Scientific Paper

Functions of ecosystemic services in animal husbandry systems in Cuba

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Abstract

Objective: To analyze the functions of ecosystemic services in animal husbandry systems for sustainable food production in Cuba.

Materials and Methods: The current situation of ecosystemic services as components of animal husbandry systems was analyzed, with priority given to the provisioning ones, such as the soil, species biodiversity, animal genetic resources, water and energy.

Results: In any food production system, the systemic approach and appraisal about the protection of ecosystemic services is crucial, because they constitute the motor force for environment protection and human welfare. Although all the ecosystemic services participate in an important way, the conservation of soil, water and biodiversity is essential because they are the basis of the pyramid that supports all the ecosystemic resources. There is innovative evidence in agricultural production systems on agroecological bases that supports the need to change the way of thinking, inhabiting and moving towards reconversion of conventional systems.

Conclusions: Ecosystemic services are focused from an integrating vision, and it is agroecological management the one that allows the understanding of their benefits. Agroecology is based on the protection of natural resources and considers the multidimensionality of systems and interactions, including the human factor and local knowledge, elements that make food security viable.

Keywords: agroecology, integration, sustainable management

Introduction

The conception of the food production process from a systemic approach implies the existence of certain elements, which determine not only the performance of the system, but its productive possibilities. At present, Cuba undergoes a moment of great affectations that threaten the development of society. In the light of facing the climate change and the COVID-19 pandemic, not all the approaches and solutions that were functional before are applicable to the current context.

In this sense, the soil-air-water-plant-animal-climate-energy relationship cannot be linearly managed as it has been done until now (investing-producing-consuming-throwing away). The climate change, growth of the world population, soil and biodiversity deterioration, among others, imply that other determining factors are considered, which require other methods of agroecosystem management.

Ecosystemic services (ES) have a close correspondence with the soil-air-water-plant-animal-climate-energy relationship in animal husbandry ecosystems. They comprise soil formation, maintenance of biodiversity, carbon sequestration, hydric regulation, provision of plant and animal genetic resources, among others. They constitute the motor force for environment protection and good living (Camacho-Valdez and Ruíz-Luna, 2012).

The depletion of available natural resources surpasses the regeneration capacity of ecosystems. To reverse this process it is necessary to change the paradigm of economy, so that the useful life of such resources in the system is prolonged.

Circular economy is a production and consumption model, which implies sharing, renting, reutilizing, repairing, renovating and recycling existing materials and products to create an added value. In practice, it means reducing residues to the minimum. The change to sustainable energy leads to only 55 % of the reduction in emissions; while the remaining 45 % will result from the way of making and using the products and the form of producing food and administering the land. That is, from the circular economy that is implemented for the benefit of the planet (Ingrassia, 2019).

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The best agricultural system that could face future challenges is the one based on the agroecological principles that exhibit high diversity and resilience levels, and at the same time it offers reasonable yields and ecosystemic services. Agroecology intends to restore the landscapes that surround farms, which enriches the ecological matrix and its ecosystemic services, such as natural pest control and water and soil conservation, among others (Altieri and Nicolls, 2020).

Taking into consideration the situation the world is going through, related to facing the pandemic and the climate change, and in view of the emergency to produce food, knowing and adequately using ES is an opportunity that, in the medium and long term, allows the construction of more resilient and sustainable systems. The objective of this study is to analyze the functions of ecosystemic services in animal husbandry systems for food production in a sustainable way in Cuba.

Materials and Methods

From the revision of more than 100 scientific papers published in internationally prestigious databases, the current situation of ecosystemic services, as components of animal husbandry systems, was analyzed. The topics of provisioning, such as soil, species biodiversity, animal genetic resources, water and energy, were given priority.

