

Characterization of cattle husbandry by smallholder farmers in southwest Holguín

Yuri Freddy Peña-Rueda¹ <https://orcid.org/0000-0002-6945-5316>, Diocles Guillermo Benítez-Jiménez¹ <https://orcid.org/0000-0002-1046-1885>, Nelvis Alipio Almaguer-Pérez² <https://orcid.org/0000-0003-0843-1422> and Cruz Emilio Pacheco-Peña³ <https://orcid.org/0000-0002-9842-3348>

¹Instituto de Investigaciones Agropecuarias Jorge Dimitrov. Carretera Bayamo-Manzanillo km 16 ½ Código postal 85100. Gaveta Postal 2140. Bayamo, Granma. ²Departamento de Ciencias Agropecuarias, Universidad de Holguín. Avenida de los Libertadores # 287. Código Postal 80100. Gaveta Postal 57, Holguín, Cuba. ³Empresa Pecuaria Calixto García, Ceiba Hueca, Calixto García, Holguín, Cuba.

*E-mail: freddy@dimitrov.cu

Abstract

Objective: To characterize cattle production of the farmer sector in southwest Holguín, Cuba

Materials and Methods: A case study of the Cooperative of Credits and Services Ignacio Agramonte y Loynaz, Calixto García municipality, was conducted. For such purpose, two workshops were carried out, where through the elaboration of the cause-effect diagrams and Pareto's diagram, as well as the evaluation of the acceptance degree, the problems and their possible solutions were identified. The limitations were grouped according to the researchers' criterion in the evaluation areas, referred to the work methods, tools used and link with the environment. In addition, the percentage represented by each evaluation area with regards to the occurrence of the fundamental problem was calculated, from the weight of its contribution.

Results: Cattle husbandry in southwest Holguín shows as fundamental problem the deterioration of productive indicators. Its limitations are related, first, to the utilization of tools (35,0 %). In order of importance, it is followed by the ones concerning the environment (33,0 %); while the use of methods had lower representation (32,0 %). Problem selection was statistically validated for the deficit of medicines, lack of wire, insufficient area and lack of water, with Kendall's concordance coefficients *W* higher than 0,5. The inadequate genotypes had a low concordance coefficient, with high significance ($p < 0,01$).

Conclusions: The main problems of the farmer sector in the cattle husbandry activity in southwest Holguín are subjective. They are related to the lack of methods and tools to improve the productive results of the farms, even when the environment is little favorable for animal production.

Keywords: rural development, innovation, animal production

Introduction

The productivity of many crops and the animal husbandry that small producers carry out in developing countries will have a significant reduction in the next decades, due to the increase of climate variability and climate change, among other factors (Vignola *et al.*, 2015).

To face these effects on animal production, Murgueitio *et al.* (2019) promote the use of animal husbandry agroforestry and intensive silvopastoral systems. Oliveira Silva *et al.* (2017) propose optimized pastureland rehabilitation.

Under the conditions of the Cauto basin, Benitez *et al.* (2009) obtained favorable results in the dry season with the application of energy supplementation through the use of sugarcane (*Saccharum officinarum* L.) and king grass (*Cenchrus purpureus* Schumach. Morrone). These authors established, at least, 30 % of the area with legumes. In reproduction, the effectiveness

of simple yards, the concentration of mounts and births in the most favorable season of the year, as well as the manipulation of the calf lactation has been proven.

These practices constitute a way to maintain acceptable productive indicators, and although they are easy from the conceptual point of view, they could be difficult to implement because of the diversity of farms, pasture species and cattle genotype in tropical regions, especially in peasant farms. Schut *et al.* (2016), in areas prone to the degradation of the Central African plains, found that the restrictions in the increase of the productive results have their origin in the absence or in the poor functioning of the governing institutions in matters of politics and market, as well as in limited financial capacities and resources, to which the ineffective interaction and collaboration among actors is added.

