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Evaluation of agrobiodiversity in Ilam Province (during 2004-2016)

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Introduction: Diversification of agriculture is considered an important strategy to overcome the challenges faced by many developing countries due to the opportunities it offers to face heterogeneous production conditions, increase income generation through entry into new markets, and risk management. Conservation of biodiversity is one of the sustainable development concepts in agriculture. Excessive attention to the number of products and the extreme use of off-farm inputs, regardless of other ecological functions of these systems, has led to the reduction of biodiversity at all levels. In this context, a comprehensive plan for monitoring crop diversity and identification of factors influencing diversification is necessary. Accordingly, this study was conducted to evaluate the temporal and spatial changes in the biodiversity of agricultural systems in the Ilam province during 2004 and 2016.

Material and methods: Data were gathered from statistical yearbooks and reports from the Plan and Budget Organization and Organization of Jihad Agriculture. Stepwise regression analysis was used to identify the factors influencing regional crop diversity fluctuation over time. Also, stepwise recursive regression analysis was used to evaluate the determinant factors in the changes of diversity in agricultural systems. In order to evaluate the spatial variation of crop diversity in irrigated agroecosystems and its determinants factors, the Shannon-Weiner diversity index was calculated. Based on the assumptions of the study, the influencing factors on the spatial variation of crop diversity were classified into geographical factors, climate and ecological factors, sociocultural factors, economic factors, and management factors. Then, insignificant factors on crop diversity were excluded from the model and finally, the most important determinant on variations between different regions of the province remained in the model.

Results and discussion: The findings of this study revealed that over the 12-years period, the general trend in the changes of production systems was a decreasing one; so the agricultural systems' diversity in all counties, except for Ilam and Dehloran, had decreased, of which the highest value of the Shannon-Weiner diversity index was calculated 1.90 in 2016. The main reason for this increase in diversity was the increase in the number of vegetable crops and reducing the area under

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cultivation of dominant crops (wheat and barley) during the studied period. Furthermore, the main determinant factors of diversity in the agricultural systems of Ilam Province were the number of villages with inhabitants, average annual net income of a rural household, number of cooperatives, number of dusty days, agricultural land areas, number of production units, age of the beneficiary, minority percentage, amount of urea fertilizer, number of family members, and literacy rate, respectively.

Conclusion: Studying the critical points in the agricultural systems of Ilam Province indicated that the top-priority actions to improve sustainability and increase the diversity of these systems are educating farmers, helping them reach economic stability and improving production management and water resources management.

Keywords: Agrobiodiversity, Agroecosystem, Socioeconomic factors, Species richness, Sustainability

Introduction

Biological diversity or biodiversity is the variation of life and refers to variability in all forms, levels, and combinations of biological organization (Gaston and Spicer, 2004; Gorgini Shabankare, 2015). Agrobiodiversity encompasses the biodiversity of living organisms used in agriculture (Wood and Lenne, 1999; Love and Spaner, 2007; Yousef *et al*., 2018). There are about 391,000 vascular plant species currently known to science (Willis and Bachman, 2016), of which only 1500 species have been used in agriculture and three-grain food; wheat, rice, and maize produce more than half of the food energy consumed by humans (FAO, 1998; Khoshbakht and Hammer, 2008).

The universal transition into intensively exploited landscapes has led to a considerable reduction in agricultural plant biodiversity, especially for traditionally extensive agroecosystems in developing countries (Jafari *et al*., 2018; Asgharipour *et al*., 2019; Amiri *et al*., 2019). Diversification of agriculture is considered as a principal policy to conquer the problems experienced by a great number of developing countries because of the opportunities it provides for increased revenue generation, tackling heterogeneous production situations, conserve valuable water and soil resources, alleviate poverty, and risk reduction (Winters *et al*., 2006; Bhattacharyya, 2008). Agriculture diversification refers to developing substantial crop or enterprise-mix in favor of valuable and more advantageous enterprises. It means a switch from the domination of one crop at a large scale to the production of many crops (Reddy, 2011). Crop diversification is an instrument for development addition to being a function of sustainability, risk management and enhanced income and encouragement of agricultural diversification (Ali and Abdullah Farooq, 2004; Winters *et al*., 2006).

