Albanian j. agric. sci. 2013;12 (4): 539-544 *Agricultural University of Tirana*

RESEARCH ARTICLE **(Open Access)**

Analysis of the sustainability of agricultural farms through agri-environmental indicators at the level of biodiversity and landscape

ALBERT KOPALI[1]

Department of Agro-environment and Ecology, Agricultural University of Tirana, Albania

Abstract

Implementation of conventional agriculture has led to major changes in the agricultural sector, in particular in terms of structural simplification of agro-ecosystems, which has caused direct repercussions on their biodiversity. Demolition of balances between agriculture and biodiversity has decreased self-retaining ability of agricultural systems. The more simplified biodiversity in agro-ecosystems, through management models, the less they are able to self-regulate and self-maintained. A careful administration, which increases the level of biodiversity of inland, strengthens relationships and increases the stability of agro-ecosystems. Use of bio-indicator, to assess the level of diversity and sustainability of agro-ecosystems, has been widely used in recent years in many countries. From the analysis, with some levels, in order to assess the biological complexity in agricultural systems, we show that organic agriculture systems plant biodiversity indicators at the level of plot, the farm level ecological infrastructures and other indicators of agro-environmental, we are the approximate value of farm sustainability indicators, in comparison with the conventional system, indicators result in very low levels, which shows the instability of these systems. This makes necessary interventions in their structural plan, in order to increase the level of biodiversity, sustainability and quality of agro-ecosystems. Research conducted aims at identifying the differences between different types of agro-ecosystems, in order to design sustainable agro-ecosystems.

Key words: biodiversity, agro-ecosystem; biological complexity, bio-indicators, sustainability.

1. Introduction

Maintaining the balance in the biosphere and increase sustainability, except reports on the natural ecological systems, is significantly influenced by agricultural systems. Modifications made by anthropic factor include a large part of natural ecosystem. According to recent assessments [1], the majority of terrestrial environment is used for activities related to agriculture. The implementation of agriculture from the Neolithic time constitutes the first and most important activity, implement large-scale, which has made progressive modifications of natural ecosystems, turning them in agricultural systems, process which still continues to this day in the developing countries [2]. Agriculture has determined the time a structural simplification of the environment, replacing the natural biodiversity of ecosystems with a limited number of cultivated plants and domesticated animals [3]. This structural simplification has led to a significant decrease in levels of biodiversity, consequently,the sustainability of the ecological system. It is therefore necessary, by practical, be designed multifunctional agricultural systems, the answer to biodiversity maintenance aiming at protecting plants from pests, improvement of soil fertility, integration of herbal cultivation with wood, the cultivated spaces with uncultivated, and integration of cultivation with animal husbandry [4]. Ecological principles today represent a useful knowledge base to promote the transformation of agriculture towards a greater sustainability and environmental compatibility [5]. The biodiversity of natural ecosystems can be considered for the design and implementation of sustainable agro-ecosystems [6]. Biodiversity – sustainability reports must be seen as an important element of the organization of sustainable agricultural systems. In practice, agriculture must perform the multifunctional role [7], and should be a socio-economic and environmental values. Environmental assessment has a keys role in the design processes, managing and resolving territorial issues [8, 9] and the use of sustainability indicators of agro-ecosystems is an effective tool to describe the sustainability of agricultural systems. The use of agri-environmental indicators, may allow the estimated minimum level of sustainability and the choice of indicators must be related to the referal environmental sector and set targets[10]. The European Commission has suggested the introduction

[1]This work is dedicated to Prof. Velesin Peçuli (1949-2013), the fameous scientist in the area of ecology and environment.

Correspondence: Albert Kopali< Agricultural University of Tirana; Email: albertkopali@yahoo.it
(Accepted for publication 20 October 2013)
***ISSN**: 2218-2020, © Agricultural University of Tirana*

of agri-environmental indicators to improve agricultural statistics as to assess the results of operations performed and to draw up action plans for the future [11]. It highlights the need for the introduction of landscape-level indicators function of ecological networks (eg, length of plant fences,than agricultural surfaces.etc.), to improve the structural characteristics of agricultural farms in order to increase of their sustainability.