Limitations like these could curb options in grazing systems in southwest Holguín. The

Received: July 25, 2019

Accepted: September 16, 2019

How to cite a paper: Peña-Rueda, Y. F.; Benítez-Jiménez, D. G.; Almaguer-Pérez, N. A. & Pacheco-Peña, C. E. Characterization of cattle husbandry by smallholder farmers in southwest Holguín. *Pastos y Forrajes*. 42 (4):282-289, 2019

This is an open access article distributed in Attribution NonCommercial 4.0 International (CC BY-NC4.0) <https://creativecommons.org/licenses/by-nc/4.0/>
The use, distribution or reproduction is allowed citing the original source and authors.

potential for the approach of the agricultural innovation system to the complex problems of agriculture remains underutilized in many fields of study. According to Oquendo (2011), this region, located in the Cauto river basin, south of the municipalities Calixto García, Cacocum and Urbano Noris, destines extensive areas to animal husbandry. However, the agroecosystem experiences a progressive deterioration of its natural conditions, with decreased productivity and evolution towards an almost desert environment. This is due to the affectation of water sources (low rainfall) and the indiscriminate use of the soil, due to the lack of integral exploitation models, which include the use of sustainable management systems and salinity-tolerant grasses.

Considering the above-explained facts, this work aimed at characterizing the cattle husbandry of the farmer sector in southwest Holguín.

Materials and Methods

In the case study, an animal husbandry cooperative of credits and services (CCS) was selected in the southern Holguín agroecosystem, in the Cauto river basin. Other works have been conducted in such entity, for which basic information is available (Peña-Rueda *et al.*, 2018a; 2018b). It is known that there is integration between the board of directors and the farmers, as well as willingness to participate in the research process

Socio-productive and environmental characterization. The CCS Ignacio Agramonte y Loynaz is located in the Sabanaso town, in the Calixto García municipality, in the southwest Holguín province, Cuba. It is dedicated to animal husbandry and uses 965,2 ha for this purpose. In 2018, it produced 350,4 thousand milk liters and 170,1 t of standing beef. Its products have a secure market through contracting with the Enterprises of Meat and Dairy Products, both from Holguín.

The CCS has 179 members. From them, 31 are owners, 121 beneficial owners, 10 co-owners, nine landless associates, cattle holders, and eight are workers. The average age is 53 years and there are 27 young people under 35 years.

The local climate stands out for the accentuated seasonal distribution of rainfall, with 71,4% in the period from May to October. The average temperature during 2018 was 25,6 °C (ONEI, 2018). Vertisol soils prevail (Hernández-Jiménez *et al.*, 2015), with poor to very poor drainage, and available water holding capacity of 125-150 mm.

The texture of the soils is fine, with mostly vertic properties, and prevalence of the clayey fraction, which limits their ability to evacuate surface and temporal over-wetting, which gives it a tendency to salinization.

Study procedure. The work was carried out between June, 2018, and February, 2019. It consisted in the characterization of the problems and the identification of solutions. Two workshops were held, with a facilitation protocol aimed at creating an environment in which participants were able to grow and discuss their ideas freely, thus guaranteeing the effectiveness of brainstorming (Rawlinson, 1986).

The cause-effect diagram was used to determine the main problem and its causes, as well as their relations. The Pareto chart was used to visualize the solutions, which were selected by direct and open vote. The participants copied on a sheet of paper the list of problems and possible solutions and evaluated them taking into account the criteria about the problem: “it is a problem factor”, “it is direct cause”, “it is a solution of the problem”. With regards to the last criterion, it was assessed whether the solution “is feasible”, “is measurable” or if “it is low-cost”. They were awarded a weighting of 1 to 3 points, according to the degree of acceptance.

The limitations were grouped by the researchers' criterion in the evaluation areas referred to the working methods, used tools and link with the environment. In addition, the percentage represented by each evaluation area was calculated with regards to the occurrence of the fundamental problem from the weight of its contribution, which was obtained through the equation:

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

Where:

AE_k : Weight of the k -eth evaluation.

m : Quantity of limitations in the evaluation area.

e_j : Value of the evaluation criterion of the j -eth limitation.