Western Iran is dominated by wheat culture accounting for 70.5 percent of the total cultivated area (MAJ, 2016). Researchers emphasize crop diversification to generate employment and poverty reduction (Rahman and Kazal, 2015). Local farmers in Iran grow multiple crops with wheat to meet cash requirements and subsistence (Koocheki *et al*., 2004; Mahdavi Damghani *et al*., 2007). However, cultivation expansion of non-cereals (e.g. oilseeds, pulses, fodder, fibers, vegetables, and fruits) and medicinal plants is slow, although they are more beneficial than wheat cultivation. Since the 1979 revolution, attempts in the expansion of wheat-based agroecosystems to achieve self-sufficiency of food grain has mainly been paid off in current years across the country (Salehi Arjmand *et al*., 2009). There are concerns that the attainment in self-sufficiency of food grain may have come at a cost of losing agricultural system diversity of the country, which potentially threatens agricultural sustainability.

Conservation of crop species or agrobiodiversity is crucial because of the need to develop crops for regional adaptation, prevent the loss of adapted ecotypes, and broaden the genetic resources of crop plants (Cooper *et al*., 2001; Love and Spaner, 2007).

The epidemic of the southern maize leaf blight and the great famine of Irish potato are examples of the treats of a small genetic resources (Harlan, 1972; Bursh, 2004). Agrobiodiversity value is important for farmers and plant breeders from dissimilar aspects. Agrobiodiversity may be valued due to use values, option values and existence values (Pardey *et al*., 1998). Use values are the current effect of genetic resources on the crop yield. Option values reflect further unknown use, such as resistance to new diseases. Existence value is related to the consent people derive from knowing that diversity exists (Bellon, 1996; Love and Spaner, 2007). Conservation of agrobiodiversity is a requisite for developing sustainable agriculture because it permits breeders to address variable environmental issues (such as climate change).

There is a need for comprehensive monitoring of agricultural system diversity and recognize factors influencing diversification. Few studies were conducted on the analysis of crop-based agricultural production system diversification in Iran. Koocheki *et al*. (2008) provided an overview of the agricultural diversity based on comprehensive analysis of wheat-based and rice-based cropping systems of 183 counties in 27 provinces at cropping system, crop species and crop variety levels, and noted that the practicing monoculture of wheat led to considerable decrease in agrobiodiversity of Iran in recent decades, which endangered the sustainability of agricultural system. Pourghasemian and Moradi (2016) examined diversification of agronomic and horticultural crops of Isfahan Province using regional data for 2012 and noted that diversification into non-cereals increased largely to reduced risk rather than increase income, and road density and electricity were negatively correlated with diversification.

Ilam Province is one of the 31 provinces of Iran that is located in the western part of the country, adjacent to Iraq. Historical evidence and archaeological studies demonstrate that Ilam Province was a part of the Mesopotamia and ancient Elam (Elamite Empire). Mesopotamia has been regarded as one of the centers of origin for the domestication of many grain crops and animals (Harlan, 1977). Despite the long history of agriculture and the past share of its domestication to world food production, a few research has been done to understand the previous achievements, existent situation, and the future perspective of crop production in the province. To bridge this gap, this study used a broad range of climatic, socio-cultural, economic and managerial factors to recognize determinants of agricultural systems diversification at the regional scale in Ilam Province covering a period of 12 years (2004–2016). In addition to developing the empirical modeling, the analytical framework of the study and conclusion was presented.

Material and methods

Study area

Ilam province is located west of Alborz mountains, between 32º 03’ N to 34º 02’ N and 45º 40’ E to 48º 03’ E with an area of about 20137 square kilometers. The majority of the area is composed of highlands and mountainous regions between the Zagros Mountains, which lead down to low-lying plains with steep slopes. There are 14 perennial rivers in the Ilam Province with an annual inflow of about 4.5 billion cubic meters. In terms of climate, this province is considered to be a tropical region; however, it’s composed of tropical, cold, and temperate regions due to large latitude, heights and the difference in temperature and precipitation in the northern, southern and western districts. Ilam Province consists of 10 counties, 26 districts, 25 cities, 49 rural districts and 668 villages with inhabitants (Fig. 1). Among the counties, the maximum and minimum temperatures belong to Dehloran with 53 ºC and Eyvan with -14 ºC, respectively. Eyvan and Abdanan have the highest average annual precipitation with 635 and 587 millimeters, respectively, and Mehran and Dehloran have the lowest among the counties with 226 and 264 millimeters, respectively.