Results and Discussion

Ecosystemic services. ES have been defined as environmental services that people obtain from nature. They are manifested in the form of values or goods and services (Arenas, 2017). Although they are four, one of them sustains the remaining three, called support ecosystemic services:

1. *Support services*. They are necessary for the production of all the other ecosystemic services: nutrient and seed dispersal and recycling, primary production, habitat, diversity conservation.
2. *Provisioning or supply services*. They are products obtained from the ecosystem: food, water, biotic raw materials, construction materials, geotic materials, renewable fuels, genetic resources, ornamental resources, biochemical resources for different pharmacological and medicinal uses.
3. *Regulation services*. It comprises the benefits obtained from the regulation of the ecosystem processes and make life possible. The improve air quality, carbon capture and storage, climate regulation, water cycle regulation, erosion control, maintenance, soil fertility, waste recycling and purification of residual waters, pest and disease control, crop pollination, reduction of damages caused by natural catastrophes.
4. *Cultural services*. They are non-material values or benefits, which are obtained from the ecosystems through personal or spiritual enrichment, cognitive development, nature enjoyment and aesthetic pleasures offered by ecosystems. They are inspirers of cultural, religious and intellectual diversity. The ecosystems reflect the formal and informal education of a society and constitute a source of inspiration for art, folklore, national and regional symbols; architecture and publicity. The natural patrimony is part of the patrimony of many societies. So much so that many people spend their free time with nature, due to the recreational ecotourism services it offers, besides the fact that in itself it constitutes the laboratory for experimentation and increase of scientific knowledge.

Ecosystem services could be classified into several groups, according to the point of view from which they are observed. Freshwater, for example, could be within the four service types.

Apart from the ES concept, there is a wide discussion about the concept of payment for ecosystem or environmental services (PES), discussion that has gone beyond the academic borders and has become an important instrument of public policy, of great influence in several countries of Latin America and the Caribbean.

There are three arguments that criticize the PES:

1. It is an anthropocentric definition, instead of recognizing the intrinsic value of nature.
2. It understands conservation as a means to an end, to produce incomes that serve the interest of human beings, and not as an end in itself.
3. It could be utilized as a mechanism based on property rights, which could give rise to a general privatization of open access resources, such as water and air.

In spite of the above-referred theoretical objections, the payment has been applied in developed and developing countries that try to fight climate change (Eslava, 2017).

All ES are important, but the provisioning ones have an influential role on the products that can be obtained from ecosystems and, in which the soil is the pyramid basis. At moments of climate emergency it is important to know their functions and how to contribute to their protection.

Soil. The soil is a finite and non-renewable natural resource, which provides diverse services. Among them is the one related to its participation in the biogeochemical cycles of key elements for life, which continuously and due to the available energy, pass from living systems to the non-living components of the planet. According to Burbano-Orjuela (2016), the soil serves as basis to human activities and is an element of the landscape and cultural patrimony. Because of the environmental services it provides and promotes for the benefit of people, it acquires the category of social good.

The world report about the situation of soil states that erosion, loss of organic carbon and unbalance of its nutrients, constitute, at global scale, the most significant threats that affect the performance of its functions. All indicates that the situation will worsen, unless the private sector, governments and international organizations take agreed and right actions towards sustainable soil management (FAO, 2016).

In Cuba, 71,2 % of the soils are distributed in the categories from little to very little productivity, and are affected by limiting edaphic factors, which prevent reaching potential yields (CITMA, 2020). Burbano-Orjuela (2016) classifies the agroproductive categories of soils into:

1. Soils that allow crops to express more than 70 % of their potential
2. Soils that allow between 51 and 70 % of their potentialities
3. Soils that admit between 30 and 50 %
4. Soils that achieve only up to 30 % of the potential they have

The soil, as resource, fulfills the following tasks:

- *It participates in the production of food and biomass*. From the soil, in direct or indirect form, more than 95 % of the world food population results. Nevertheless, its degradation is a major problem that threatens food production in the planet.
- *It stores or fixes C*. It constitutes the largest provider of C in nature (the C stored in the first meter of soil is 1,5 times higher than the one accumulated in the vegetation).
- *It stores and filters water.*
- *It is the support of human activities and source of raw materials*. On the soil industrial activities are carried out, residential zones are built, roads and other civil works are constructed.
- *It constitutes a biodiversity reserve*. The large number of organisms that live in it turn it into source of biodiversity.
- *It is a deposit of the geological and archeological patrimony.*
- *It constitutes the physical and cultural environment of mankind*.

