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Evaluation of agricultural crops biodiversity in Iran: a case study in Kermanshah province during 2003-2012

Shahla Allahyari*, Saeid Jalali Honarmand, Farzad Mondani, Mahmood Khoramivafa

Department of Agronomy and Plant Breeding Department, Campus of Agriculture and Natural Resources, Razi University, Kermanshah, Iran

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Abstract

Plants and animals biodiversity affects the ecological functions of natural and agricultural systems. Therefore, reduction of biodiversity can be a serious threat for survival of ecological systems. Data were carefully provided from Ministry of Agriculture of Iran during 2003-2012. The results of diversity indexes indicated high biodiversity in Kermanshah province. They showed that a diversity of agricultural products, including field and horticultural crops, are cultivated in Kermanshah province. Of the different counties in the province, Paveh and Harsin had the highest Shannon index while Qasr-e-Shirin had the lowest value. The trend of Shannon species diversity index of the agricultural crops showed significant temporal variations over 2003-2012 and also among the counties of the province. Shannon species diversity index for the agricultural crops in the province over 2003-2012 showed the highest and lowest values in 2010 (1.77) and 2005 (1.49), respectively. The overall trend of Shannon index of the agricultural crops of the province was increasing during these 10 years.

***Corresponding Author:** Shahla Allahyari ✉ Shahla_allahyari@yahoo.com

Introduction

Biodiversity is the variety within the organisms of the universe, including xerophilous and aquatic ones, and hierarchically owns three diversity levels of intraspecific, interspecific and ecosystem diversity (Ghorbani, 2010). Plant and animal biodiversity are considered as factors which affect the functions of agricultural and natural ecosystems (Altieri, 1999). Thus a biodiversity decline is deemed as a serious threat to the survival of those ecosystems (Tscharntke, 2012).

Demand of food and other agricultural crops is increasing by population growth; therefore, the maintenance of biodiversity is one of the main concerns of ecologists and policy-makers (Falco *et al.*, 2010; Didier le *et al.*, 2002). Nowadays, the extinction rate of plant and animal species is increased due to human's destructive activities especially in agriculture sector, which thereinafter decreased the stability of ecosystems (Pimentel *et al.*, 1992; Tilman *et al.*, 2001; Foley *et al.*, 2005). Biodiversity enhancement plays a critical role in maintaining ecosystems and this has raised its importance. This holds true as an increase in the number of the species of a region. On the one hand, it augments the structural complexities and on the other hand promotes the ecosystems' ability in responding to the occurrence of any environmental change (Jenkins, 1998). The role of the ecological biodiversity is clearly apparent in food production, pest management, weeds and diseases science, soil fertility and biodiversity enhancement of soil organisms, decreasing dependency on external items and energy conservation (Falco *et al.*, 2010; Didier le *et al.*, 2002; Lijbert *et al.*, 2007). Therefore, studying agricultural biodiversity and protecting it has been at the center of ecologists attentions, especially in recent years (Pimentel *et al.*, 1992).

Ecologists have suggested various methods for the evaluation and quantification of biodiversity. The simplest one which is called "species richness" is obtained by counting plant species in a region. There are numerous indicators for species richness, each one illustrating the richness of region by a number, but among them counting the total number of species is the most popular (Meff *et al.*, 1997; Nasiri-Mahallati *et al.*, 2002; Ghorbani, 2010). As indicator of species richness does not consider the abundance of species, it's not a precise way for the evaluation of biodiversity (Meff *et al.*, 1997; Nasiri Mahallati *et al.*, 2002). The Shannon diversity index is most used mostly included among the biodiversity evaluation's indices. This index is a combination of species richness and uniformity between species (Barnes, 1998; Magurran, 1988; Smale *et al.*, 2003). Its value increases by the number of the species in a given community and it could theoretically reach to high values too. The greater Shannon index, the more divided the dominance to more species which deducts from the sensitivity of the ecology with respect to environmental changes (Ghorbani, 2010). Although the importance of biodiversity is expressed by scholars (Altieri, 1999; Foley *et al.*, 2005; Godfray *et al.*, 2010; Jenkins, 1998; Jackson *et al.*, 2009; Pimentel *et al.*, 1992; Power, 2010; Tilman *et al.*, 2001; Tscharntke *et al.*, 2012; Tscharntke *et al.*, 2005), there is little information in this regard (Naeem *et al.*, 1995) and the consensus is on that we could intensify the intrinsic complexities of ecologies by increasing diversity which in turn would yield an improvement in the processes (Altieri, 1999).