The main economic activity in this province is animal husbandry and agriculture, and on the next level, honey bee breeding. The area of the agricultural lands in the province was 259695 hectares in Octo-

Fig. 1- Geographical map of Ilam Province, Iran

ber 2014; of which 150200 and 62475 hectares were respectively allocated to the cultivation of wheat and barley (Iran Statistical Yearbooks, 2017).

Tables 1 and 2 plot the names of the counties, the geographical coordinates, area, population, climate characteristics and agricultural land areas in the Ilam Province.

Climates of counties were defined according to Q2 pluviothermic quotient and Emberger's (1966).

$$Q_2=\frac{2000\,P}{(M+m+546.24)(M-m)} \quad (1)$$

where Q2 is pluviothermic quotient, P is the mean annual precipitations in mm, M is the mean of maximal temperature in °C for the hottest month and m is the mean of minimum temperature in °C for the coldest month (Dufour-Dror and Ertas, 2004).

Effective factors on the biodiversity of agro-ecosystems

Thirty five criteria were chosen in order to evaluate the effective factors on the diversity of agricultural systems in a 12-year time period. These factors were classified into five groups of geographical, climate and ecological, sociocultural, economic, and management factors. The studied indices, which were used to evaluate the changes in diversity in these systems were as follows (Rahman and Kazal, 2015):

Table 1- Geographical coordinates, population and area of agricultural land in the studied counties

	Geographical coordinates		Land area	Population[a]		Agricultural land area[c]	
	Minimum	Maximum		Rural	Urban	Irrigated land	Dryland
Province	N, 45.24 E 31.58	E N, 48.10 34.15	20138	199327	356896	70905	188790
Abdanan	N, 47.02 E 32.15	N, 48.00 E 32.00	2385	17769	28987	752	41926
Badreh	N, 47.12 E 33.14	N, 47.14 E 33.29	577	[b]_	_	453	7118
Chardavol	N, 46.15 E 32.15	N, 47.15 E 34.45	1555	51128	20989	6618	43903
Darreh Shahr	N, 46.00 E 32.45	N, 48.10 E 34.15	903	34288	24961	6122	5281
Dehloran	N, 46.15 E 32.00	N, 48.15 E 33.30	6817	26132	40267	41819	16258
Eyvan	N, 45.50 E 33.45	N, 45.25 E 34.00	903	16281	32518	2325	13423
Ilam	N, 45.45 E 33.15	N, 47.45 E 34.15	2165	35245	177988	1079	30025
Malekshahi	N, 46.51 E 33.30	N, 47.00 E 32.31	1608	7883	14559	438	14483
Mehran	N, 45.00 E 33.00	N, 48.10 E 33.45	2556	10601	16627	9746	7460
Sirvan	N, 47.00 E 33.25	N, 47.01 E 33.48	669	_	_	1553	8913

[a] Statistical center of Iran (2011).
[b] Badreh and Sirvan were formed by division of Darreh Shahr and Chardavol, respectively, after the parliamentary approval on June 23, 2011.
[c] Statistical center of Iran (2014).

Table 2- Climatic characteristics of counties of Ilam Province

County	Rainfall ($mmyr^{-1}$)	Mean temp. (°C)	Q^2 coefficient [a]	Bioclimates [b]
Abdanan	587	21.95	69	Sub-humid
Badreh	471	21.50	52	Semi-arid
Chardavol	462	20.36	48	Semi-arid
Darreh Shahr	445	19.24	66	Sub-humid
Dehloran	461	22.57	46	Semi-arid
Eyvan	635	17.47	72	Sub-humid
Ilam	569	17.85	66	Sub-humid
Malekshahi	585	17.53	70	Sub-humid
Mehran	226	25.00	28	Arid
Sirvan	264	26.89	33	Semi-arid

[a] Q^2 was calculated for each site using P, M and m average values for the period 1981–2011 from data provided by the Iranian National Institute of Meteorology