2. Material and methods

Search is carried out in two farms that are found in lowland Mediterranean agro-ecological zone in the region of Durres (Shijak), an biological farm in administration, with an area of about 0.3 hectares planted with peach and an other one in the conventional management with an area of 0.4 hectares cultivated with the same fruit tree during the years 2010-2011. Cultivation technologies significantly differentiated in both farms. In the study area is rich in natural spaces that enrich the biodiversity of the area in the landscape level, mainly along the river "*Erzeni*" which can be considered as a natural ecological corridor. It is an agricultural area of mainly fruit trees - viticulture and vegetables and stands for a low level of human intervention in the landscape level. Agri-environmental indicators used in this study belong to the system of biodiversity and landscape in both types of farms. The values of the indicators found were compared with values "*optimal*" data in the literature [6] under the direction of farm production. Through analyzing indicators of diversity is the diversity of herbaceous species present in both farms expressed as the number of species of flora by Braun-Blanquet method [12] which consists in evaluating of eyes of the relative quantity (coefficient of density/dominance) the different wild species present on the surface of the plot [13] and the Shannon indicators of the diversity of herbaceous species for level of plot (Field specie diversity):

$$DSA = -\sum_{1}^{n}(P_s x log_n P_{s})$$

where: s = no. the species identified and Ps = % of the presence of the species on the total. Optimal value X>2. Wealth of herbaceous species in the plot level (Field species richness) calculated as the amount of species identified. Optimal value X>40. [14]. Identification is carried out in an area 100 m^2 during April-May.

Analysis of the diversity of fauna for indicators of wealth entomological target species (richness of target species) (carbides) calculated as species richness. Optimal value X > 25. [15]. Sampling was done with a portable device with suction in each plot at three different positions, located 3 m between them. Aspirations are repeated every 15-30 days in the period between March and June. Species have been identified in laboratory seizures. Structural diversity index of entomological target species are calculated by the Shannon index:

$$HSA = -\sum_{1}^{n}(P_s x log_n P_{s})$$

where: s = no. of the species identified; Ps = % of the presence of the species on the total. Optimal value: X>2.

Agricultural landscape level is analyzed presence of natural vegetation space (ecological infrastructures) [16, 17, 18, 19, 20, 21]; cultural diversity index of Shannon [22, 23] and indicator of the quality of the landscape elements [10].

3. Results and discussion

Search conducted, by analyzing data on biodiversity in *agricultural farm level*, for herbaceous species in conventional and biological cultivation systems, for two indicators of species richness and Shannon diversity index, from the data provided in the resulting file:

Table 1: Values of indicators of herbaceous species richness and structural diversity in two cultivation systems

Cultivation system	*Year 2010*		***Year 2011***	
	Indicator species richness (no.) (Optimal value X> 40)	The Shannon diversity index (Optimal value X> 2)	Indicator species richness (no.) (Optimal value X> 40)	The Shannon diversity index (Optimal value X> 2)
Conventional cultivation	10 (X<40)	1.2 (X<2)	14 (X<40)	1.3 (X<2)
Biological cultivation	33 (X<40)	2.2 (X>2)	40 (X=40)	2.4 (X>2)

Review of the analyzed indicators shows that there is a significant loss of species richness in the conventional system (X =10, in 2010 and X=14, in 2011, the optimal value is X>40), to the use of herbicides and other management practices and structural diversity values of less than optimal (X =1.2 in 2010 and X=1.4, in 2011, the optimal value is X>2).

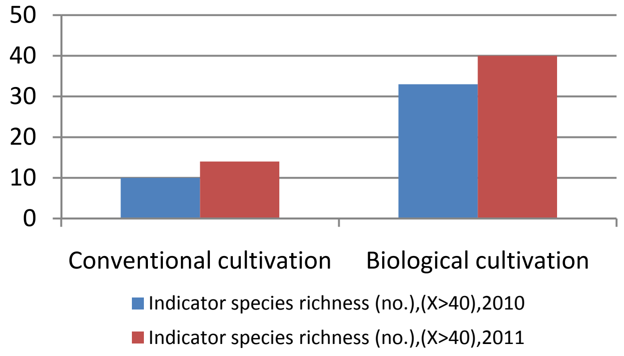

Figure 1: Indicator values of herbaceous species richness in conventional and biological systems of cultivation

Significant changes are of species richness of herbaceous species in biological farming system (X =33, in 2010 and X=40, in 2011, when the optimal value is X>40), number higher than the conventional system due to the practice of cultivating eco-compatible. At the same time, the structural diversity of Shannon is with the values higher than optimal (X=2, in 2010 and X=4, in 2011, when the optimal value is X>2).