Among Iran's provinces, Kermanshah has devoted a great share of the agricultural products due to its continental conditions. In this regard, for instance, the biodiversity of the horticultural crops of Kermanshah province was reported as desired in evaluating the biodiversity of Iran's vegetables and horticultural crops (Koocheki *et al.*, 2005). However, to reach a better understanding of biodiversity's importance it is urgent need to conduct such studies more precisely. Regarding the importance of the subject, this study, therefore, is conducted to evaluate the biodiversity trend of the agricultural crops of Kermanshah province, separately for each County of

the province and over a 10-year time span during 2003-2012.

Materials and methods

Site description

This study was carried out during 2003-2012 in Kermanshah, western Iran. Kermanshah province with an area over 2,339,000 hectares is geographically located at 31°33' to 17°35'N and 23°35' to 50°38'E. This province is consisted of 14 counties including Dalaho; Gilan-e-gharb; Harsin; Islamabad-e-gharb; Javanrod; Kangavar; Kermanshah; Paveh; Qasr-e-Shirin; Ravansar; Sahneh; Sarpol-e-Zahab; Salas-e-Babajaniand Songhor. Its average annual precipitation is around 537 mm, i.e. 270 mm higher than the mean annual precipitation of Iran. The average annual temperature is about 13.2°C (www.kermanshahmet.ir).

The total agricultural land areas of the province is 933,000 hectares (excluding fallow land) of which 228,000 (equivalent to 23.3%) and 663,500 (equivalent to 71%) hectares is allocated to irrigated and rainfed lands, respectively and 33,200 hectares to horticultural products (irrigated and rainfed/ equivalent to 3.6%) (www.kermanshah.agri-jahad.ir).

Methodology

To perform this study the required agricultural products information has been collected from 14 counties of Kermanshah province over 2003-2012. This information has been obtained from Kermanshah Agriculture of Jahad Organization using specifically created questionnaires and also case interview with relevant authorities.

Biodiversity Indices of Products

Species Richness

Species richness is a determinant presence of various species and is obtained through the enumeration of plant species in a region. There are invented numerous indicators for species richness, each one depicting this richness by a specific number. However, enumerating the total number of the species is the most common one (Ghorbani, 2010).

Shannon Species Diversity Index

Shannon species diversity index (H) is in fact a hybrid indicator of species richness and uniformity (Barnes, 1998; Magurran, 1988).

Formulae

(1) $$H = -\sum Pi \times Ln\ Pi$$

Where, $= \frac{n_i}{N}$, n_i is the number of the individuals (biomass) of each species (species i) and N accounts for the total number of the individuals (total biomass) of a given region. $\frac{n_i}{N}$ represents the ratio or the relative species abundance. To calculate Shannon index, $\frac{n_i}{N}$ is set as the cultivation area of each county divided by the cultivation area of the province. Shannon index is more than or equal to zero and its higher value indicates more diversity of crop species.

Results and discussion

Species Richness

The results showed that the agricultural crops were cultivated in Kermanshah province, including field and horticultural crops had a good diversity partly. Tables 1 and 2 illustrate different groups of cultivable field and horticultural crops. Amongst the field crops, farmers regardless the cultivation area were interested in cultivating cereal and legumes group especially wheat, barley and pea. On the other hand, among the horticultural plants, this interest in most counties holds for all cultivable crops including fruit with seeds, nucifer fruits, granule fruits, dried fruits and tropical and subtropical fruits.

Table 3 depicts the species richness of different counties with respect to the agricultural crops over 2003-2012. The results demonstrated different species richness for different counties during the consecutive years.

The species richness in the counties was mostly affected by the cultivation of horticultural crops. Moreover, the share of cultivable horticultural plants were higher than field crops, which indicated that the farmers were more interested in cultivating horticultural plants. Amongst the counties of Kermanshah province, Harsin, Kermanshah and Sahneh had the most number of species while the least numbers were grown in Qasr-e-Shirin and Paveh.

Table 1. Different fruits groups and the number of cultivated species in Kermanshah province

Tropical and subtropical fruits	Dried fruits	Granule fruits	Nucifer fruits	Fruit with seeds
Date	Pistachio	Grapes	BlackCherry	Apple
Fig	Almonds	Mulberry Tree	Cherry	Pears
Citrus	Walnut	Strawberry	GreenTomate	Quince
Pomegranate	Hazelnut		Plum	
Olive	Sea-buckthorn		Peach	
Persimmon			Apricots	
			Nectarine	
Total 6	5	3	7	3

Table 2. Different crops groups and the number of cultivated species in Kermanshah province

Industrial plants	Pulses	Forage plants	Oil seeds	Grian
Cotton	Pea	Forage maize	Rape	Wheat
Potato	Beans	Alfalfa	Soybean	Corn
Sugar beet	Lentil	Sainfoin	Sunflower	Rice
	Faba bean	Millet	Sesame	Barley
	Vetch	Persian clover	Safflower	Triticale
		Vetch		
		Sorghum		
		Green pea		
		Cowpea		
		Other forage		
Total 3	5	10	5	5

