American Journal of Biology and Life Sciences
2014; 2(6): 191-197
Published online January 20, 2015 (http://www.openscienceonline.com/journal/ajbls)

A study on the levels of biodiversity and sustainability in traditional and conventional vineyards (*Vitis vinifera L., cv. "Shesh i zi"*) through using of bio indexes

Albert Kopali[1], Zydi Teqja[2], Erta Dodona[3], Adrian Doko[1]

[1]Department of Agro-Environment and Ecology, Agricultural University of Tirana, Tirana, Albania
[2]Department of Horticulture and Landscape Architecture, Agricultural University of Tirana, Tirana, Albania
[3]Department of Plant Production, Agricultural University of Tirana, Tirana, Albania

Email address
albertkopali@yahoo.it (A. Kopali)

To cite this article
Albert Kopali, Zydi Teqja, Erta Dodona, Adrian Doko. A Study on the Levels of Biodiversity and Sustainability in Traditional and Conventional Vineyards (*Vitis vinifera L., cv. "Shesh i zi"*) through Using of Bio Indexes. *American Journal of Biology and Life Sciences*. Vol. 2, No. 6, 2014, pp. 191-197.

Abstract
The variability of life forms is the key of maintaining and guaranteeing of ecological equilibrium in the terrestrial ecosystem. Loosing of species implies reduction of the genetic richness in natural conditions. The presence of many beneficial species is very significant for the biodiversity evaluation. Species presence in agro ecosystems is an indicator of quality and they are considered as bio indexes. Using of bio indexes has been applied widely during last times aiming the evaluation of agro ecosystem diversity and stability. This study analyses the use of bio indexes on two types of agro ecosystems (traditional and conventional), in several levels, aiming the evaluation of their biological complexity and the differences created as a result of different management techniques, the stability of organisms community and agro ecosystem sustainability also.

Keywords
Biodiversity, Agro Ecosystem, Bio Indexes, Biological Complexity

1. Introduction

Agro ecosystems (cultivated areas) actually represent more than 24% of world land area (MEA, 2005). Biodiversity in agro ecosystems is defined as agro biodiversity, that is richness of varieties, races, life forms and genotypes, and as a presence of different types of habitats, of structural elements (like fences, marshes etc.), crops and different types of landscape management (Büchs, 2003). There are many ecological functions played by biodiversity in agricultural systems, but just a little about them is well-known. Besides plants and animals, the biodiversity has a very special importance because it is part of and guides many ecological processes. The relationship and interdependency between agriculture and biodiversity create the possibility for a better management of resources in our disposal and increase the stability of agro ecosystems. Many are the negative effects of modern agriculture as reduction of plant and animal biodiversity of the use of pesticides (Holzschuh,2007). The data studies comparing energy costs for cultural systems in the regime of biological and conventional agriculture (Gomiero et.al.,2008). The modifications and intensive practices of cropping have changed their structure and functionality; landscapes are modified, habitats are lost, a big number of wild species are disappeared because of the fragmentation of the territory and the genetic erosion of domesticated species. This process of cultural simplification has made it possible that actually worldwide we crop just 12 species of cereals, 23 species of vegetables and 35 species of fruit trees (Fowler et al., 1990). Natural ecosystems maintain a level of biodiversity that guarantees their sustainability over time, something which does not happen in conventional ecosystems. Agro ecological principles represent nowadays a helpful basic knowledge to promote a conversion of agriculture towards a greater sustainability and environmental compatibility (Caporali, 2004). Given that in sustainable agricultural systems they who apply agriculture have deep knowledge, based on their tradition, of biodiversity and its components, it is necessary that this knowledge be integrated in new agricultural schemes in order to sustain and develop the resources of rural territories (Altieri et al., 1991). From the technical side it is necessary to determine multifunctional agricultural systems that react to the maintenance of biodiversity aiming protection of plants from their enemies, improvement of soil fertility, integration of herbaceous plants cropping with fruit trees, integration of cultivated areas with non cultivated and integration of cropping with livestock breeding (Altieri et al., 2003). Consequently, the greater the diversity of the system the greater its adaptability to changes and lower its relative fragility and vulnerability (Andreella, et.al., 2010). Since agriculture is a form of land use that combines natural and human components and processes, it is needed that inside of agricultural areas, which represent considerable space, we should maintain the inner biodiversity of agricultural systems. In practice it is required that agriculture should play a multifunctional role (Jordan et al., 2007), with socio-economic and environmental valence. Precisely this study, through an analysis in several levels using bio indexes, aims the determination of structural and functional differences in two types of agro ecosystems; differences on the levels of biodiversity and the impact on their stability.