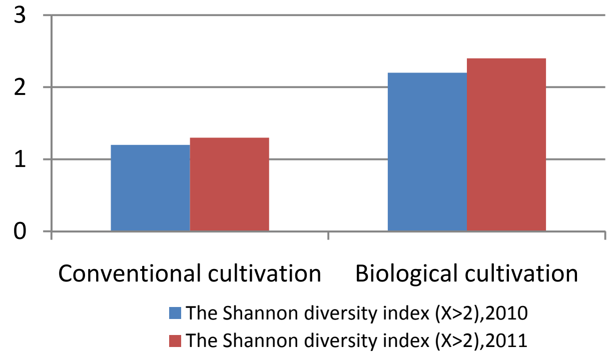

Figure 2: Indicator values of structural diversity of Shannon in conventional and biological systems of cultivation

The analysis of the diversity of fauna species, the richness of entomological target species (richness of target species), (carabidet), calculated as the amount of species identified (indicator of wealth) and the Shannon diversity index results:

Table 2: Values of indicators of entomological species richness and structural diversity of Shannon in two cultivation systems

Cultivation system	*Year 2010*		***Year 2011***	
	Indicator species richness (no.) (Optimal value X> 25)	The Shannon diversity index (Optimal value X> 2)	Indicator species richness (no.) (Optimal value X> 25)	The Shannon diversity index (Optimal value X> 2)
Conventional cultivation	18 (X<25)	1.3 (X<2)	20 (X<25)	1.4 (X<2)
Biological cultivation	37 (X>25)	2.4 (X>2)	41 (X>25)	2.8 (X>2)

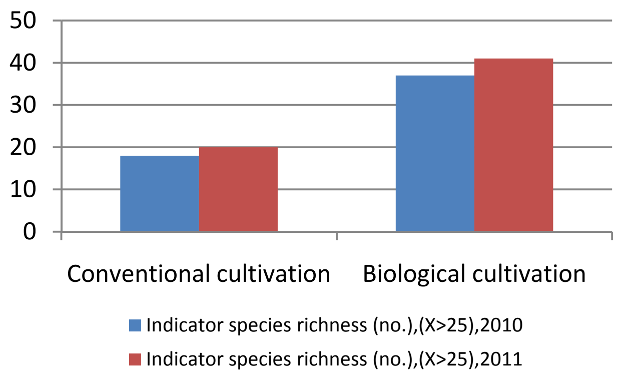

Figure 3: Indicator values of entomological richness species in conventional biological systems of cultivation

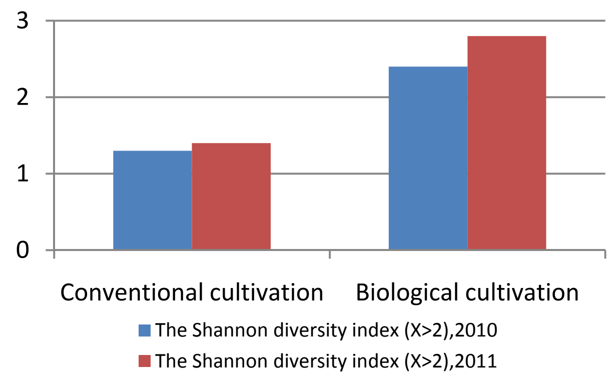

Figure 4: Indicator values of structural diversity of Shannon of entomological species in conventional and biological systems of cultivation

Table 3: Values of indicators of biodiversity in farm level

Cultivation system	*Year 2010*				***Year 2011***			
	Indicator of herbaceous richness species (no.)	The Shannon diversity index of herbaceous species (no./hectares)	Indicator of entomological richness species (no.)	The Shannon diversity index of entomological species (no./hectares)	Indicator of herbaceous richness species (no.)	The Shannon diversity index for herbaceous species (no./hectares)	Indicator of entomological richness species (no.)	The Shannon diversity index of entomological species (no./hectares)
Conventional cultivation	10 (X<40)	1.2 (X<2)	18 (X<25)	1.3 (X<2)	14 (X<40)	1.3 (X<2)	20 (X<25)	1.4 (X<2)
Biological cultivation	33 (X<40)	2.2 (X>2)	37 (X>25)	2.4 (X>2)	40 (X=40)	2.4 (X>2)	41 (X>25)	2.8 (X>2)
Optimal values (X)	(X>40)	(X>2)	(X>25)	(X>2)	(X>40)	(X>2)	(X>25)	(X>2)