Table 3. Species richness agricultural crops in Kermanshah province for 2003-2012

	Year									
City	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Eslamabadgharb	28	27	27	30	23	25	26	26	28	23
Paveh	24	27	29	23	24	24	22	21	22	22
Salas babajani	24	24	24	27	24	24	23	25	29	23
Jwanro	29	28	26	25	22	25	22	25	26	24
Dalahoo		-	-	-	24	20	20	23	27	22
Ravansar	-	-	-	-	25	26	27	28	30	28
Sare pole zahab	29	28	28	28	24	23	23	25	28	23
Songhor	23	28	27	28	24	31	30	31	31	24
Sahneh	35	35	37	33	31	36	33	33	33	31
Qasrshirin	17	19	18	20	17	17	17	19	28	23
Kermanshah	31	35	36	33	35	37	36	39	40	37
Kangavar	40	28	30	26	29	31	30	33	36	28
Gilangharb	31	28	25	30	26	25	25	27	32	27
Harsin	30	29	34	31	32	36	35	37	39	34

Our results also indicated that cultivation of specific crops was desired in each county. So in Paveh the share of the horticultural plants were greatly sensible due to highly steep lands while in Counties like Qasr-e-Shirin the field crops were mostly cultivated. The biggest and the weakest producers were Kermanshah (with about 70% of all different species) and Qasr-e-Shirin (with about 52% of all different species), respectively.

As a precise evaluation of agricultural products, biodiversity becomes impossible just by considering the number of species (Smale, 2003; Thrupp, 1998). Using Shannon species diversity index is one of the exact methods of biodiversity evaluation in which the roles of both number and abundance of species are given attention (Barnes, 1998).

Shannon Species Diversity Index

The results demonstrated that among the province's counties, Paveh and Harsin had the highest Shannon species diversity index while Qasr-e-Shirinhad had the lowest value in the targeted time span (Fig. 1). The trend of Shannon species diversity index of the agricultural crops showed significant variations over 2003-2012 and also among the counties.