2. Materials and Methods

2.1. Study Area

This study analyses two types of agro ecosystems: traditional and conventional cropping of grapes (*Vitis vinifera L., cv. "Shesh i zi"*). The vineyards are located in a hilly area of Ndroq commune, in Tirana district. The practice of traditional grape cropping is old in this area. The practices of natural vegetal cover, compost application and green manure are applied in a vineyard of an area of 0.3 Ha. In the study area there is another vineyard where the intensive practices (conventional) are applied. The area of this vineyard is about 0.4 Ha.

2.2. Study Design

Different indexes based on different biotic and a biotic criteria are used to evaluate and compare farms sustainability and the structural biodiversity levels, consequence of different cropping practices (Dauvin 2005; 2007). A new legislation is developed during last years as is the case of *WFD* (*Water Framework Directive "Directive 2000/60/EC)*. WFD establishes a framework for community action for water and it is considered the most important legislation of last 20 years (Andersen et al., 2004). Aiming to apply what WFD has foreseen, the concept of *EcoQ* (Ecological Quality Status), is developed to make evaluation of environment status. *Ecological Quality Status* describes the quality of structure and ecosystem functioning. Different indexes are proposed to evaluate *EcoQ* (Ecological Quality Status) (Henocque et al. 2003; Borja et al., 2004; Casazza et al., 2004). Several classification schemes are set up, including structural indexes Shannon-Wiener (1949*)*, that allow the classification of five ecological statuses, with their threshold values of H'. The classifications for H' are considered as a data for environmental stress and evaluate the ecological qualities of the environment (Vincent et al., 2002).

Table 1. *Threshold values of different EcoQ for H'*

EcoQ	H'
High	H'> 4
Good	3 < H' < 4
Moderate	2 < H' < 3
Poor	1 < H' < 2
Bad	H' < 1

Different groups of organisms are used as bio indexes to evaluate environmental qualities (sustainability) and the level of biodiversity. The necessary data are collected for each of the bio indexes from both types of farms and calculating formula according to the index and their optimum values are used to make the analyses.

2.3. Data Analysis

This analysis is done in several levels: *In the underground strata* of cultivated soil, the components of edaphic fauna are analyzed: diptera (crane flies, gnats, mosquitoes, horse, robber flies, bee flies etc.); hymenopterans such as honeybees and true ants; colembula or springtails such as leaf litter, logs, dung, cave, etc.; arachnids: scorpions, pseudo scorpion; opilionida, pedipalpida (whip scorpions) and acarina, horseshoe crabs, ticks, mites etc. and proturans. According to a standard methodology soil samples are taken from both systems and the presence of micro arthropods is analyzed through a Berlese-Tüllgren selector (1905), (Dry-funnel methods). The samples are analyzed in laboratory for their identification according to the respective classes for both systems. The soil biological quality is evaluated through using of *QBS index (Quality Biological Status)* (Parisi et al.2005, Menta et al., 2008). The level of diversity of all samples is analyzed through *QBS*, *Shanon diversity index* (Shannon and Weaver 1949) and *species richness index* (Simpson 1949). *Shannon-Wiener* index *(H')* is: $DST = - \Sigma^{n}{}_{1}(Ps * \log_{n} Ps)$; where: s = number of verified species; Ps = % of any species presence compared to the total, expresses the structural diversity. The optimum value: $X>2$. This is the most used index in the ecological analysis (Vincent et al., 2002; Bouchet et al., 2008). It allowed us to measure the diversity of species present (*taxa*), considering both the specific richness and equilibrium: $H = - \Sigma(ni/N)\log(ni/N)$, where: ni = the number of individuals "*i*" specie; N= the total number of individuals. *Simpson diversity index* (Simpson 1949) is: $D=1/\Sigma pi^{2}$, serves to express both the number of community species and the way the organisms are distributed for different species. The differences found for bio diversity values (based on bio diversity indexes *Shannon-Wiener* (1949) and *Simpson* (1949), are evaluated by using the variance analysis (Anderson 2001; 2005).