In 2015, the Institute of Soils conducted agrochemical studies in the main animal husbandry enterprises of Cuba, which represent 12 % of the area dedicated to animal husbandry, from which 25 % was sampled. The highest milk and meat production of the country corresponds to them, and they also have the highest concentration of cattle stock. The analysis indicated that 90,6 % of the utilizable agricultural area in these enterprises was affected by one or more limiting factors: 45 % with low natural fertility, 30 % with little effective depth, which reduces the water and nutrient volume available for the root system; 20,5 % with low water retention capacity, among the most important ones (Lok-Mejías, 2016).

In spite of the above-explained facts, in a narrow and long island, without great natural richness, it is necessary to accelerate the delivery of lands that remain idle for producing food. According to Figueredo-Reinaldo *et al*. (2019), in Cuba, in 2017, the idle areas occupied 917 299 ha, with one third of them available to be delivered to farmers for their cultivation, which would imply giving priority to the soil and water protection.

Soil management is significantly important in the system properties and the components and processes that serve as basis for the services offered by the soil. Among the most utilized management practices to improve soil functions are minimum tillage, manual weeding, application of organic and mineral fertilizers and green manures; besides the use of composting and earthworm humus, association of multipurpose forage woody plants to naturalized and cultivated grasses in the paddocks (SPS), intensive rational grazing (IRG), among others. All these practices can contribute significantly to promote changes in the services supplied to the ecosystem.

With the management of the VRG (high stocking rates and necessary resting time for recovery) a high deposition of feces and urine in the grazing areas is achieved, between 29,2 and 56,9 t of excreta/ha/year (Huerta *et al*., 2018; Domínguez-Escudero, 2020), which positively increases nutrient recycling in the system. The edaphic biota plays a determinant role here, by using the excreta as microhabitat and contributing to the decomposition process (Pinheiro-Machado, 2016). In studies conducted in Cuba, with intensive management and high instantaneous stocking rates in grass monoculture, an annual deficit of nutrients of only 2 and 9 kg/ha of N and P, with positive balance of K (Crespo, 2018).

Domínguez-Escudero (2020), in a VRG system in Panama, found that the system recycled 256,0; 74,0 and 93,0 kg of N, P, K respectively, higher values than the ones reported with mineral fertilizers in systems without irrigation in Cuba, corresponding to the last third of the 20th century.

The soil organisms contribute, in turn, fundamental services for the sustainability of all the ecosystems. They constitute the main agent of the nutrient cycle, regulate the dynamics of the soil organic matter, carbon retention and emission of greenhouse gases (GHG); besides, they modify the material structure of the soil and water regimes and improve the quantity and efficacy of the nutrient acquisition of the vegetation, as well as plant health.

VRG management, without chemical fertilizers and with high instantaneous rate, promotes species biodiversity and high excreta discharge, which favors the appearance of the groups that make up the macrofauna (especially, Oligochaeta), and which contribute to burying the organic matter, improve soil structure and porosity and decrease by 35,5 % the quantity of insects (Sánchez *et al*., 1997).

Martín-Martín *et al.* (2019) evaluated several farms with different soil uses and observed diverse responses in the functional groups of the edaphic biota (detritivores, engineers, herbivores, predators) depending on the system. The detritivores were found to be most abundant, significantly, in the farm that had silvopastoral systems, due to the high availability and quality of the tree litter, humidity and lower disturbance.

Besides the application of organic fertilizers, compost, intercropping of legumes, green manures, among others, an alternative for the improvement the functions of soils aimed at animal husbandry is the utilization of diverse inoculants, produced by different scientific institutions with excellent results in seed production areas and in forage areas.

Among the inoculants Biofer® and Fosforina®, produced by the Soil Institute, Azofert-F® and EcoMic®, of the National Institute of Agricultural Sciences; Nitrofix®, of the National Sugarcane Research Institute; Dimargon®, of the Tropical Agriculture Fundamental Research Institute Alejandro de Humboldt stand out; besides the fertilizer Agromenas-G, of the Mineral-Metal Industry Research Center and IHPLUS® BF, of the Pastures and Forages Research Station Indio Hatuey.