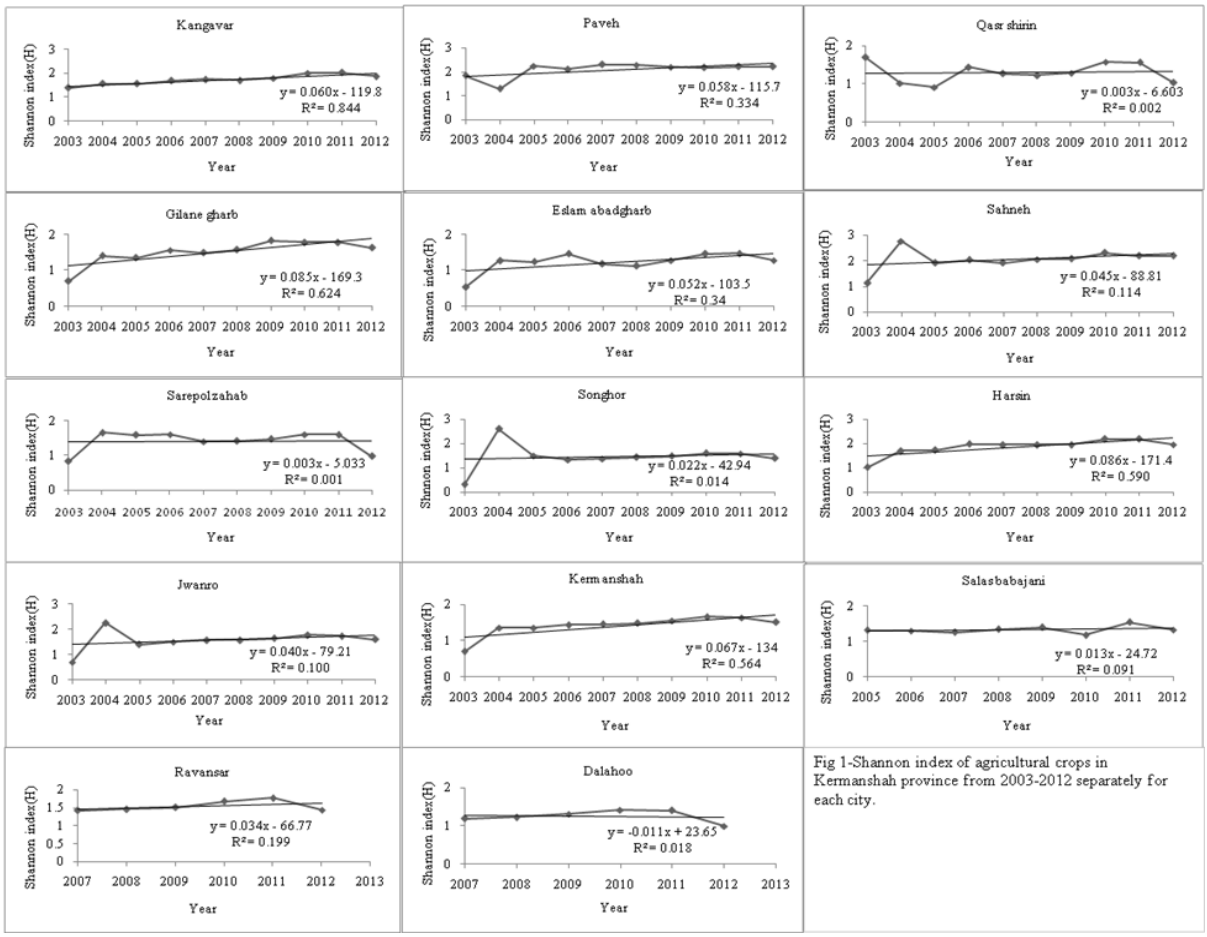

Fig 1-Shannon index of agricultural crops in Kermanshah province from 2003-2012 separately for each city.

The variation of Shannon species diversity index has an increasing trend for all of the counties except for Dalahoo because of a severe reduction of its amount in 2012. For Dalahoo the annually diversity declining was 0.01 which in turn in a 10-year period based on Shannon species diversity index 0.1 unit of diversity decreased. Harsin had the highest annual increase of diversity (0.08%) which in this time period based on Shannon species diversity index, about 0.8 units has been added to the diversity.

Regarding to the species richness and Shannon species diversity index, the obtained results illustrated that the changes in Shannon species diversity index in different counties and for the consecutive years do not follow the trend of the species number. A County like Paveh, by having the least number of the species in most years, had higher Shannon species diversity index than a County like Kermanshah, although the number of the cultivated species in Kermanshah was much more than Paveh. In addition to the number of species, also, ecological of diversity is affected by species variety (Ghorbani, 2010).

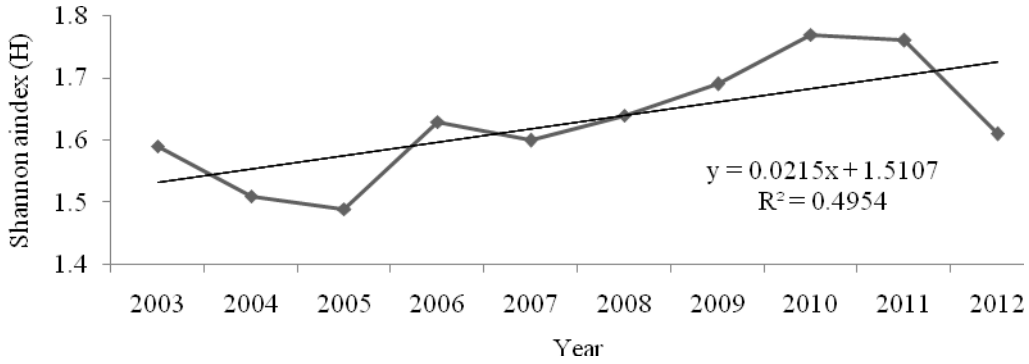

Fig 2. Shannon species diversity index of agricultural crops in Kermanshah province for 2003-2012.

Fig. 2 shows the trend of Shannon species diversity index for the agricultural crops of this province over 2003-2012. The greatest value was observed in year 2010 (1.77) and the least one was related to year 2005 (1.49). The overall trend of Shannon species diversity index of the agricultural crops of the province was increasing during these 10 years.

The climatic conditions and the physical and chemical characteristics of soil, which are themselves a function of the region's continent, form the basis of the present diversity in field ecologies all over the world (Stocking, 1999). Koocheki *et al*., (2005) declared that in regions without desirable condition with respect to the continent and soil fertility, the number of vegetable species cultivated was less and also the cultivation area is unevenly distributed between the species, which in turn yields to the dominance of a few species. They found a high similarity between some provinces of the country regarding the cultivated varieties of wheat and this similarity was greater between counties with similar climatic conditions.

Based on our results, Kermanshah province was at a desired perspective level of the biodiversity during years 2003-2012. It seems that was due to its diverse climatic conditions. Whereas increasing of cultivated species diversity has positive effects such as compatibility with environmental conditions (Vigouroux *et al*., 2011; Falco *et al*., 2010), the production of agricultural products and easy food supply (Falco *et al*.,2007), the diversity of soil's microorganisms and finally the preservation of stability and sustainability, maintaining and improving biodiversity is one of the most important targets for ecologists (Didier le *et al*., 2002). Recognizing and understanding the biodiversity benefits and also their effects on agricultural production systems requires comprehensive information about various cultivated varieties and their distribution.

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