At the ground area, at parcel level, the components of above ground fauna and the floristic composition (spontaneous vegetation) are analyzed. The number of fauna groups present (*taxa*) (invertebrate community like arachnids: acaries, gastropods (land snails and land slugs), myriapods (millipedes, centipedes), diptera etc.), and their diversity is evaluated. To analyze the target entomological species (*arthropods*), sampling is done through pitfall traps method. In each parcel, during the period March to June, every 15 days, 3-5 traps are located in three different positions in a distance of 10 meters in between them. During sampling the data are registered and the species trapped are identified in our laboratory. The index of structural diversity is evaluated by comparing the calculated values with the optimum ones. The optimum values are $X>2$. The index of richness of target species is calculated as the sum of identified species compared to the threshold optimum value ($X > 25$) (ISPRA, 2008). A portable aspiration device is used for sampling, aiming to analyze entomological species at order/family level. In each parcel, in three different positions, 3m from each other at least 10 aspirations are done. The aspirations are repeated every 15-30 days during the period from March to June. The species caught are identified in laboratory. The index of structural diversity is calculated by Shannon index: $DSA = - \Sigma^{n}{}_{1}(Ps * log_{n} Ps);$ where*:* s = number of species identified; Ps = % of every species presence compared to total. The optimum values are $X>2$.

At the ground area, the analysis of herbaceous species at parcel level is accomplished to evaluate the density of species according to the floristic method Braun-Blanquet (1932) which consists on the eye evaluation of the relative quantity of different wild species (coefficient of density/dominance) present at parcel surface and evaluates the particular species covering in percentage (Cappelletti 1976; Pignatti 2005) and after that transforming them in digital terms (Van der Maarel,1972). Recording is done on an area of 100 m^2. The diversity of herbaceous species at parcel level (*Field species diversity*) is calculated by diversity index of Shannon, based on a optimum values $X>2$. The richness of herbaceous species at parcel level (*Field species richness*) is calculated as the sum of recorded species. The optimum values are $X>40$.

In the Ecological Infrastructures (Ecological Infrastructure Diversity) (IOBC-OILB, 2004), which represents an important element for functioning potentials for a given ecosystem (Canters et al., 1999, Vereijken et al., 1997, Bure et al., 1995, Burel 2002, Hansen et al., 1992, Farina 1995), a*t farm level* the analysis for herbaceous and wood species at the level of ecological infrastructures is done by the method Braun-Blanquet (1932). The method foresees the division of linear elements in sub units with 100 m length for which all species presence and the percentage of density/dominance are registered in a file (the value Braun-Blanquet). The analysis of wood and herbaceous species in linear ecological infrastructures is done by using the linear analysis method through recording every 50 meters species that are met in 100 cm. The species diversity (both herbaceous and wood species) in ecological infrastructures (*Ecological Infrastructure Diversity*) is calculated through Shannon diversity index (Shannon et al., 1949). The richness of species (both herbaceous and wood species) at the level of ecological infrastructure (*Ecological Infrastructure Species Richness)* is calculated by Simson index (Simpson 1949).

The presence of spaces with natural vegetation (*ecological infrastructure*), at agricultural landscape level (Smeding 1994; Canters et al., 1999; Burel et al., 1995; Burel 2002; Hansen et al., 1992; Farina 1995) is analyzed by the *diversity of cultivated plants index of Shannon* (Farina 1993; O'Neil 1998) and the *index of quality of landscape elements* (Lazzerini et al., 2001).