Table 4: Agri-environmental indicators in the agricultural landscape level

Cultivation system	*Year 2010*			***Year 2011***		
	Busy area of natural spaces (%)	The diversity of cultivated plants (no. of plants planted / year)	Quality landscape (no.)	Busy area of natural spaces (%)	The diversity of cultivated plants (no. of plants planted / year)	Quality landscape (no.)
Conventional cultivation	2.9	0.7	5	3.2	0.8	6
Biological cultivation	3.6	0.9	7	3.8	1.3	8
Optimal values (X)	X -= 3-5%	X = 0.8-1	X>15	X -= 3-5%	X = 0.8-1	X>15

By analyzing the results we see that there are significant differences in species richness in biological cultivation respectively that conventional which results in much lower value than the value determined optimal (wealth index is X=18 from to 25 is optimal in 2010 and X=20 in 2011,when in biological system it results in higher than optimal, X=37 from to 25 is optimal in 2010 and X=41 from 25 in 2011).

The same results is for the structural diversity index of Shannon (X=1.3 in 2010 and X=1.4 in 2011 when the optimal value is X>2 in conventional system and X=2.4 in 2010 and X=2.8 in 2011, when the optimal value is X>2 in biological system), indicators which give values that increase the sustainability of the farm.

By analyzing the data in *landscape level* spaces for the presence of natural vegetation or ecological infrastructures (Ecological Infrastructure Diversity), results in a greater presence of natural habitats in the biological system, something which is influenced by the preservation of plant fences spaces. Compared with the optimal indicator in both cultivation systems, values are lower which indicates to a greater utilization of floor space available for farm production purposes. Indicator plant diversity (cultivated plants) resulting in higher biological system since in this system management practices are implemented plant-year association (mainly in the first bean and clover in the second year and partly vegetable plants are also cultivated as a green salad of onion. Much lower in the indicator turns conventional practices which is generally applied mono-cultural system. Analysis of the quality indicators of landscape elements shows relatively low values in both their farms, compared with optimal values for indicators of sustainability given that more total surface area of the farm is used for production purposes.

From an analysis of the overall results of biological breeding farms is higher levels of sustainability, although the quality of the landscape values lower than optimal. The diversity of cultivated plants is at levels close to those of optimal, this affected by cultivation practices in biological systems. This is evident by comparing the values of indicators with optimal values from the literature data [6].

4. Conclusions

Search conducted for assessing the sustainability of different agricultural systems through the use and analysis of agri-environmental indicators, reaches the conclusion that you have a structural biodiversity loss and species richness, the farm under conventional cultivation versus biological, which leads not only to a farm negative behavior in terms of sustainability, but also in deterioration of environmental qualities.

Conventional cultivation systems have a negative attitude to farm sustainability terms.

The data obtained from this study are useful as highlight the importance of using the system of agri-environmental indicators as an important indicator for assessing the sustainability and environmental qualities in different cultivation systems of agricultural plants.

Created differences, in terms of sustainability, identify the important ecological role of ecological infrastructures that have (green spaces or ecological networks) and other practices eco-compatible farm association as plant, soil and vegetation coating etc, we increase the level of biodiversity on the farm, maintaining biological balances, and consequently its sustainability.

The conclusions of this study, compared with literature data [6] show that there are no universal indicator can be applied in all situations [24] and that the sustainability of these indicators is still discussed [25].

Another important aspect is he making reference parameters for the farm environment was studied as an area of ecological conditions are different from those of another area, although the species may be the same or have the same ecological valence. In various studies have found differences in the basis of assessment indicators used [26].

To achieve sustainable conclusions, would be appropriate and a deep knowledge of the field of study subject cultivated, in order to know how is environmental condition, where are the major influences of environmental factors, especially anthropic, as for environments that analyzed, missing historical data series, which may give more indication of how ecological situation has changed and which may be the terms of reference to assess the current state [27].

5. References

1. Gliessman S R.: **Agro-ecology: the ecology of sustainable food systems**. 2nd Edition. ed. CRC Press, Boca Raton, FL, 2006.
2. Swanson T M.. **The Economics and Ecology of Biodiversity Decline: the Forces driving Global Changes**. Cambridge University Press, 1995.
3. Andow D.: **Effect of agricultural diversity on insect populations. In: environmentally sound**

agriculture, Lockeretz W. Ed, Praeger, New York. 1983, 91-115.

4. Altieri M A, Nicholls C I, Ponti L.: **Biodiversità e controllo dei litofagi negli agroecosistemi**. Accademia Nazionale Italiana di Entomologia, Firenze, 2003.

