

Review paper

Economic appraisal of the environment and its application in the Cuban animal husbandry sector

Nadia Báez-Quiñones

Instituto de Ciencia Animal, Apartado postal 24, San José de las Lajas, Mayabeque, Cuba
E-mail: nadia@ica.co.cu

Abstract

The objective of this paper is to present the environmental economic appraisal methods and their application in the Cuban animal husbandry sector. For such purpose the Total Economic Value theory is taken as reference, and the most widely used methods and techniques are identified according to the adopted concept of value. A group of studies about the application of the environmental economic in Cuba is reviewed, and four cases of interest in the animal husbandry sector are analyzed. The topic of the application of the environmental economic appraisal in the animal husbandry sector is not very frequent in scientific literature. This is only limited to determining the main environmental functions and the magnitude of their impact, but their economic value is not taken into consideration. It is concluded that the Total Economic Value theory is one of the most widely used for the economic appraisal of the environment. In addition, there are diverse highly useful techniques for economically appraising the environmental impact of animal husbandry in Cuba.

Keywords: animal husbandry, environmental impact, economic viability

Introduction

Some of the main environmental problems that exist in Cuba are: soil degradation and deforestation; loss of biodiversity; contamination; as well as the deficiencies and difficulties regarding management, water availability and quality, and their impacts on climate change (CITMA, 2016). These problems have incidence on the agricultural sector and are often caused by it; in which the excessive exploitation of animal husbandry systems plays an important role.

Animal production significantly contributes to the emissions of greenhouse gases (GHG). The main emission sources in the sector are enteric fermentation, manure management and deposit of feces and urine in the pasturelands (Wilkes *et al.*, 2017).

In most cases, the environmental problems, or the benefits generated by ecosystems, are not considered in economic accountancy systems (Biondi, 2016). This constitutes one of the main causes of the increasing overexploitation and deterioration of natural resources (Miranda *et al.*, 2007).

For such reason, Miranda (2002) stated that, when a new technology is going to be incorporated, the costs that, at long term, can be generated by the environmental deterioration caused by the assimilation of a new technology, should be taken

into consideration, and not only the investment costs and their recovery period.

In recent years, in Cuba there has been progressive advance in the economic appraisal of the environment, mainly in protected areas and in the tourism and forestry sectors (Machín and Hernández, 2009; Hernández, 2011; Rodríguez *et al.*, 2011; Domínguez-Junco *et al.*, 2012; Labrada, 2013; Poey and García 2013; Zequeira *et al.*, 2013; Rodríguez-Córdova *et al.*, 2017). This proves the need and importance of the use of economic appraisal, so that it allows the practice of effective and economically efficient policies for the sustainable management of species and ecosystems (Machín and Casas, 2006).

The objective of this paper is to present the environmental economic appraisal methods and their application in the Cuban animal husbandry sector.

Economic appraisal of the environment and Total Economic Value (TEV)

The relation between growth and environment has gained great strength for economics researchers in recent years, mainly because of the increasing degradation of natural resources –which accompanies the increase of production at world scale– and to the need of quantifying the elements that compose ecosystems (Figuroa, 2013).

Although some natural resources have a price in the market, it does not contemplate, in most cases, the wide variety of functions that add a higher economic value, generally disesteemed when making decisions related to their management. This value lies on the fact that natural resources and the environment fulfill at least four functions, positively perceived by society (Rangel *et al.*, 2013). They are:

- they are part of the function of production of a large quantity of economic goods and services;
- they perform environmental functions, whose services are demanded by society;
- they act as receptors of diverse types of residues and wastes;
- they constitute an integrated system that provides the elemental means to sustain all kinds of life.

The environmental economic appraisal constitutes an important tool for the adequate definition of the instruments of environmental policy. It can be defined as a set of techniques and methods which allow to measure the expectations of benefits and costs derived from actions, such as the use of an environmental asset, the performance of an environmental improvement or the generation of environmental damage (Azqueta, 1994).

In the last decades, the environmental appraisal methodologies have had a broad development in the measurement of those aspects that were previously classified as intangible and which at present can be measured in monetary terms (Hernández *et al.*, 2013).

