiente. Bases fundamentales*. La Habana: ACPA.

Qian Tan, Y. C., Bing Chen. (2017). An Enhanced Radial Interval Programming Approach for Supporting Agricultural Production Decisions Under Dual Uncertainties and Differential Aspirations. *Journal of Cleaner Production*. https://doi.org/10.1016/j.jclepro.2017.08.180

Ramírez-Barboza, J. I., Valverde-Abarca, A. y Rojas-Bourrillón, A. (2016). Efecto de raza y niveles de energía en la finalización de novillos en pastoreo. *Agronomía Mesoamericana*, *28*(1), 43-57. https://dx.doi.org/10.1016/10.15517/am.v28i1.21472

Rodríguez, Y., Ponce de León, R. y Rodríguez, M. (2015). Genetic parameters of growth traits in Cuban Zebu through the multi-trait animal model and reaction norm model. *Cuban Journal of Agricultural Science*, *49*(4), 465-469. https://www.cjascience.com/index.php/CJAS/article/view/488/452

Sarraf, F. y Nejad, S. H. (2019). Improving performance evaluation based on balanced scorecard with grey relational analysis and data envelopment analysis approaches: Case study in

water and wastewater companies. *Eval Program Plann*, *79*, 101762. https://doi.org/10.1016/j.evalprogplan.2019.101762

Senra, A. (2005). Indices para controlar la eficiencia y sostenibilidad del ecosistema del pastizal en la explotación bovina. *Cuban Journal of Agricultural Science*, *39*(1), 13-21. https://www.redalyc.org/pdf/1930/193017852002.pdf

Senra, A., Martínez, R. O., Jordán, H., Ruiz, T. E., Reyes, J. J., Guevara, R. V. y Ray, J. V. (2005). Principios básicos del pastoreo rotacional eficiente y sostenible para el subtrópico americano. *Cuban Journal of Agricultural Science*, *39*(1), 23-30. https://www.redalyc.org/pdf/1930/193017852003.pdf

Tagne, A. M., Marino, F. y Cosentino, M. (2018). Tithonia diversifolia (Hemsl.) A. Gray as a medicinal plant: a comprehensive review of its ethnopharmacology, phytochemistry, pharmacotoxicology and clinical relevance. *Journal of Ethnopharmacology*, *220*, 94-116. https://doi.org/10.1016/j.jep.2018.03.025

Weltin, M., Zasada, I., Franke, C., Piorr, A., Raggi, M. y Viaggi, D. (2017). Analysing behavioural differences of farm households: An example of income diversification strategies based on European farm survey data. *Land Use Policy*, *62*, 172–184. https://doi.org/10.1016/j.landusepol.2016.11.041

AUTHOR CONTRIBUTION

Conception and design of research: YFPR, EGB; data analysis and interpretation: YFPR, EGB, CEPP; redaction of the manuscript: YFPR, EGB, CEPP.

CONFLICT OF INTERESTS

The authors declare no conflict of interests.