Another alternative to improve soil properties is the use of biochars, produced from recycling cuttings and pruning of forage trees aimed at animal feeding and of invasive weeds. They, when enriched with IHPLUS® BF and the substrates obtained from its mixture with compost, allow to broaden the possibilities of restoring the soil and nourishing plants (Díaz-Solares *et al*., 2020; Pentón-Fernández *et al*., 2020).

Water. Freshwater ecosystems and tropical forests are the most biodiverse environments of the world. They contribute considerably to the supply of ecosystemic services through ecological processes. However, the progressive loss of biodiversity causes these ecosystems to be more vulnerable, affecting their adaptation capacity.

The vertiginous growth in water consumption, at world scale, is due to three main causes:

1. *Industrial development*.
2. *Population growth*. It is estimated that, towards 2025, there will be 2 500 million people more than today, whom will have to be supplied and fed.
3. *Expansion of irrigation agriculture*. From 50 million ha, irrigated at the beginning of last century, more than 250 million are irrigated at present.

There is a close relation among water, agriculture and energy. Agriculture is the largest water consumer, and represents 70 % of its extractions throughout the world. Industry and energy together represent 20 % of its demand. The most developed countries have a much higher proportion of freshwater extractions for the industry than the least developed countries, in which agriculture prevails (ONU-DAES, 2014).

In Cuba, utilizable water resources are evaluated, approximately, in 24 000 million m^3 per year, and 75 % correspond to surface waters and 25 % to underground ones. Most of the provinces have hydric stress values over 50 %, for which special attention should be paid to the policy of rational use of water resources, if the influence of climate change is taken into consideration (González-Piedra and Domínguez-Pastrana, 2019).

The available water resources from the hydraulic infrastructure amount to 13 904 million m^3. The development of such infrastructure in Cuba allows to place 58 % of the utilizable resources at the disposal of economic, social and environmental demands. The current infrastructure has 242 dams, which store a little more than 9 000 million m^3. To them 58 diversion dams, 729 micro-dams, 810,95 km of master channels, 16 large pumping stations and 1 400,1 km of dikes, are added. In the last decade, the water volume annually delivered for all uses oscillated between 6 000 and 8 000 million m^3. More than half was used in agricultural productions (CITMA, 2020), mainly in the cultivation of rice (40 % of the needs). Nevertheless, in animal husbandry, approximately 0,7 million cattle travel to other places each year during the dry season, searching for water supply sources; while thousands of animals receive the water in tankers, for which water supply is a strong and significant electricity and fuel consumer in this productive sector, which makes it vulnerable with regards to the fluctuations of their availability and price. In 2020 the act about water supply to the animals was passed, which regulates the quantities to be supplied per category in cattle (Ministerio de Justicia, 2020).

Another important aspect, to which no due attention has been paid either, is rainwater capture, which is easy to obtain for human consumption and agricultural use. Like every system, it shows advantages and disadvantages. Among its advantages it can be cited that it is not subject to interruptions in the supply network, reduces runoff and erosion and its availability is independent from public service companies; besides decreasing mosquito breeding sites. The water is pure and soft by nature, free for those who collect it, free from chlorine and byproducts and pesticides, among others of its benefits. As disadvantages it is known that it is not controllable during drought, that it can be contaminated by animals, organic matters and atmospheric contaminants. Cisterns increase construction costs, which constitutes a limitation for low-resource families, and if they are not protected the presence of mosquitoes can be induced (Torres-Hugues, 2019).

Species diversity. The term biodiversity refers to the plurality of living organisms that inhabit the planet at all levels. Biodiversity is classified as genetic, of species and of ecosystems. The set of those aggregates and complements integrate the biosphere (OCREZ, 2014). Biological diversity sustains the functioning of ecosystems and provides essential services for human welfare. It guarantees food security, human health, air and freshwater supply, for which in contributes to subsistence means and economic development to achieve sustainable development goals.