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

Results and Discussion

The fundamental problem of cattle husbandry in southwest Holguín lies in the deterioration of productive indicators. Its main causes are the limited

surface that is exploited and genotype productivity. According to this study, the first limitations of this activity are related to the use of tools (35,0 %). Then, in order of importance, are those related to the environment (33,0 %), which include the restrictions associated with low water availability and the existence of weeds in the paddocks, especially *Dichrostachys cinerea* (L.) Wight & Arn. The medicine deficit and lack of wire for fences are two restrictions related to the use of methods (figure 1).

The deficit of medicines (antiparasitic drugs, antibiotics and supplements) is a factor that directly affects cattle in this region and is determined, to a large extent, by the scarce supply of drugs to the entities and the poor feeding that the herds receive. Meanwhile, the lack of wire for fences is a factor of moderate incidence and is determined by poor supply and lack of funding. Both constitute policy restrictions, related to imports, and affect materially. They are due to the economic pressures that limit the development of Cuba since 1990 (Ponce *et al.*, 2015).

The limited area that is exploited is a relative restriction, since its origin is due to the high stocking rate to which these systems are subject, along with the low productivity of naturalized grass, especially in the dry season. These two aspects are related to the way in which the farm is managed, because they happen every year and measures for their improvement can be applied. According to

Peña-Rueda *et al.* (2018a), in the animal husbandry of the farmer sector in southwest Holguín, the factors production, feeding and management explain 78,9 % of the variability that occurs in the operation of the farms.

The farmers' statements were based, fundamentally, on the fact that they are "unadapted breeds". However, the regional climate, available feedstuffs, low water availability and existence of weeds in the pasturelands are not adequate for specialized genotypes (Peña-Rueda *et al.*, 2018b).

The limitations related to the environment, lack of water and existence of weeds were considered of medium weight, as factors of the problem, and are determined by the lack of infrastructure and the degradation of the environment. These impediments are difficult to eliminate in the medium term, because the region is in one of the areas of the country that are historically affected by the highest intensity of drought (Cutié and Lapinel, 2013). The prevailing soils can be alluvial or gleyed dark plastic vertisols, whose drainage and productivity depend on the topographic position, amount of clay and Na⁺ cation in their composition (Oquendo, 2011). There are no reservoirs, and there is only one river, La Rioja (ONEI, 2018). With regards to the deterioration of pastures, in the study area the degradation processes have an anthropic origin, mostly. This is due to the use of natural pastures, under continuous grazing, without seasonal regulation of the stocking rate and without any type of forestation (Peña-Rueda *et al.* 2018a).

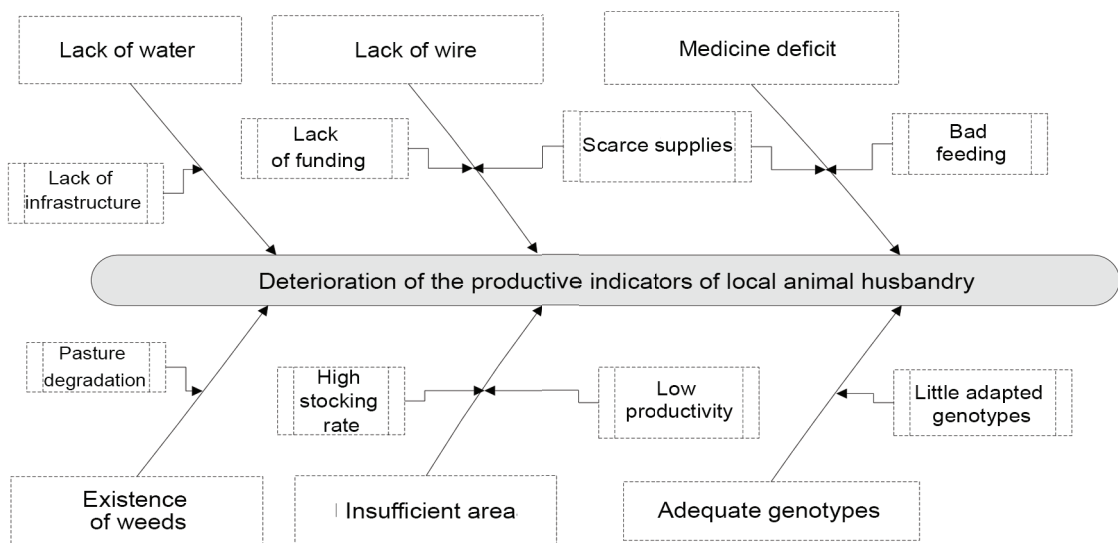


Figure 1. Cause-effect diagram of the deterioration of the productive indicators of farmer cattle husbandry in southwest Holguín.