3. Results and Discussions

For a careful evaluation of the environmental status in both types of agro ecosystems the foreseen indexes from *WFD* (*Water Framework Directive "Directive 2000/60/EC)* are applied. The data taken during spring of 2011 and 2012 at underground strata for the parcel level, with sampling method, are analyzed for edaphic fauna components, micro arthropods, in each of cropping systems (traditional and conventional vineyards). For these data that belongs to three samples, *QBS (Quality Biological Status) index, diversity index of Shannon* and *species richness index of Simpson* are calculated. The values of indexes taken are compared with predetermined optimum values. For *Shannon index (H')* the calculated values are used to prescribe the ecological status according to *EcoQ index (Ecological Quality Status),* foreseen from *WFD*.

From the analysis represented at table 2 it is shown that there are obvious differences between conventional and traditional cropping regarding edaphic fauna (*micro arthropods*). These differences are highlighted by not just *QBS* values, where there are obvious differences between conventional and traditional cropping, but by diversity indexes Shannon and Simpson. This situation is observed by other previous studies also (Gomez et al., 2006). *QBS index (Ecological Quality Status)*, for year 2011 from 49 in conventional system goes to 114 for the traditional system and from 53 for year 2012 in the conventional system, goes to 118 for the traditional system. Based on the values of this index we can conclude that traditional cropping obviously improves the ecological quality status of the vineyard. In the traditional cropping system of the vineyard, Shannon diversity index is 2.3 (X>2), while this value for the conventional cropping system of vineyard resulted to be 1.2 (X>2), so being much lower than the optimum threshold value. Likewise for the index of species richness of Simpson it results to have a difference of 9-11 species more in the traditional system compared to the conventional one. The values of conventional system are lower than the optimum threshold values: 14 (X>25) for year 2011 and 16 (X>25) for year 2012.

Analyzing the technical files it resulted that there have been accomplished a relatively high number of applications, especially soil milling, resulting with soil compactness and lack of aeration that seem to be the main factors in this process, because regarding other studies it is seen that soil structure impacts the diversity and edaphic community structure even more that pH and organic matter (Sessitsch et al., 2001). Similar results are achieved by other authors also (Paoletti 1999). Frequent applications of herbicides and pesticides, their deposition at underground strata have impoverished especially the presence of arthropods. A much better situation is observed in traditional cropping system that is impacted by the applications accomplished in this case. For both years of the study, threshold values of *EcoQ,* using variance analysis (Anderson 2001), are calculated for *H'* index which determine the ecological status in both cropping systems (table 3).

Tabele 2. *QBS and edaphic diversity fauna indexes according to cropping systems*

Cropping system	Indexes					
	Year 2011			Year 2012		
	QBS	The Shannon diversity index (Optimum value X> 2)	The Simpson species richness index (no.) (Optimum value X> 25)	QBS	The Shannon diversity index (Optimum value X> 2)	The Simpson species richness index (no.) (Optimum value X> 25)
Conventional cropping vineyard	49	1.2	14	53	1.3	16
Traditional cropping vineyard	114	2.3	23	118	2.5	27

Table 3. *Threshold values of EcoQ for H' index in two different cropping systems*

Cropping system	Year 2011			Year 2012		
	EcoQ	H'	Threshold values of EcoQ	EcoQ	H'	Threshold values of EcoQ
Conventional cropping vineyard	Poor	1.2	1 < H' < 2	Poor	1.3	1 < H' < 2
Traditional cropping vineyard	Good	2.3	3 < H' < 4	Good	2.5	3 < H' < 4

The results shown in table 3 demonstrate that in parcels managed by traditional practices there is an edaphic community richer and more diversified, though the values are not "*high*", according to *EcoQ (Ecological Quality Status).* Based on the data taken, according to *EcoQ* index and the determined threshold values, the ecological status in the traditional vineyard is considered "*good*", while in the conventional cropping system, *EcoQ* index gives "*poor*" values. The "*poor"* environmental status according to the values foreseen by *WFD*, shows that the practices of conventional cropping bring in the environment consequences for edaphic fauna communities that are difficult, if not impossible to be repaired (Mocali et al., 2008).