Among the most important challenges faced by the world are biodiversity conservation and sustainable use. According to Sarandón (2009), agriculture is the main activity in the change of land use, which has transformed ecosystems into agroecosystems. In Cuba, the loss of biological diversity is acknowledged as one of the environmental problems that affect the country. There are different causes that increase biodiversity loss: overexploitation of agricultural areas, contamination, habitat loss, invasive exotic species and climate change.

Regarding agrobiodiversity, Nieto-Rodríguez (2017) reviews its classification and its relation to ecosystemic services. She classifies thus the components of agrobiodiversity: planned, associated and surrounding diversity.

Planned diversity refers to the crops subject to deliberated incorporation and specific management. Associated diversity comprises the wild flora and fauna sustained by the farm, which colonizes the agroecosystems after they have been structured by the farmer; it includes all the wild species related to domesticated species, which can be crossed and contribute to the genetic reserve of their crops, besides surviving autonomously and fighting pests and diseases of the crops. The surrounding diversity includes the wild species that emerge from natural communities and which, in turn, are part of another agroecosystem, benefit agricultural environments through the provision, protection, shade and regulation of underground water.

In Cuba several plant formations have been described. In general, they can be grouped into forests, scrubs, herbaceous vegetation, vegetation complexes and secondary vegetation, where about 50 % of the vascular plants and 42 % of the terrestrial vertebrates of the world inhabit, concentrated around 2,3 % of the terrestrial surface of the planet. Insects, followed by fungi and plants (angiosperms and gymnosperms), represent 76 % of the known Cuban terrestrial biodiversity (Mancina and Cruz, 2017).

For feeding cattle in Cuba there is a richness of endemic species from the legume family, which have acceptable nutritional value. However, among grasses, the species of the endemic flora have little forage or nutritional value, which has served as basis to organize the research program aimed at the introduction, evaluation and utilization of forage and pasture species, for their utilization in the animal husbandry development program of the island (Blanco-Godínez *et al*., 2017). More than 5 000 cultivars have been evaluated in this program executed by different scientific institutions of the country.

The period 2000-2010 was characterized by continuous decrease and lack of areas of cultivated pastures and forages, as a result of the lack of fertilizers, inadequate pasture enclosing of the areas, and of the scarcity of fuel for making hays and silages, which propitiated continuous overgrazing and deterioration of such areas, along with the poor achievement of new plantings and of pastureland rehabilitation.

The limitation in input imports generated minimum dependence on them, and higher self-sufficiency was achieved with regards to previous periods. In 2008, only approximately 16 % of the areas had cultivated pastures and 39 % was occupied by *Dichrostachys cinerea*. In the agrotechnical management of pastures only the planting of grass forage areas for cutting, mainly sugarcane and king grass, was given priority (Milera-Rodríguez, 2011).

In the period 2010-2020, woody protein plants (*Morus alba* L., *Tithonia diversifolia* (Hemsl.) A. Gray, *Moringa oleifera* Lam, mainly) were given priority, but not the planting of locally adapted pastures and forages, and the invasion of *D. cinerea* continued in more than 30 % of the areas dedicated to grazing. This proved that in animal husbandry the problem is not solved with campaigns, but with soil protection and availability of diverse herbaceous and tree plant genetic resources, according to regionalization, which contribute to cover animal requirements, and which are resilient to climate change. In current animal husbandry, the loss of biological diversity is acknowledged as one of the environmental problems that affect the entire country. Most of the species, of high productivity and fragility, are subject to adverse climate conditions, to the geographical location and to insularity and high degree of geographical isolation.

Plant species for livestock feeding. The scientific centers that are dedicated to the study of livestock feeding and management in Cuba have collections of different pasture species, such as forage, herbaceous and woody plants. Among pastures and forages the most representative ones are *Megathyrsus maximus* (Jacqs.) B.K. Simon & S.W.L. Jacobs*, Cenchrus purpureus* (Schumach.) Morrone*, Urochloa* sp.*, Cynodon* sp. and *Saccharum officinarum* L. Within the woody plants *L. leucocephala, M. alba, M. oleifera, T. diversifolia*, stand out, besides other species of native herbaceous legumes and other cultivars of different species, which do not constitute collections.

