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Approach to the assessment of sustainability in organic livestock farms in a Colombian Andean region

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Key words: Organic, livestock, sustainability, production system.

Abstract

This study aimed to compare conventional livestock production systems in relation to organic production, evaluating environmental, productive and economic variables in 6 farms of Guayabal de Síquima (Colombia). The work established significant differences on water quality between the affluent and effluent water for variables such as pH, nitrate and phosphorus. The microbiological analysis of soil found significant difference in bacterial counts made for organic systems compared with the conventional. The botanical composition of grasslands showed a significant difference in the amount of grass on organic farms. The organic management stimulated the arthropod species diversity and its density per m^2 in the prairies in relation to conventional systems. Fertilization costs were lower and effective control of ecto and endoparasite burden was higher under the organic management system. An evaluation of 12 indicators related with sustainability evidenced the best results in organic systems.

Introduction

The intensified agricultural systems have suffered recently, by the high use of fertilizers, synthetic pesticides, antibiotics, hormones and fossil fuels, with effects on the environment (Pimentel et al. 2005). As result, agroecology has emerged to contribute to the solution of these problems (Sarandon and Labrador 2001). Organic agriculture, as application of agroecology, seeks the improvement and maintenance of soil fertility and productivity, satisfaction of human needs, economic viability, social acceptability, ecological adaptation and development systems by long-term (IFOAM 2009, Gómez-Limón 2010).

Methodological schemes that assess the sustainability of animal production systems continue to evolve based on the measurement of them (Masera 1999), using economic, social and environmental indicators, including agricultural practices, evaluation of soil, water, energy use, waste generated by the system, animal welfare and conservation of biodiversity (Nahed et al 2007).

Material and methods

This study aimed to compare conventional livestock production systems in relation to other forms that implement organic production, evaluating environmental variables (in water: nitrite, nitrate, phosphate, pH and availability of oxygen using photometric methods and Winkler modified method. In soils: counts of bacteria and fungi using MPN method, and physicochemical properties. In meadows: Prairie composition, quantity and density of arthropods), productive variables (in forages: biomass estimation using the methodology by Campbell and Arnold, nutritional quality using bromatology methods, in animals: milk production, and carrying capacity), and economic variables (Fertilization cost and control ecto-endo parasites cost) in 6 farms Township Guayabal de Síquima (Colombia). Three of them were classified as conventional while other three farms were classified as organic (2 certified following Colombian organic regulation and 1 in conversion process) in relation with management. Samples were taken periodically during 12 months for the components soil, water, plants and animals involved in the production process. The variables were compared statistically using T-test.

Results

The work established effects of conventional systems on water quality, significant differences were found between the affluent and effluent water for variables such as pH ($P = 0.046$) from 7.1 to 6.9, nitrate NO_3-N ($P = 0.027$) by the increasing from 10.0 to 20.8 mg L^{-1}, and phosphorus as PO_4^{3-} ($P < 0.001$) when going from 10.3 to 12.0 mg L^{-1} respectively. In the organic management systems, the values associated with nitrate as NO_3^-N and phosphorus in the effluent water decreased (15.0 to 11.7 mg L^{-1}; 11.0 to 10.3 mg L^{-1} respectively) and increased available oxygen (4.8 to 5.2 mg L^{-1}) but there was no significant difference between them. Regarding the microbiological analysis of soil (Table 1) found in most bacteria counts made for organic

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systems (average 1.58 x 10^7 cfu gDS^{-1}) being found significant difference compared to the conventional system (average 5.22 x 10^6 cfu gDS^{-1}), as well as many fungi (Conventional 1.30 x 10^4 and Organic 2.13 x 10^4 spores gDS^{-1}) although there was no statistical difference between the two systems.

Table 1. Counts of bacteria and fungi in soils from conventional and organic handling farms.