From the analysis of the data taken at the ground level, regarding above ground fauna the target groups (*richness of target species*), arthropods including coleopterans, acarie, gastropods, myriapods, opilione, diptera etc. using *species richness index* (Simpson) and *Shannon diversity index* it is demonstrated a higher degree of diversity in traditional cropping compared to conventional cropping with significant differences especially for the presence of coleopterans and diptera larve (Table 4).

Table 4. *Values of indexes of entomological species richness and structural diversity of Shannon in two cropping systems*

Cropping system	Year 2011		Year 2012	
	Index species richness (no.) (Optimum value X> 25)	The Shannon diversity index (Optimum value X> 2)	Index species richness (no.) (Optimum value X> 25)	The Shannon diversity index (Optimum value X> 2)
Conventional cropping vineyard	19	1.4	22	1.7
Traditional cropping vineyard	35	2.6	38	2.9

It can be seen that in conventional system the richness of species is obviously lower not just compared to the traditional vineyard, in both years of study, but lower than threshold optimum values (Index of species richness is 19 in 2011 and 22 in 2012, compared to the optimum value 25). Likewise the values of Shannon diversity index for conventional vineyard are 1.4 and 1.7, respectively for year 2011 and 2012, so they are lower than threshold optimum value (X>2). Meanwhile these values for the traditional vineyard are relatively good and higher than the threshold optimum value; respectively 2.6 and 2.p for year 2011 and 2012, compared to X>2.

The above shown results demonstrate the fact that in vineyards with conventional management practices, especially those related to the control of vineyard pests and diseases, the number of the target groups of above ground fauna (*arthropods*) is considerably reduced. So, by analyzing the entomological species at order/family level, based on the sampling accomplished at parcel level, the index of species richness and Shannon diversity index resulted to be as shown in Table 5:

Table 5. *Index values of entomological species at order/family level at ground strata*

Cropping system	Year 2011		Year 2012	
	Index species Richness (no.) (Optimum value X> 25)	**The Shannon Diversity index (Optimum value X> 2)**	**Index species Richness (no.) (Optimum value X> 25)**	**The Shannon Diversity index (Optimum value X> 2)**
Conventional cropping vineyard	21	1.5	23	1.9
Traditional cropping vineyard	38	2.8	41	3.1

From the other side regarding the analysis of entomological species at order/family level, based on *structural diversity index* of Shannon, compared to index optimum values, there are significant differences between cropping systems with a clear advantages of the traditional system. Species richness index fluctuate from 21 to 38 (X>25) for year 20011 and from 23 to 41 (X>25) for year 2012, while Shannon diversity index fluctuate from 1.5 to 2.8 (X>2) for year 2011 and from 1.9 to 3.1 (X>2) for year 2012. The values belong respectively for the conventional cropping system (*lower values*) and for the traditional cropping system (*higher values*).

To study floristic composition (*herbaceous species*) at parcel level, herbaceous species diversity at parcel level through using of Shannon diversity index (*Field species diversity*) is analyzed and compared to optimum values. The analysis of data taken, through Braun-Blanquet method (1932), demonstrates differences of richness and diversity between two cropping systems (Table 6).

Table 6. *Values of richness index and Shannon diversity index for herbaceous components at parcel level during year 2011 and 2012*

Cropping system	Year 2011		Year 2012	
	Index species richness (no.) (Optimum value X> 35)	**The Shannon diversity index (Optimum value X> 2)**	**Index species richness (no.) (Optimum value X> 35)**	**The Shannon diversity index (Optimum value X> 2)**
Conventional cropping vineyard	18	1.3	24	1.7
Traditional cropping vineyard	42	2.6	56	3.0

During two years of this study 74 herbaceous species are registered in both farms altogether belonging to 18 different families. The analysis was concentrated within the parcel and from the data collected it was demonstrated that the traditional farm was more sustainable both regarding species richness and their diversity also. Similar results are demonstrated by other previous studies also (Altieri et al., 2003, Vandermeer et al., 1995, Lazzerini et al., 2007; Migliorini et al., 2007).