The economic value of environmental goods and services is a very controversial topic in literature. Cerda (2003) states that it is important to emphasize that neither «the environment» nor «the life» are being appraised, as many people assume,

but that the preference of people in the face of changes in the conditions of the environment and with regards to changes in the risks they face are appraised. In this sense, Hernández *et al.* (2010) suggested that economists should appreciate the value of ecosystems far beyond their contribution in raw materials and tangible products. From these ideas, the Total Economic Value (TEV) theory is proposed, which has been used by such authors as Ferro *et al.* (2016) and Almeida *et al.* (2018), as the approach to be taken into consideration for determining the economic value of an ecosystem.

The TEV approach states that any good or service is composed by several attributes, some of which are tangible and easily measurable, while others can be more difficult to quantify. However, the total value is the sum of all these components and not only of those that can be easily measured. The limits and terminology for the TEV components slightly vary between one specialist and the other, but it generally includes value of use and value of non-use (Dixon and Pagiola, 1998). Besides, each one can be subdivided into additional categories (table 1).

The value of use is formed by the value of direct use, which refers to the resource that is obtained by the development of certain activity; the value of indirect use, including those benefits that are derived from the functioning of ecosystems; and the value of choice, which refers to the possibility of using, or not, the environmental resource in the future. On the other hand, the value of non-use is subdivided into legacy value and existence value. The former refers to the possibility that the resource be consumed by future generations, and the latter, to the knowledge of the existence of a certain environmental asset; which, although due to moral conviction, seems valuable (Ferro *et al.*, 2016).

Table 1. Categories of the economic value ascribable to natural resources.

Value of use			Value of non-use	
Direct use	Indirect use	Choice value	Legacy value	Existence value
Directly consumable values	Benefits derived from ecosystem functions	Future direct and indirect values	Value of the resources for future generations	Value of knowing that there still is an environment component
Milk, meat, biomass, recreation, health	Control of: climate, soils, nutrient recycling	Bioprospection, conservation of habitats	Conservation of habitats in the face of irreversible changes	Habitat, species, genes, ecosystems

Source: modified from Pearce and Morán (1994).

Summarizing, the TEV theory is one of the most used in scientific literature, because it allows to appraise the environmental goods and services taking into consideration the highest possible quantity of the values they have. Thus, a monetary value is assigned to such resources, which, in spite of not being their real value, offers the possibility of including them in the accountancy systems at the different levels. Nevertheless, it is criticized by some experts due to its subjective character, because the assignation of values depends, to a large extent, on the specialist's point of view.

Most utilized methods and techniques for the economic appraisal of the environment

Environmental appraisal techniques intend to obtain the willingness to pay for a positive change in an environmental good or the willingness to accept a compensation for a negative change. The environmental economy is focused on two basic areas: the field of appraisal (impact and environmental cost studies), for which it uses a series of instruments and methodologies such as benefit/cost studies, contingent appraisal and disposition to

pay, among others; and the field of environmental policy and management, in which it proposes diverse instruments of environmental fiscal policy, constitution of secondary markets, environmental policies and management (Raffo, 2015). It should be clarified that this review adopts the position of environmental economy, emphasis is not made on the precepts of ecological economy¹.

The different values that are assigned to environmental goods and services can be excluding, alternate or competitive, for which it is not always possible to consider that the total economic value associated with an environmental good or service is the simple sum of the different values of use and non-use (Leal, 2005). In this regard, there are diverse appraisal methods and techniques, which are classified according to the concept of value that is adopted or the level of availability of the required information. The most common classifications in literature are: methods of declared preferences or revealed preferences (Maldonado and Cuervo, 2016); and direct or indirect methods (Pardo and Sanjinés, 2014). The most utilized techniques according to the concept of value are shown in figure 1, and are explained below.