The problems have been statistically validated for the medicine deficit, lack of wire and insufficient area and lack of water, with a Kendall's concordance coefficient W higher than 0,5. This indicates an adequate level of agreement among the participants (Legendre, 2010). Inadequate genotypes showed a low concordance coefficient. However, they had high significance ($p < 0,01$) with regards to the statistic X^2 , for which it is considered that there was a significant effect in relation to the deterioration of the productive indicators of local animal husbandry (table 1).

The lack of water showed the highest W value. Contradictorily, it did not have high significance with regards to the statistic X^2 ($p < 0,05$). In the case of the existence of weeds, the concordance coefficient was very close to 0,5 and with regards to the statistic X^2 there was no significance. This could be explained by the way in which the problem is perceived, since the lack of water is a collective and common difficulty, but the adaptation was not observed from the community and its practices.

The same happened with the solution for the existence of weeds. Both are aspects that affect, to some extent, all farm types and conspire against the quality and productivity of the pasturelands of the region under study (Peña-Rueda *et al.*, 2018b)

Table 2 shows the relative contribution of the solutions. Regarding the methods, were generally focused on improving the animal management and, particularly, on feeding. The first solution for the medicine deficit, with a scope of 49,6%, would be the development of a medicine purchase plan that is adjusted to the incidence and prevalence of the main causes of morbidity and mortality of the herd. Early contracting with suppliers is added to this. However, this solution is not objective because there is economic shortage in Cuba, which limit the real supply of pharmaceutical products year after year, regardless of the organizational effectiveness that productive forms can achieve.

Performing the perspective feeding balance and meeting nutrient requirements are solutions

Table 1. Statistical significance of the identified restrictions in cattle husbandry in southwest Holguín.

Variable	Medicine deficit	Lack of wire	Insufficient area	Inadequate genotypes	Lack of water	Existence of weeds
n	6	12	9	12	3	3
W	0,60	0,57	0,53	0,39	0,77	0,50
X^2	25,22	47,86	33,32	32,36	16,07	10,46
Df	7	7	7	7	7	7
P - Value	0,001	0,000	0,000	0,000	0,025	0,164

n: Number of individuals, W : Kendall's concordance coefficient, Df: degrees of freedom

Table 2. Cumulative percentage contribution of the solutions for farmer animal husbandry in southwest Holguín.

Limitation	Solution	Percentage
Lack of medicines	To elaborate plans and hire them with the provider.	49,6
	To perform feeding balance and cover the nutrient requirements throughout the year.	100,0
Insufficient area	To carry out selection and sell unproductive animals.	49,8
	To rehabilitate the paddocks and utilize the tree stratum with rational grazing systems.	100,0
Lack of wire	To hire the wire with potential providers.	48,8
	Request credits.	100,0
Breeding	To buy sires or utilize artificial insemination.	57,0
	To carry out selection and sell unproductive animals.	100,0
Lack of water	To drill wells, build reservoirs and implement water holding practices.	100,0
Weeds	To rehabilitate the paddocks and use the tree stratum with rational grazing systems.	100,0

with 100 % reach. These are solutions that depend on the capacities that farmers can develop, without considering other actions, zootechnical and sanitary, to face malnutrition and endoparasitic infestation, which are the main causes of animal death at the end of the dry season and beginnings of the rainy season.

From the zootechnical point of view, there is evidence that silvopastoral systems contribute to the stability and better performance of some parasitosis, which is explained by the effect of the decomposition process on reducing the parasitic load of excreta and in the relation established among dry matter availability, pasture height and chemical composition of the herbaceous and tree strata (Soca *et al.*, 2007).

In the health field, the use of plants with medicinal properties is not contemplated. There are variants that can combine antiparasitic effects with improvements in the ration for animals, by introducing the cultivation of such plants 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).