The analysis of species diversity (both herbaceous and woody species) in ecological infrastructure (*Ecological Infrastructure Diversity*), at farm level, based on the data calculated by using Braun-Blanquette (1932) method, shows the differences between two different cropping systems (Table 7).

Table 7. *Values of species richness and species diversity for floristic components at farm level (Ecological Infrastructure Diversity).*

Cropping system	Year 2011		Year 2012	
	Index species richness (no.) (Optimum value X> 40)	**The Shannon diversity index (Optimum value X> 2)**	**Index species richness (no.) (Optimum value X> 40)**	**The Shannon diversity index (Optimum value X> 2)**
Conventional cropping vineyard	14	1.1	19	1.3
Traditional cropping vineyard	38	2.1	48	2.4

From the analysis of structural diversity and species richness for ecological infrastructures at farm level there are obvious differences that range from 14 to 38 (X>40) in year 2011 and from 19 to 48 (X>40) for year 2012, respectively for conventional vineyard and traditional vineyard.

Likewise interesting results are taken from the analysis for the *presence of spaces with natural vegetation* (*ecological infrastructure*) at landscape level, accomplished through Shannon diversity of cultivated plants index and through the index of quality of landscape elements (Table 8).

Table 8. *Analysis of landscape quality*

Cultivation system	Year 2011			Year 2012		
	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 cropping vineyard	1.4	0.8	4	1.5	1.1	5
Traditional cropping vineyard	3.7	1.1	15	3.8	1.4	16
Optimum values (X)	X -= 3-5%	X = 0.8-1	X>15	X -= 3-5%	X = 0.8-1	X>15

The data in Table 5 demonstrate that spaces with natural vegetation in traditional vineyard are higher compared to conventional vineyard ranging from 3.7 to 1.4 (the optimum value is X=3-5%) for year 2011 and from 3.8 to 1.5 for year 2012. In the traditional vineyard for both years of the study the values of busy areas with natural spaces is within optimum values. Likewise the index of diversity of cultivated plants resulted to be 1.1 in traditional vineyard and 0.8 in conventional vineyard (optimum values X=0.8-1) for year 2011 and it fluctuated from 1.4 in traditional vineyard to 1.1 in conventional one, for year 2012. In this case the index values for the traditional vineyard are within optimum values also.

A very important index analyzed at agricultural landscape level is the quality of landscape (eco mosaic). This index fluctuates from 15 in the traditional vineyard to 4 for the conventional vineyard in year 2011 (Optimum values X>15) and from 16 to 5 respectively for traditional and conventional vineyards in year 2012. In both years of this study the index values are within optimum threshold values.

4. Conclusions

The data observed through this study demonstrate the importance of bio indicator system application as significant indexes to evaluate the sustainability and environment qualities in different cropping systems characterized by different degrees of human intervention. The conclusions of this study are similar to some other previous studies (Dauvin et al., 2007).

The application of different indexes gives different data for sustainability and environmental qualities evaluation of different types of agro ecosystems dominated by different degrees of human intervention. This argues the fact that there is not universal indicators that could be applied in all situations (Borja et al., 2009) and that to achieve a good evaluation for the level of biodiversity and sustainability of agro ecosystems, it is necessary to integrate these indexes.

From the analysis accomplished in several levels, in this study it results that the agro ecosystem type that has a more negative behavior in terms of biodiversity and sustainability is the system with conventional management practices, with implications in the quality of environment and system functioning also.

The evaluations of this study regarding *EcoQ (Ecological Quality Status),* for conventional cropping systems, demonstrate that this index results with lower values than the optimum ones, fact that tells the impact of frequency of human intervention in these agro ecosystems.

The analysis demonstrate also the fact that the quality of landscape in conventional cropping systems is much lower that the optimum values of reference and this fact reflects the lack of ecological Infrastructures at agricultural landscape level.

Similar to what is demonstrated by other previous studies (Borja et al., 2009), this study shows also that the lack of series of chronological data, brings limitations to its findings and underline the need to continue this kind of study in the future (Muxika et al., 2007).