[b] Bioclimatic zones were defined according to Dufour-Dror and Ertas (2004) climate classification

Geographical factors	Including geographical coordinates and altitude above sea level
Climate and ecological factors	Including annual temperature, precipitation, wind speed, number of sunny, frosty, dusty and rainy days, and the area of jungles, pastures, and deserts
Sociocultural factors	Including land ownership status, literacy rate among people older than 6 years, age of the farmers, minority percentage (ratio of farmers with less than one hectare of land to all beneficiaries), percentage of inhabitants in villages, percentage of working population, percentage of farmers inhabiting rural districts, number of family members, percentage of working population in agricultural districts to the total population of the county, number of villages with inhabitants
Economic factors	Average annual net income of urban households, average annual net income of a rural household, number of livestock units in the county, the tonnage of agricultural productions in the county, number of active agricultural cooperatives working under the Co-op administration
Management factors	Including the number of production units (cultivation, gardening, greenhouse, animal husbandry, poultry breeding, and honey bee breeding), agricultural land areas, area under cultivation of annual products, area under cultivation of productive gardens, the amount of urea fertilizer distributed in the county, amount of triple superphosphate fertilizer distributed in the county, and the amount of toxins sold

Method of analyzing information

In this study, a GLS test was used to determine the role of each effective factor in diversity. The Shannon diversity index was calculated for agricultural systems in different counties based on the area under cultivation of agricultural systems for different products in the 12-year period. This index was calculated based on equation 2 (Gliessman *et al*., 1998).

$$H' = -\sum_{i=1}^{s} p_i \, lnp_i \qquad (2)$$

In this equation, p_i indicates the relative abundance and is obtained through $\frac{n_i}{N}$; in which n is the number of people in each group (the i^{th} group) and N is the total number of people in a region. In this study, in order to calculate the Shannon index of the agricultural systems of each county, the value of $\frac{n_i}{N}$ was calculated by dividing the area under cultivation of each cultivation product to the area under cultivation of all agricultural systems in the county.

In order to determine the importance of different factors affecting diversity, the final diversity index was considered as the dependent variable and the oth-

er factors were considered as independent factors. For this purpose, the general form of the regression equation was used:

$$Y= f(x_1, x_2 \ldots x_n) \quad (3)$$

Accordingly, the general linear regression model was fit as follow:

$$Y= (b_0 + b_1x_1 + b_2x_2 + \ldots b_nx_n) \quad (4)$$

In which, $b_1,\ldots,n$ are the coefficients of the independent variables, b0 is the constant of the equation and Y is the dependent variable. Then, the unnecessary variables are removed using the stepwise recursive analysis method. Thus, the basic model determining the relative importance of the variables is calculated and a simpler model is created based on a limited number of main variables that significantly justify the changes in the dependent variable.

The data were analyzed through SPSS22 (SPSS for Windows, Rel. 10.0.0. 1999. Chicago: SPSS Inc.) and the indices, tables, and diagrams were calculated and plotted using Excel. Cluster analysis was done with Ward's minimum variance method, using the Euclidean distance coefficient as the criterion.

Results and discussion

Table 3 plots the level of biodiversity in the agricultural systems of different counties and Fig. 2 illustrates the general trend of the changes throughout the time period. As illustrated in Fig. 2, changes in diversity has been decreased in the twelve-year time period (2004-2016), despite high fluctuations. During the 12-year period, the diversity of agricultural production systems in all counties except for Ilam and Dehloran have been decreased. Dehloran County, which has the largest area under cultivation in the province, holds the first place in producing goods such as wheat, rapeseed, and sugar beet and is known as the agricultural pole of the province. Water transfer through a canal from Karkheh Dam to the farms in this region has led to an increase in the area under cultivation of agricultural lands from 49906 hectares in 2004 to 63332 hectares in 2015 and also a development in the cultivation of industrial plants (specifically rapeseed and sesame), fodder (alfalfa and forage corn), vegetables (potatoes, onions, garlic, tomatoes, and okras) and beans (mung). In addition, the ratio of the area under cultivation of cereals to the total area under cultivation decreased from 54% to 43% during the 12-year period. In Ilam County, another county in which diversity increased in the 12-year period as opposed to other counties in the province, the area under cultivation of agricultural lands increased from around 7000 hectares in 2004 to about 10000 hectares in 2015. A ratio of the area under cultivation of cereals to the total area under cultivation decreased by 17% during the time period, which is substituted by oil products or vegetables like tomatoes, eggplants, dried garlic, pepper, parsley, tuber vegetables, and okra. This has led to an 18% increase in the diversity of agricultural systems in this county.