The area limitation keeps in the herd animals that are not part of the replacement and the production line, during the dry season. The proposed solution had a 49,8 % reach. According to Hanke and Barkmann (2017), traditionally, in semi-arid tropical areas, the cattle surplus is sold in the dry season to obtain income during low production times. With this, it is possible to preserve the basic stock, conserve the pasture reserves for the regrowth in spring, protect the soil and relieve the remaining restrictions.

To the above-stated facts it is added that, in rainfed areas with low rainfall, it is necessary to seek energy supplementation for the dry season from the use of sugarcane (*S. officinarum*) or king grass (*C. purpureus*). In addition, at least 30 % of the area should be established with legumes to guarantee protein supplementation (Benítez *et al.* 2009). Another option would be the rehabilitation of grazing systems (de Oliveira Silva *et al.* 2017) with the incorporation of the tree stratum. In addition to increasing biomass production, they generate environmental carbon capture and biodiversity services (Murgueitio *et al.* 2019).

This last action brings with it the reduction of resources for fencing, by using the tree as a live post. The early and effective contracting of resources with suppliers must contribute 48,8 % to the solution of the fencing problems, which is completed by obtaining funding for investment, either with farmers'

income or through credit. These aspects show the rooting of conventional agriculture and external dependence in cattle husbandry activity in this zone.

Shared solutions give a higher score to management solutions than to improving supply levels and funding management. This coincides with what was stated by Casimiro (2016), who says that Cuba needs to develop alternative agricultural models that permanently apply the principles of agroecology. According to this author, the implementation of these alternative models should not be motivated by the scarcity and high prices of agricultural inputs, although there are guidelines in economic policy, aimed at promoting credit as a mechanism to boost the economic activity of the country and to the strengthening of the internal market (PCC, 2017).

The purchase of sires or the introduction of artificial insemination could solve up to 57 % of the breed improvement. The rest could be remedied with the selection and sale of unproductive sires.

Efficiency improvement through a genetic program and parturition manipulation were associated to feeding, as a way to improve the tool restrictions. Loyola *et al.* (2012) suggested that, according to local characteristics, the reproduction activities should be planned, coordinated and organized in the most propitious months, mainly aimed at inducing or synchronizing estrus and parturition, as well as reinforcing estrus detection, so that a high pregnancy percentage is obtained in that brief time.

In this sense, Benítez *et al.* (2009a) proved the effectiveness of concentrating the mount and parturitions in the most favorable season of the year, manipulating the calf lactation to overrun postpartum anestrus and using the simple yard technique. The latter, given the limitations of infrastructure and technical personnel, the dispersion of farms and the state of access roads in the region, could be less complicated compared with artificial insemination. All this, along with the use of targeted grazing methods, allows to produce replacement females, with high biological and economic efficiency (Benítez *et al.*, 2009b).

The lack of water could be completely solved with the drilling of wells, construction of reservoirs and application of water holding practices. The first two actions, in the practical order, are expensive and could be ephemeral due to the aridity of the territory, even though the flow of underground waters of the Cauto Valley has a predominantly northeast-southwest direction. The Mir stream, which flows into La Rioja

river, is the third most perspective section for the exploitation of groundwater in the hydrogeological regionalization (Sánchez-Sánchez *et al.*, 2013). The last option would produce a volume of water perceived only as humidity, but it is a more autonomous way that only requires the incorporation of new ways of doing.

The implementation of practices to eliminate the excess global stocking rate has effect on the water deficit through the reduction of consumption and the use of compensation areas, associated with legumes and sugarcane. The above-explained facts, along with the intensification of production, also contribute to the rehabilitation of pastures and the eradication of weeds. The drought tolerant cultivars of *C. purpureus*, evaluated by Ray *et al.* (2016), could be used in cutting as in biomass banks (Lok *et al.* 2009), associated to silvopastoral systems that improve the comfort environment and contribute to retain moisture in the soil (Murgueitio *et al.* 2019). To this the practices of soil conservation, such as the mulch between cultivation strips, contour and drainage ditches, pasture barriers and rock walls, are added (Altieri and Nicholls, 2000).