At present, Cuba has more than 30 certified species. In total, more than 80 can be used for different purposes in livestock feeding or recovery of animal husbandry soils. Nevertheless, to promote them it is necessary to rehabilitate or replace the current ones, because in the case of cultivated grasses under grazing conditions, it is estimated that they do not exceed 16 %.

It is known that a pasture is degraded when it has experienced a considerable decrease of its potential productivity and of the covered area under certain edaphoclimatic and biotic conditions. In this sense there are methods for its recovery, renovation, rehabilitation and maintenance.

Rehabilitation is the restitution of the productive capacity of a pasture until reaching acceptable technical-economic levels, taking as basis the population of desirable species present in the pasture. It assumes that there are still one or more desirable species in sufficient population (50-60 %) so as to justify that they are stimulated, preserved and complemented. There are different labors, according to the soil type and species.

Renovation is the total restitution of the pasture through the elimination of the existing vegetation and planting a new one. It assumes that the desirable species have disappeared, or that their population is so low that its rehabilitation is not worthy (less than 40 %).

The maintenance works are periodically applied, so that the crop does not have affectations in its population, production and quality.They are practiced in cutting forage banks and include earthing up, fertilization, manual or mechanized weeding, replanting of parts of the depopulated plots, among others (Milera-Rodríguez, *et al*., 2017).

Pastureland renovation, as well as the establishment of new areas, is not possible without the production of specialized seed, as it occurs with other crops.

In the case of grasses with gamic reproduction, seed production demands that a group of requisites are fulfilled in order to obtain a quality product, practicing good soil preparation, as well as fulfilling the technical regulations during planting, harvest, processing, drying, storage and packaging. The production areas are fertilized with mineral or organic fertilizers, according to the requirements of the species.

In the processing, conservation and storage process, there are methods that should not be violated. When a grass seed field consistently reduces it yields, it should be subject to a rejuvenation process. Although there are seed production technologies in Cuba (Pérez-Vargas *et al*., 2019) for specialized production and at large scale, funding for initial investments is needed, besides maintaining production in a stable and sustainable way. However, it is possible to produce seeds at small scale, mainly in the form of specific seed banks.

Animal genetic resources. Almost all the mammal and bird species present in Cuba, which are used for food and agriculture, were inexistent when the colonizers arrived in the Island. In general, 16 500 species are known. Among them, 42 species of mammals, 350 birds, 121 reptiles, 46 amphibians, 7 493 insects, 1 300 arachnids and 2 900 mollusks, stand out (Hernández-González, 2015).

The Spaniards introduced most of the species that, after more than 500 years, are called locally adapted or creole species, as in the case of Creole cattle, Creole Pelibuey sheep, Creole goat, Creole pig, and Cubalaya Creole chicken, among others.

Creole is a naturalized cattle breed, with more than 500 years, descendant from *Bos indicus*, and has three varieties: Carirubio, Carinegro and Mezclado. It was used as mother breed in the formation of crossed genotypes, aiming at increasing beef production (Crimousin genotypes, from the crossing with Limousine, (3/4 Limousin x 3/4 Creole), and also milk production in the crossings with Holstein, from which Taíno de Cuba was obtained (5/8 Holstein x 3/8 Creole).

In the period 1900-1959, some breeds were introduced. In the case of cattle, Charolais, Zebu and Santa Gertrudis; also some pig breeds and, among birds, Leghon and Rhode Island breeds.

From 1964 to 1977, more than 46 thousand animals of different breeds were imported, after the program continued with bulls born in Cuba. The crossing scheme contemplated, in a first stage, the absorption of the Holstein breed through the selection of better adapted animals, and in a second stage, the formation of new breeds, which conjugated the specialized mothers and the rusticity of the local breed. The types were Siboney de Cuba (62,5 % Holstein and 37,5 % Zebu) and Mambí de Cuba (75 % Holstein and 25 % Zebu), aimed at milk production. Experimenting has also been done with other breed lines for dairy (Suiza Parda, Ayrshhire, Jersey) and beef cattle (Charolais Cubana, Santa Getrudis and Criolla) (Aguilar *et al*., 2004).