References

[1] Andersen, J.H., Conley, D.J., Hedal, S. (2005).Palaeoecology, reference conditions and classification of ecological status: the EU Water Framework Directive in practice. Marine Pollution Bulletin 49, 283-290.

[2] Anderson, M.J. (2001). A new method for non-parametric multivariate analysis of variance. Austral Ecology 26, 32–46.

[3] Anderson M.J. (2005). PERMANOVA: a FORTRAN computer program for per mutational multivariate analysis of variance. Dep. of Statistics, Univ. Auckland, New Zeland.

[4] Andreella M., Duprè E., (2010). Now there is a shared strategy. Ecoscienza 3, 12-13.

[5] Altieri M.A, Hecht S.B. (1991). Agroecology and small farm development. CRC Press, Boca Raton, FL.

[6] Altieri M.A., Nicholls C.I.(2003). Ponti L. Biodiversità e controllo dei litofagi negli agroecosistemi. Accademia Nazionale Italiana di Entomologia, Firenze.

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

[8] Bouchet V.M.P. & Sauriau P.G. (2008). Influence of culture practices and environmental conditions on the ecological quality status of intertidal mudflats devoted to oyster-farming in the Pertuis Charentais (SW France). Marine Pollution Bulletin, 56, 1898-1912.

[9] Braun-Blanquet J. (1932). Plant sociology. McGraw Hill, London New York.

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

[11] Burel, F. (2002). Connectivity in agricultural landscapes, its influence on biodiversity at several levels of organization and consequences on managment policies. Universit. degli Studi di Milano-Bicocca. 3-14.

[12] Büchs W.(2003). Biodiversity and agri-environmental indexes-general scopes and skills with special reference to the habitat level. Agriculture, Ecosystem and Environment, 98: 35-78.

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

[14] Caporali F. (2004). Agriculture and Health. The Challenge of Organic Farming. Editeam, Cento (FE), Italy.

[15] Cappelletti C. (1976). Trattato di botanica, Utet, Torino.

[16] Casazza, G., Lopez Y Royo, C., Silvestri, C. (2004).Implementation of the 2000/60/EC Directive, for coastal waters, in the Mediterranean ecoregion. The importance of biological elements and of an ecoregional co-shared application. Biologia Marina Mediterranea 11 (1),12 e 24.

[17] Dauvin, J.C. (2005). Expertise in coastal zone environmental impact assessment. Marine Pollution Bulletin 50, 107-110.

[18] Dauvin, J.C.(2007). Paradox of estuarine quality: Benthic indexes and indices, consensus or debate for the future. Marine Pollution Bulletin 55, 271-281.

[19] Farina A. (1993). L'ecologia dei sistemi ambientali. Cleup Editrice, Padova, : 199 p.

[20] Farina, A.(1990). Ecotoni. Patterns e processi ai margini. Cleup, Padova. 1995

[21] Fowler C., Mooney P. Shattering. Food, politics and the loos of genetic diversity. The University of Arizona Press, Tucson, AZ.

[22] Gomez E., Ferreras L., Toresani S.(2006). Soil bacterial functional diversity as influenced by organic amendement application. Bioresour. Technol., 97(13): 1484-1489.

[23] Gomiero T., Pimentel D.,Paoletti M.G.(2008). Energy andf environmental issue in organic and conventional agriculture.Critical Reviews in Plant Science 27,239-254.

[24] Jordan N., Boody G.,Broussard W.,Glover J.D.,Kenney D.,McCown D.,McIsaac G.,Muller M.,Murray H.,Neal J.,Pansing C.,Turner R.E.,Warner K. And Wyse D. (2007). Sustainable development of the agricultural Bio-economy. Science, , 316 (5831), 1570-1571.

[25] Hansen, A.J., Di Castri, F.(1992). Landscape boundaries: consequences for biotic diversit. and ecological flows. Springer, New York-Berlino.

[26] Henocque, Y., Andral, B.(2003). The French approach to managing water resources in the Mediterranean and the new European Water Framework Directive. Marine Pollution Bulletin 47, 155e161.IM.