The above-described practices will not generate an increase in the production or farmers' incomes, if they are not incorporated, in the short and medium term, to the operation of farms in southwest Holguín. This incorporation must be carried out based on the rational use of the agroecosystem resources. Institutionalization of mechanisms that allow to expand multiactoral collaboration in local innovation, is also required (Schut *et al.*, 2016).

The country normative basis allocates to the CCS the function of processing and facilitating the technical, financial and material assistance that the State provides to increase the production of small farmers and facilitate its commercialization (CE, 2019). However, this is not enough to move the bases of the prevailing linear generation and technology transfer scheme, which also has the entrepreneurial sector as its main focus.

It is necessary that researchers and technicians know and practice methods and attitudes that allow them to place their scientific discipline in the context of interaction with other disciplines and other actors (decision-makers, traders and farmers). These implications should be conceptually reassessed based on innovation as a more general process, which leads to sustainable changes based on collective learning, focused on enhancing the capacity to find solutions and the adaptation to the

different conditions of local actors (Rodríguez *et al.*, 2009).

The emergence of rural development conceptions that emphasize its territorial and innovation dimension, and highlight the importance of the exchange and learning links among different actors and institutions, as well as the existence of new scenarios that demand the collective management of natural resources, have led to place the inter-institutional articulation as one of the priority lines of action of rural extension (Landini *et al.*, 2017a). Thus, if the group and promotion work of agricultural associations is taken, such as the proposal of inter-institutional articulation, it is observed that the management of collective processes constitutes one of the nucleuses of the task of rural extension workers (Landini *et al.*, 2017b; Wossen *et al.*, 2017).

This must be the new focus to reduce problems and maximize the opportunities that allow to implement the action plans to move to higher productive categories in farmer animal husbandry. These plans should also enable government policies for food production, the introduction of science, technological innovation and the enhancement of work in river basins, to materialize.

Conclusions

The main problems of the farmer sector in the cattle husbandry activity in southwest Holguín are subjective. They are related to the lack of methods and tools to improve the productive results of the farms, even when the environment is little favorable for animal production.

There are practical solutions that have been tested in dry tropic environments, in Cuba and in other regions. The preservation of the production line in the herd and its replacement, the use of energy supplementation by means of sugarcane or king grass, the association with creeping and herbaceous legumes or legumes that are part of silvopastoral systems, as well as the conservation of the animal husbandry agroecosystem through agroecology, constitute the main actions that must be implemented to face the dry season.

Acknowledgements

The authors thank the members of the CCS Ignacio Agramonte y Loynaz, of the Calixto García municipality (Holguín, Cuba), for their valuable contribution, as well as the participants in the project Tools for the rehabilitation of animal husbandry in the Cauto river basin.

Authors' contribution

- Yuri Freddy Peña-Rueda. Carried out the revision, development of key concepts, formulation of objectives, establishment of work methods, conduction of the workshops and data collection. In addition, worked on the statistical data processing and on writing and structuring the manuscript.
- Diocles Guillermo Benítez-Jiménez. Carried out the revision, development of key concepts, formulation of objectives and establishment of work methods, conduction of workshops and data collection. In addition, worked on the statistical data processing and on writing and structuring the manuscript.
- Nelvis Alipio Almaguer-Pérez. Worked on the statistical data processing and carried out the grammar correction.
- Cruz Emilio Pacheco-Peña. Coordinated the conduction of the workshops at the Entrepreneurial Base Unit. Collected the data, performed the statistical processing and improvement of sections and subsections.

Conflict of interests

The authors declare that they do not have any conflict of interests.