Similar strategies were followed with sheep, goats, rabbits, horses and pigs and many bird species were introduced, which include hens of high egg- and meat-producing lines. In different periods, 2 984 buffaloes of the Swamp and River breeds, were imported. All that introduced gene pool is maintained almost entirely and constitutes an animal genetic resource (OCREZ, 2014).

The herds with Holando genotype, although of higher production level, showed higher production costs in feeding, health and others. Under the rearing conditions the studies were conducted in Cuba, the genotype with low crossbreeding level was the one that provided higher cost-effectiveness (Aguilar *et al.,* 2004). These analyses indicate the need of coherence between genetic transformations and environmental and productive conditions, because in the crossings not only productive yield is important, but the economic effect of the productive performance and other adaptive traits, especially with the current climate changes.

Energy

The flow of solar energy on earth is the key that determines the production of organic substances, and photosynthesis is the process through which photochemical energy is transformed into stable biochemical compounds, and which can be carried out only by green plants. The energy stored by plants allows the development of all the other organisms (consumers and decomposers) and follows a flow in the food chain (García-Trujillo, 1996). If the plants or other producers of an ecosystem were eliminated, there would be no way in which energy could enter the trophic network and the ecological community would collapse. This is due to the fact that energy is not recycled, but dissipated as heat, by moving through the ecosystem, and that it should be constantly replaced.

According to Godio (2001), in animal husbandry systems the components and nutritional relations that affect the losses in the system, specifically in the management of feeding, are highly important. These relations are: structural carbohydrate/non-structural carbohydrate (fibers-concentrate feed), protein/energy, degradable protein/non-degradable protein and balance of carbohydrates in the feedstuffs (biological value). The development of high-quality energy reserves (grains, forage reserves) should be enhanced, deposit energy reserves (supplements) should be used, materials should be recycled, control mechanisms should be organized that allow adaptation and stability and exchanges should be established with other systems to supply the system (specialized production, integrated systems).

The efficiency of energy utilization is noted when the farm activities are adequately organized. Irrigation should not be performed with high temperatures, and in the case of the use of non-renewable energy, low-consumption machinery should be used. It is necessary to install biodigesters in the anaerobic fermentation of excreta, so that they can be utilized in lighting, food conservation and cooking. The use of solar panels in fences, electrical pumps, domestic appliances, and the use of wind energy in windmills are among other procedures that are practiced today in peasant farms in Cuba.

In 2014, renewable energies in Cuba represented only 4,3 % of the electrical generation of the country. However, for 2030 it is foreseen that it will be 24 % of such generation (Martín-Martín *et al.*, 2020). In pig rearing, in peasant farms and large-scale state production, innovative experiences already exists which are related to the utilization of biodigesters of different sizes and volumes, which include the covered lagoon ones and gasifiers that generate energy to the system (Suárez-Hernández *et al*., 2018).

ES conservation needs funding to protect and manage ecosystems, on which sustainable development depends; besides, coordinated efforts are demanded among governments, enterprises and international institutions to reinforce governance, so that their conservation is guaranteed.

Conclusions

Ecosystemic services are focused from an integrating vision, and agroecological management is the one that allows to understand their benefits. This science is supported on the protection of natural resources, considers system multidimensionality and the interactions that occur in them, including the human factor and local knowledge, which make food security viable.

Innovative examples in animal husbandry systems available in the country have agroecological principles, not only for production increase, but also for obtaining innocuous foodstuffs, which contribute to human health and climate change adaptation and mitigation in a sustainable way.

In view of the economic situation of Cuba, during the pandemic and after, it will be necessary in the public, private and academic field, to indicate a unique strategy that allows the resilience of feeding systems, and return to agroecological practices of nutrient cycle closure at local and regional scale, as a way to be freed from the disaster of the world ecosystem.

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