	Bacterias		**Fungi**	
	Conventional farms	Organic farms	Conventional farms	Organic farms
Dry season	3,85E+06	8,25E+06	7,65E+03	1,43E+04
Rainy season	6,59E+06	2,34E+07	1,84E+04	2,83E+04
Average	5,22E+06*	1,58E+07*	1,30E+04**	2,13E+04**

*Bacterias: Highly significant difference. T test (P=0,003)
**Fungi: No significant difference. T test (P>0,05)

The botanical composition of grasslands showed a significant difference (P<0.001) in the amount of grass of organic farms (80.1%) than in conventional (62.2%) and the amount of weed (P<0.001) being higher on conventional farms (32.1% versus 11.5%). Forage production per year was higher in conventional farms (112.1 tons ha^{-1} against 81.66 tons ha^{-1}), enabling higher carrying capacity on them (1,768 kg BW ha^{-1} in Conventional to 957 kg LW ha^{-1} in Organic) but not significant difference (P>0,05) between the systems (Figure 1).

The development of silvopastoral systems in the organic farms, allowed the incorporation of various species in the animal feed, and may have influenced the diversity of arthropods in the meadow, along with other practices that additionally favored an integrated pest management. Around 23.5% of the fodder in organic farms comes from the trees and shrubs established in the silvopastoral system (*Trichantera gigantea, Erythrina edulis, Thitonia diversifolia and Bohemeria nivea)*.

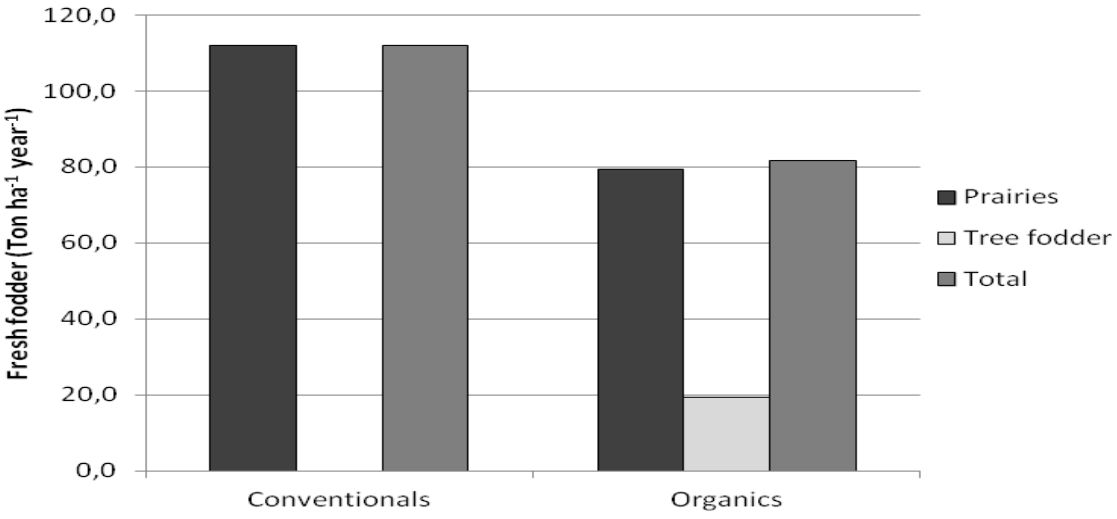

Figure 1. Forage production in organic and conventional farms

There was no significant difference in relation with the nutritional quality of fodder for variables evaluated in conventional and organic farms, as protein (12.2% vs. 12.7%), NDF (64.5% vs. 65.0%), ADF (30.3% vs 29.1%), lignine (3.5% vs. 2.8%), cellulose (26.8% vs. 26.4%), hemicellulose (34.2% vs. 35.8%), calcium (0.46% vs. 0.49%) and phosphorus (0.2% vs. 0.2%) respectively. The Organic management stimulated the arthropod species diversity (7.67) and its density per m^2 in the prairies (0.331 arthropods) in relation to conventional systems (6.67 and 0.190 arthropods), although there was no significant difference between them.

The comparison in fertilization costs and control of ecto and endoparasites was lower in organic management systems than in conventional agriculture based on the use of compost and enthomopatogenic fungi. Overall management of composting and soil microbial broths of organic systems favored more soil microbiology, and generate less pollution effects of nitrogen and phosphorus products in effluent waters. The

conventional farms used Ivermectin, Triazine, Cypermethrine for ticks and insects control, and urea and chemical composed fertilizers for soils during the crops process.