Bibliographic references

- Altieri, M. A. & Nicholls, Clara I. *Agroecología: teoría y práctica para una agricultura sustentable*. México: PNUMA, 2000.
- Benítez, D.; Ricardo, Yanet; Romero, A.; Guevara, O.; Torres, Verena; Ramírez, Alina *et al.* Alternativas para la producción sostenible de carne vacuna en el Valle del Cauto. *Rev. Cubana Cienc. agríc.* 43 (4):369-377, 2009.
- Casimiro, Leidy. Necesidad de una transición agroecológica en Cuba, perspectivas y retos. *Pastos y Forrajes*. 39 (3):81-91, 2016.
- Consejo de Estado. *Decreto Ley No. 365/2018 "De las Cooperativas Agropecuarias"*. GOC-2019-464-O37. La Habana: Ministerio de Justicia, 2019.
- Cutié, V.; Lapinel, B.; González, N.; Perdigón, J.; Fonseca, C.; González, I. *et al.* *La sequía en Cuba, un texto de referencia*. La Habana: Agencia de Medio Ambiente, 2013.
- Hánke, H. & Barkmann, J. Insurance function of livestock: farmer's coping capacity with regional droughts in South-Western Madagascar. *World Dev.* 96:264-275, 2017. DOI: <https://doi.org/10.1016/j.worlddev.2017.03.011>.
- Hernández-Jiménez, A.; Pérez-Jiménez, J. M.; Bosch-Infante, D. & Castro-Speck, N. *Clasificación de los suelos de Cuba 2015*. Mayabeque,

Cuba: Instituto Nacional de Ciencias Agrícolas, Instituto de Suelos, Ediciones INCA, 2015.

- Landini, F.; Brites, W. & Mathot y Rebolé, María I. Towards a new paradigm for rural extensionists' in-service training. *J. Rural Stud.* 51:158-167, 2017a. DOI: <https://doi.org/10.1016/j.jrurstud.2017.02.010>.
- Landini, F.; Vargas, Gilda; Bianqui, V.; Mathot y Rebolé, María I. & Martínez, Manuela. Contributions to group work and to the management of collective processes in extension and rural development. *J. Rural Stud.* 56:143-155, 2017b. DOI: <https://doi.org/10.1016/j.jrurstud.2017.09.014>.
- Legendre, P. Coefficient of concordance. In: N. J. Salkind, ed. *Encyclopedia of Research Design*. Los Angeles, USA: SAGE Publications, Inc. p. 164-169. 2010.
- Liu, Y.; Wang, X.; Wei, X.; Gao, Z. & Han, J. Values, properties and utility of different parts of *Moringa oleifera*: An overview. *Chin. Herbal Med.* 10 (4):371-378, 2018. DOI: <https://doi.org/10.1016/j.chmed.2018.09.002>.
- Lok, Sandra; Crespo, G.; Torres, Verena; Fraga, S. & Noda, Aida. Impacto de la tecnología de banco de biomasa de *Pennisetum purpureum* Cuba CT-115 en el sistema suelo-pasto-animales de una unidad de producción de leche con ganado vacuno. *Rev. cubana Cienc. agríc.* 43 (3):307-313, 2009.
- Loyola, C. de; Bertot, J. A. & Guevara, R. V. Perspectivas de la actividad reproductiva para la producción lechera estacional en rebaños de Camagüey. *Rev. prod. anim.* 24 (2):6, 2012.
- Murgueitio, E.; Chará, J. D.; Barahona, R. & Rivera, J. E. Development of sustainable cattle rearing in silvopastoral systems in Latin America. *Cuban J. Agric. Sci.* 53 (1):65-71, 2019.
- ONEI. *Anuario estadístico de Holguín 2017: Calixto García*. La Habana: Oficina Nacional de estadística e Información. http://www.onei.gob.cu/sites/default/files/anuario_est_municipal/07_calixto_garcia_1.pdf, 2018.
- Oquendo, G. *Tecnologías para el fomento y explotación de pastos y forrajes*. La Habana: Editorial Pueblo y Educación, 2011.
- PCC. *Lineamientos de la política económica y social del Partido y la Revolución para el período 2016-2021*. La Habana. <http://www.granma.cu/file/pdf/gaceta/Lineamientos%202016-2021%20Versi%C3%B3n%20Final.pdf>, 2017.
- Peña-Borrego, Maida D.; Fermoselle-Cumbá, D.; Peña-Rueda, Y. F. & Bécquer-Granados, C. Análisis bibliométrico acerca de las investigaciones publicadas sobre *Morus alba* L. *Pastos y Forrajes*. 42 (1):81-87, 2019.
- Peña-Rueda, Y. F.; Benítez-Jiménez, D.; Ray-Ramírez, J. V. & Fernández-Romay, Y. Determinant factors of livestock production in a rural