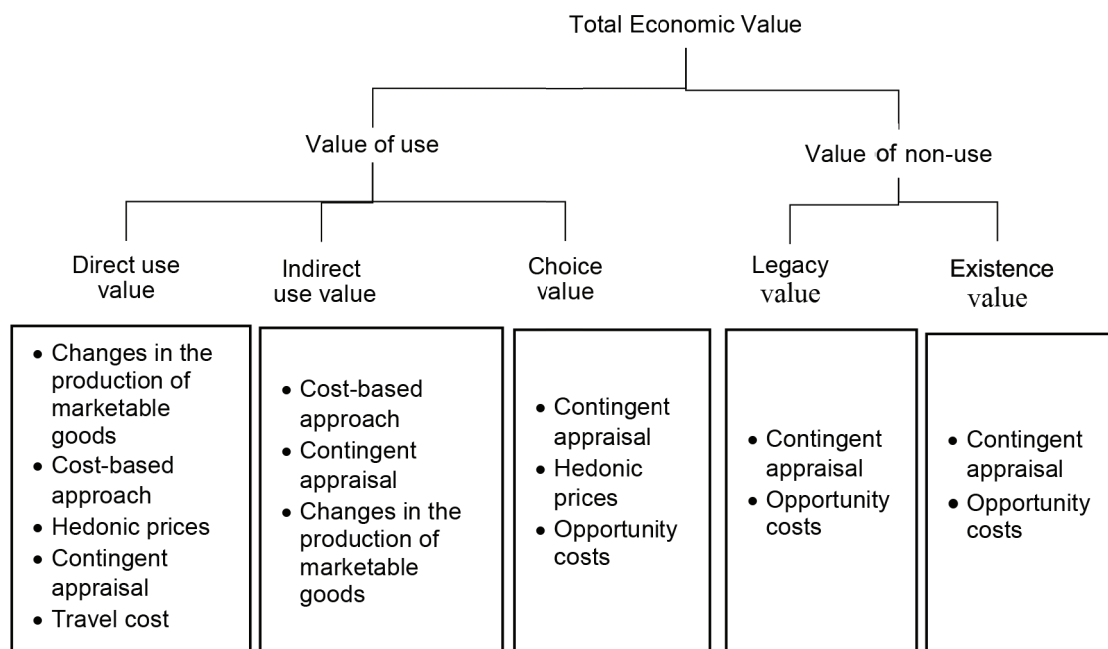


Figure 1. Techniques of economic appraisal according to the value category.

Source: adapted from Dixon and Pagiola (1998)

¹ It considers economy as a subsystem of the ecosphere, and assumes that mankind and its economy must be subject to the limits imposed by the biophysical restrictions set by ecosystems, source of the goods and services that feed them (Goodland and Daly, 1996).