5. Caporali F. **Agriculture and Health. The Challenge of Organic Farming**. Editeam, Cento (FE), Italy. 2004.

6. ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale): **Indicatori per la Sostenibilita in Agricoltura.** Linea guida, strumenti e metodi per la valutazione della qualita degli agroecosistemi. Cap.2. Analisi a livello di paesaggi,pp.9-67;Cap.3.Analisi a livello aziendale. 2008, pp.75-153.

7. Jordan N, Boody G, Broussard W, Glover J D, Keeney D, McCown B H., McIsaac G, Muller M, Murray H, Neal J, Pansing C, Turner RE, Warner K, Wyse1 D.: **Sustainable development of the agricultural Bio-economy**. Science, 2007,316: 1570- 1571,

8. De Groot R S.:. **Functions of Nature: Evaluation of Nature in Environmental Planning**. Management, 1992.

9. Costanza R, Darge R, Degroot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'-Neill R.V, Paruelo J, Raskin R.G, Sutton P, Vandenbelt M.:**The value of the world's ecosystem services and natural capital**. Nature, 1997, 387: 253–260

10. Lazzerini G, Vazzana C, Pacini C.G.: **Il ruolo degli indicatori per la costruzione di una metodologia di contabilità ambientale aziendale in agricoltura Simposio internazionale** Le regioni: approcci per uno sviluppo sostenibile Trento, 6 – 7 dicembre.2001.

11. C.E. 2003. Regolamento (CE): **Piano d'azione tecnica 2003 per il miglioramento delle statistiche agricole**. 304/2003.

12. Braun-Blanquet J.:. **Plant sociology.** McGraw Hill, London New York, 1932.

13. Vereijken, J.F.H.M., Gelder, T. van, Baars, T., Nature and landscape development on organic farms. Agriculture, Ecosystems and Environment 1997, 63: 201-220.

14. Shannon F P, Weaver W.: **The Mathematical Theory of Communication.** University Illinois Press, Urbana, 1963,117 pp.

15. Doring T F, Kromp B.: **Whith carabid species benefit from organic agricolture?**-A review of comparative studies in winter cereals from Germany and Switzerland. Agriculture, Ecosystems and Environment 2003, 2068: 1-9,.

16. Smeding F.: **Natuurwaarden van graslandpercelen en perceelsranden op twee alternatieve landbouwbedrijven**. Wageningen (NL), Politecnico Agrario di Wageningen, Dipartimento di Agricoltura Ecologica, 1994, 83p.

17. Canters K J, Tamis W L M.: **Arthropods in grassy field margins in the Wieringermeer. Scope, population development and possible consequences for farm practice.** Landscape and urban planning. 1999, 46: 63-69.

18. Burel F. and Baudry J.: **Species biodiversity in changing agricultural landscapes: A case study in the Pays d'Auge, France.** Agriculture Ecosystems and Environment ,1995, 55: 193-200

19. Burel F.: **Connectivity in agricultural landscapes, its influence on biodiversity at several levels of organization and consequences on managment policies**. Universit. degli Studi di Milano-Bicocca. 2002, 3-14.

20. Hansen A J, Di Castri, F.: **Landscape boundaries: consequences for biotic diversity and ecological flows.** Springer, New York-Berlino. 1992.

21. Farina A.: **Ecotoni. Patterns e processi ai margini**. Cleup, Padova. 1995.

22. Farina A.: **L'ecologia dei sistemi ambientali**. Cleup Editrice, Padova, : 1993, 199p,

23. O'Neil RV.: **Indices of landscape patterns**. Landscape Ecology, 1998:1 – (3),153-162p.

24. Dauvin J C.: **Expertise in coastal zone environmental impact assessment.** Marine Pollution Bulletin. 2005, 50: 107-110.

25. Borja A, Muxika I, Rodriguez J C.: **Paradigmatic response of marine benthic communities to different anthropogenic pressure, using M-AMBI, within the European Water Framework Directive**. Marine Ecology. 2009, 30, 214-227

26. Afli A, Ayari R, Zaabi S.:. **Ecological quality of some Tunisian coast and lagoon locations, by using benthic community parameters and biotic indices.** Estuarine, Coastal and Shelf Science, 2008, 80, 2:269-280.

27. Borja A, Muxika I, Rodriguez J C.: **Paradigmatic response of marine benthic communities to different anthropogenic pressure, using M-AMBI, within the European Water Framework Directive**. Marine Ecology. 2009, 30: 214-227