- community in the southwest of Holguín, Cuba. *Cuban J. Agric. Sci.* 52 (2):1-9, 2018a.
- Peña-Rueda, Y. F.; Benítez-Jiménez, D.; Ray-Ramírez, J. V. & Fernández-Romay, Y. Typology of cattle farms in a peasant community from southwest of Holguín, Cuba. *Cuban J. Agric. Sci.* 52 (3):1-8, 2018b.
- Ponce, I.; Nahed, J.; Parra, M.; Fonseca, N. & Guevara, F. Historical changes in the process of agricultural development in Cuba. *J. Cleaner Prod.* 96:77-84, 2015. DOI: <https://doi.org/10.1016/j.jclepro.2013.11.078>.
- Rawlinson, J. G. *Creative thinking and brainstorming*. New York: Taylor & Francis Group, 1986.
- Ray, J.; Herrera, R.; Benítez, D.; Díaz, D. & Arias, R. Multivariate analysis of the agronomic performance and forage quality of new clones of *Pennisetum purpureum* drought tolerant in Valle del Cauto, Cuba. *Cuban J. Agric. Sci.* 50 (4):639-648, 2016.
- Rodríguez, R.; La O, M.; Fonseca, María; Guevara, F.; Hernández, Araceli & Jiménez, Madelin. Extensión o innovación como proceso de aprendizaje social y colectivo. ¿Dónde está el dilema? *Cuban J. Agric. Sci.* 43 (4):387-394, 2009.
- Sánchez-Sánchez, Y.; Miguel-Fernández, C. de & Rothenel, S. Caracterización hidrogeológica del Valle del Cauto, Cuba. *Minería y Geología.* 29 (2):16-34, 2013.
- Schut, M.; van Asten, P.; Okafor, C.; Hicintuka, C.; Mapatano, S.; Nabahungu, N. L. *et al.* Sustainable intensification of agricultural systems in the Central African Highlands: The need for institutional innovation. *Agric. Syst.* 145:165-176, 2016. DOI: <https://doi.org/10.1016/j.agsy.2016.03.005>.
- Sigma Plus Statistiek. *SPSS-Kendall's Concordance Coefficient W*. Amsterdam: Sigma Plus Statistiek. <https://www.spss-tutorials.com/spss-kendalls-concordance-coefficient-w/>. 2019.
- Silva, R. de O.; Barioni, L. G.; Julian Hall, J. A.; Moretti, A. C.; Fonseca-Veloso, R. & Alexander, P. *et al.* Sustainable intensification of Brazilian livestock production through optimized pasture restoration. *Agric. Syst.* 153:201-211, 2017. DOI: <https://doi.org/10.1016/j.agsy.2017.02.001>.
- Soca, Mildrey; Simón, L. & Roque, E. Árboles y nemátodos gastrointestinales en bovinos jóvenes: Un nuevo enfoque de las investigaciones. *Pastos y Forrajes.* 30 (ne):21-33, 2007.
- Tagne, A. M.; Marino, F. & Cosentino, M. *Tithonia diversifolia* (Hemsl.) A. Gray as a medicinal plant: a comprehensive review of its ethnopharmacology, phytochemistry, pharmacotoxicology and clinical relevance. *J. Ethnopharmacol.* 220:94-116, 2018. DOI: <https://doi.org/10.1016/j.jep.2018.03.025>.
- Vignola, R.; Harvey, C. A.; Bautista-Solis, P.; Avelino, J.; Rapidela, B. & Donatti, C. *et al.* Ecosystem-based adaptation for smallholder farmers: definitions, opportunities and constraints. *Agric. Ecosyst. Environment.* 211:126-132, 2015. DOI: <https://doi.org/10.1016/j.agee.2015.05.013>.
- Wossen, T.; Abdoulaye, T.; Alene, A.; Haile, M. G.; Feleke, S. & Olanrewaju, A. *et al.* Impacts of extension access and cooperative membership on technology adoption and household welfare. *J. Rural Stud.* 54 (1):223-233, 2017. DOI: <https://doi.org/10.1016/j.jrurstud.2017.06.022>.