- *Direct market values or available market prices.* This technique is used in economies where there are well defined markets, in which the practice is followed of assigning a monetary value to the biological resource in question, under the assumption that such price reasonably describes the value it has, being understood that such concept goes beyond being only value of use (Guillén *et al.*, 2007).
- *Method of opportunity costs.* It is used when there are two or more choices of use of the environmental area. The opportunity cost of utilizing resources, in a certain way, is the most highly valued alternative in which these resources could have been invested and to which the society would have to renounce when the resources are used in another specific way (Zequeira *et al.*, 2016). For example, the decision of using a vegetative area to start agricultural production against the alternative of opening a national park; if opening the park is chosen, the economic appraisal is given by the market prices when weighing the agricultural losses by their price.
- *Method of the changes in productivity.* This method attempts to estimate economically the environmental impact on a natural resource, through the appraisal of the effect this impact generates on production, the cost or the profits generated by the other good which does have market. Such effect on the production of another good or service implies a change in people's welfare. Through the appraisal of such change in welfare an approximation of the value of that environmental impact is obtained. An example of the application of the method can be the case of water quality and agricultural production. If the water quality decreases due to contamination, there will be a decrease in yields, which would be translated into higher production costs and, thus, a higher price of the product. This ultimately affects people, who will have to pay a higher price for the product, and thus its usefulness decreases (MINAM, 2015).
- *Method of replacement costs.* The replacement cost technique is based on the measurement of the costs that are incurred by replacing productive assets damaged by the disturbance of natural resources and ecosystem processes. For example, the cost of acid deposition related to air contamination in urban areas could be approached through the cost of replacement or restoration of the damaged infrastructure (Murillo and González, 2017).
- *Method of hedonic prices.* The environmental quality affects the price people are willing to pay for certain goods or services. The method is based on the fact that many of the prices observed for the goods are prices for a set of attributes. This approach estimates the welfare derived from the environmental characteristics that influence directly the market prices of a specific good. The most used variants are based on the price of properties and on the salaries (Díaz, 2017).
- *Travel cost method (TCM).* It is based on the costs that are incurred by the visitor to a place to enjoy the recreation ecosystemic services provided by a certain site. For example, in the case of natural parks, people enjoy the natural areas, but, to do that, they need to consume some private goods to travel to the site, and it is on those private expenses this method is based in order to determine an approximation to the value of the natural resource (Tomio and Ullrich, 2015).
- *Method of avoided costs (MAC).* It estimates the costs which are incurred to prevent the damage caused by environmental degradation. This technique examines the expenses in order to determine the importance people assign to the impacts on the environment and health. The fundamental premise is that an individual perception of the cost imposed by damage is related to what the person pays to prevent it from occurring (Ripka de Almeida *et al.*, 2018).
- *Method of contingent appraisal or of constructed markets.* The method consists in the design of a hypothetical market, presented to the individual through a questionnaire, which is later used to simulate several markets in which values are assigned to the resources. The intention is to know the preferences of society on environmental quality, and how much it will be willing to pay for not being deprived of the benefits of having such resources (Pérez-Torres, 2016).
- *Model of economic evaluation of the eco-friendly productive activity.* This model uses three fundamental criteria to define a practice or product as eco-friendly (Barzev *et al.*, 2013). They are: 1) competitiveness: it is the technology used in each economic alternative; 2) environmental measures: it is the quantification of negative impacts (translated into costs) and the measures proposed to mitigate them, thus generating social benefits; and 3) economic viability: it is the application of the costs-benefits technique to

compare costs *versus* benefits of the economic activity (including environmental costs and benefits).

The environmental measures in the model represent the different costs that are incurred to prevent negative impacts on the environment. In addition, the additional incomes or profits generated by adopting those mitigation measures of the negative impacts, are quantified.

The methods and techniques that are used in literature vary from one author to the other, and their election depends fundamentally on the pursued objective. It is very common to find several techniques applied in the same research, which allows to appraise each of the environmental functions of the goods and services of the area under study.

Application in the Cuban animal husbandry sector

In the Cuban animal husbandry activity, the field of the instruments of environmental policy and management is very limited because there is not a clearly defined economic-environmental policy in which compensation systems are used for good practices, such as payments for environmental services, and there is not a market of carbon certificates either. These compensation systems have been applied in several countries of America by such authors as Murgueitio *et al.* (2013), Zapata *et al.* (2015), Artunduaga and Escobar (2016), with very good results in the achievement of the sustainable management of the activity.

There are several studies in the field of environmental economic appraisal which have been conducted in Cuba in recent years (table 2). Among the reviewed papers the ones that have as study object the territories and protected areas stand out. In the first case are the reports and doctoral and master of science theses which were elaborated within the framework of the UNDP/GEF Sabana-Camagüey Project. They were focused on several ecosystems of the zone, where the studies were aimed at appraising in economic terms the natural resources of national parks, mangroves and basins, which in most cases are dedicated to tourism development.

In the case of the animal husbandry sector, four cases of interest were found in the last years in which the economic appraisal of the environmental impact was applied. This does not mean that they are the only ones, because in several of the cited works (Rangel *et al.*, 2013; Ferro *et al.*, 2016; Zequeira *et al.*, 2016) the function of animal husbandry as one of the values of direct use in the studied systems was evaluated, although this sector was not the protagonist (table 2).

The study conducted by Miranda *et al.* (2007) was focused on the economic appraisal of the carbon sequestered in a farm with natural pasture and another one converted in a silvopastoral system (SPS), with 11 years of exploitation. The estimated amount of stored carbon per hectare in the systems was approximately valued in 1 590 dollars (USD). From this amount, 80 % was contributed by the SPS, which surpassed the natural pasture, and the

Table 2. Studies of environmental economic appraisal conducted in Cuba, by sector.