[27] Holzschuh A., Steffan-Dewenter I.,Kleijn D.,Tscharntke T., (2007). Diversity of flower-visiting bees in cereal fields; effects of farming system, landscape composition and regional context. Journal of Applied Ecology 44, 41-49.

[28] IOBC OILB. (2004). Ecological Infrastructures, Idealbook on Functional Biodiversity at the farm level. Swiss centre for Agricultural Extension and Rural Development (LBL), Switzerland.

[29] ISPRA, Manuali e linee guida 47/2008 (2008)- Linee guida, strumenti e metodi per la valutazione della qualità degli agroecosistemi. ISBN 978-88-448-0337-7.

[30] Lazzerini G, Vazzana C, Pacini C.G.(2001). Il ruolo degli indexi 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..

[31] Lazzerini G., Camera A., Benedettelli S., Vazzana C.(2007). The role of field margins in agro-biodiversity management at the farm level. Italian Journal of Agronomy, 2: 127-134.

[32] MEA (Millennium Ecosystem Assessment). (2005). Ecosystems and Human Well-being: Biodiversity Synthesis.

[33] Menta C. et al.: (2008). Nematode and microarthropod communities: comparative use of soil quality bioindexes in covered dump and natural soils. Env. Bioind, 3(1): 35-46..

[34] Migliorini P., Vazzana C. (2007). Biodiversity Indexes for sustainability evaluation of conventional and organic agro-ecosystems. Italian Journal of Agronomy, 2: 105-110.

[35] Mocali S., Paffetti D., Emiliani G., Benedetti A., Fani R. (2008). Diversity of heterotrophic aerobic cultivable microbial communities of soils treated with fumigants and dynamics of metabolic, microbial, and mineralization quotients. Biol. Fertil. Soils, 44: 557-569.

[36] Muxika, I., Borja, Á., Bald, J. (2007). Using historical data, expert judgement and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European Water Framework Directive. Marine Pollution Bulletin 55, 16–29.

[37] O'Neil R.V. (1998). Indices of landscape patterns. Landscape Ecology, :1 – (3),153-162p.

[38] Paoletti M.G. (1999). Invertebrate biodiversity as bioindexes of sustainable landscapes. Elsevier,p. 447.

[39] Parisi, V.(2001).La qualita. biologica del suolo. Un metodo basato sui microartropodi. Acta Naturalia de Lõateneo parmense. 37:100-114.

[40] Parisi V. et al. (2005). Microarthropod communities as a tool to assess soil quality and biodiversity: a new approach in Italy.Agr. Ecosyst. & Ecol, 105: 323-333.

[41] Sessitsch A., Weilharter A., Gerzabek M.H., Kirchmann H., Kandeler E. (2001). Microbial population structures in soil particle size fractions of a long-term fertilizer field experiment. Appl. Environ. Microbiol., 67:4215– 4224.

[42] Simpson E.H. (1949). Measurement of diversity. Nature, 163: 688.

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

[44] Shannon C. E. and Weaver W. (1949). The mathematical theory of communication. Urbana, IL: Universityne fo Illinois Press.cited in Magurran, A. E., 2004, Measuring biological diversity, Blackwell Publishing: Oxford, UK.256 p,

[45] Vandermeet J., Perfecto I. (1995). Breakfast of biodiversity. Food First Books, Oakland, California, UK.

[46] Vereijken, J.F.H.M. Van Gelder, T. Baars, T. (1997). Nature and landscape development on organic farms. Agricolture Ecosystems and Environment 63:201-220.

[47] Vincent C, McConnell BJ, Ridoux V, Fedak M.A. (2002). Assesment of Argos location accuracy from sattelite tags deployed on captive gray seals. Mar Mamm Sci 18: 156–166.

[48] Vincent, P., S.D. Desai, J. Dorandeu, M. Ablain, B. Soussi, P.S. Callahan, B.J. Haines. (2002). Jason-1: first statistical validation results, 34-th COSPAR Scientific Assembly, Houston (USA).

[49] Water Framework Directive "Directive 2000/60/EC" (2000). (WFD).