Finally, the cattle were crosses between Cebu x European breeds (Holstein, Normande, Jersey o Brown Swiss), or crosses between European breeds with a day milking by hand. The milk production registered during 9 months of evaluation were 4,5 L cow^{-1} day^{-1} for conventional farms, and 6,7 L cow^{-1} day^{-1} for organic farms. The cows of organic farms received a food supplementation at milking time, composed of fodder from trees and shrubs arranged in plots. An evaluation of 12 indicators related with sustainability evidenced the best results in organic systems (Figure 2).

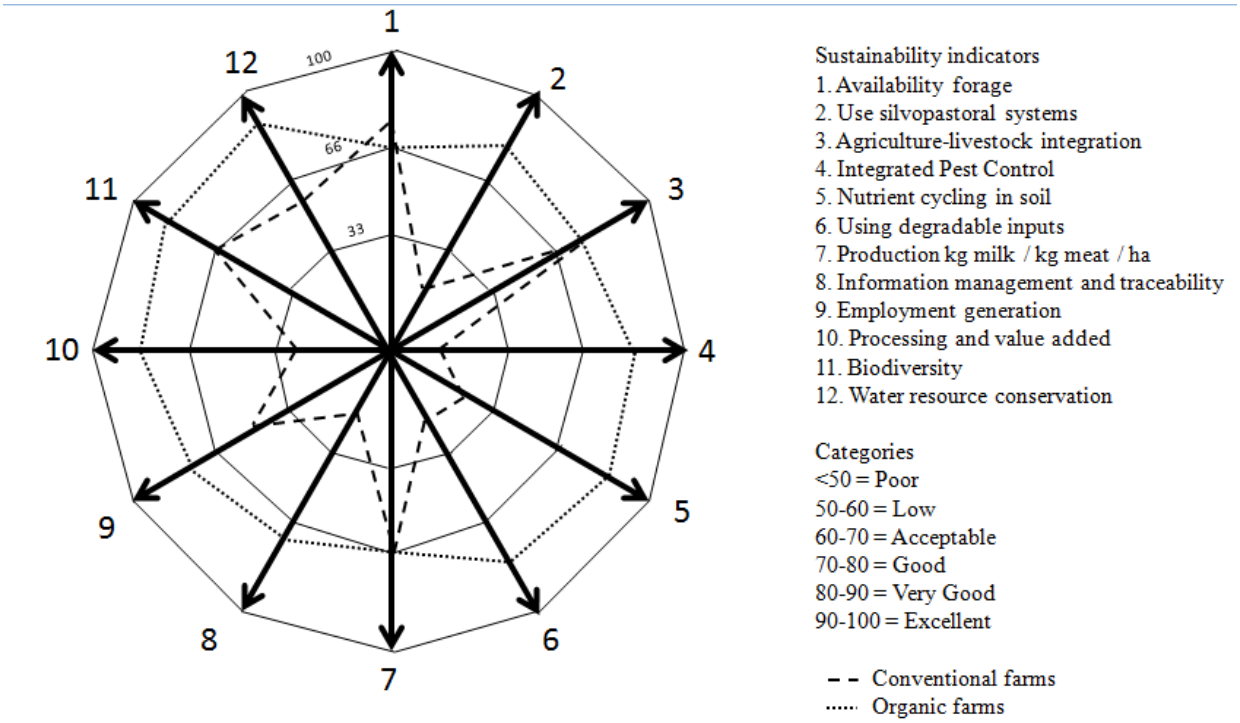

Figure 2 . Assessing the sustainability of conventional and organic farms monitored

Discussion

The sustainability assessment of conventional farms and organic farms management led to the discovery that the conventional were far less sustainable compared to a set of variables identified as key in this process. Organic farms remained higher microbiological activity of soils, greater diversity of arthropods in grassland, less use of chemical products, the farmers have better conceptualization and integration between animals and plants production system, which enabled most successful approaches such as integrated pest management.

Suggestions to tackle with the future challenges of organic animal husbandry

The systemic evaluation of social, economic and environmental components of organic farms, should allow identification of problems which let the development of particular production systems, making use of local resources, conserving and promoting biodiversity, emulating ecological cycles, and avoiding fall into the trap of setting producing certified systems under conventional schemes.

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