Sector	Studies	Authors
Animal husbandry	4	Miranda <i>et al.</i> (2007, 2008); De la Cruz <i>et al.</i> (2013); Manzano <i>et al.</i> (2013); Valdés <i>et al.</i> (2013)
Mining	1	Reynaldo and Guardado (2017)
Tourism	4	Figueredo <i>et al.</i> (2013); Gutiérrez and Soularý (2013); Labrada (2013); Zequeira <i>et al.</i> (2013)
Protected areas	5	Machín and Hernández (2009); Hernández (2011); Villarreal and Unger (2012); Delgado (2013); Rodríguez <i>et al.</i> (2017)
Forestry	3	Rodríguez <i>et al.</i> (2011); Domínguez-Junco <i>et al.</i> (2012); Poey and García (2013)
Basins	3	Rangel <i>et al.</i> (2013); Ferro <i>et al.</i> (2016); Zequeira <i>et al.</i> (2016)
Fishery	2	Bucarano <i>et al.</i> (2013); Betanzos-Vega <i>et al.</i> (2014)
Entrepreneurial	1	Cañizares-Roig and Martín-García (2016)
Territorial	8	PNUD (2007) UNDP/GEF Sabana-Camagüey Project

Source: elaborated by the author.

high economic contribution of the system with trees was proven. For its estimation the direct method of market prices was used, and the carbon mass held was multiplied by its price in the market of carbon certificates.

Miranda *et al.* (2008) completed the study with the economic appraisal of how much the biodiversity function represented in animal husbandry ecosystems. For such purpose the technique of avoided costs due to weed control, assigned to that environmental service, was used. In both study cases it was concluded that the estimation of environmental benefits, along with the economic incomes by way of milk production, constitutes a valorization of animal husbandry ecosystems.

De la Cruz *et al.* (2013) evaluated the implementation of the management plan of the buffalo stock with biodiversity conservation techniques. For such purpose two dairy farms with sustainable management and two with traditional management were compared. In spite of the costs of the dairy farms with sustainable management being higher, because they internalized the environmental costs (reforestation of the area for the utilization of living fences, protection against fires, maintenance of channels and dams, among others), in them high positive impacts were generated (decrease of soil erosion, utilization of trees for animal feeding and shade, production of fruit and firewood for sale, among others). From the economic point of view, this area showed higher incomes in all the periods. In the study all the additional incomes which would be obtained from sustainable management were not taken into consideration; thus, the positive economic impacts (externalities) were not really quantified, although it constitutes an approximation to what should be done regarding the economic appraisal of environmental services.

Valdés *et al.* (2013) studied the economic feasibility of constructing a plant of pig waste treatment with anaerobic digestion technology. For such purpose, the benefit-cost ratio and the investment recovery period were determined. In the determination of the incomes and costs the environmental aspects were taken into consideration. The savings by way of diesel substitution and contribution of nutrients from the substitution of chemical fertilization by fertilization with biosolid, were included.

During the bibliographic review, it could be observed that the environmental economic appraisal in the animal husbandry sector is not very frequent in Cuba. This is only limited to determining the

main environmental functions and the magnitude of their impact, but their economic value is not considered. However, work has been started to be done in order to determine the economic impact of the animal husbandry activity on the environment, not only from the negative point of view, but also from the large variety of environmental services and goods that are derived from it.

Conclusions

The Total Economic Value theory is one of the most used for the economic appraisal of the environment. In addition, there are diverse highly useful techniques to appraise economically the environmental impact of animal husbandry in Cuba, and their election depends on the objective pursued by the research. In the same study several techniques can be used in order to determine the economic values of each of the environmental functions identified in the ecosystem.

In recent years, the studies of environmental economic appraisal have been increased in the Cuban animal husbandry sector; nevertheless, they are not sufficient, if the role played by animal husbandry in the intensification of environmental problems and the potentialities it has for mitigating them is taken into consideration.

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