The main reason for the decrease in the crop diversity of agricultural systems in other counties of

Table 3. Shannon index of crop diversity in counties of Ilam Province

County	Share of wheat and (%) barley		Crop diversity index			change in diversi- % ty in 2016 from 2004	Trend of crop diversity in 2016 from 2004
	2004	2016	2004	2016	Mean		
Abdanan	43	62	1.43	0.99	1.21	-0.44	↓
Badreh	_	72	_	1.05	1.07	_	_
Chardavol	75	86	1.38	1.11	1.24	-0.27	↓
Darreh Shahr	73	72	1.40	1.23	1.32	-0.17	↓
Dehloran	54	43	1.05	1.35	1.20	+0.30	↑
Eyvan	70	71	1.32	1.27	1.25	-0.05	↓
Ilam	63	46	1.61	1.90	1.75	+0.29	↑
Malekshahi	52	58	1.29	1.11	1.18	-0.18	↓
Mehran	81	88	0.82	0.72	0.77	-0.10	↓
Sirvan	_	21	_	1.06	1.12	_	_

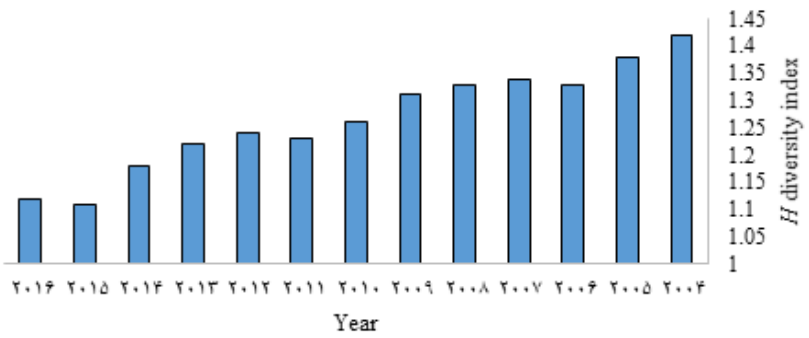

Fig. 2- Trends of Shannon index of overall agricultural land use in Ilam Province (2004-2016)

the province was a decrease in cultivating many rare crops and substituting them with products like wheat, barley, corn, and rapeseed. Several factors have been involved in neglecting many crop species, despite their economic and dietary attractions for many societies including the introduction of new species, substitution of old ones, reduced competition of these species in comparison with high-yielding crops, gradual changes in consumption patterns, cultural, economic and political matters, religious taboos and finally the disappearance of the local groups who produced and consumed these plants (Rezvani Moghaddam, 2008).

In 2004, the primary level of diversity in production systems was at its highest based on the Shannon index of Ilam, Abdanan and then Darreh Shahr; however, after 12 years, in 2016, the highest biodiversity in agroecosystems was observed in Ilam and Dehloran. A large part of these changes may be justified considering the ratio of the area under cultivation of cereals to the total area. In this 12-year period, Ilam has had the highest value of the Shannon diversity index (1.90) in the crop year 2013-2014 and Mehran has had the lowest value (0.39) in the crop year 2011-2012. In the pricey areas around Ilam, adequate population and the demand for vegetables has led to the substitution of wheat and barley cultivation by other crops with higher economic efficiency. This substitution is the reason for the high diversity in the agricultural systems of Ilam County. On the other hand, an 88% share of lands in Mehran County is allocated to wheat and barley cultivation. Also, rapeseed cultivation blooming and the allocation of over 2400 hectares of lands to rapeseed cultivation are some of the reasons for the low diversity of agricultural systems of Mehran County.

Cluster analysis of crop genotypes

The classification of the counties in the 12-year period based on the Shannon diversity index of agricultural systems using cluster analysis is illustrated in Fig. 3. Using a dendrogram cutting in a similarity distance of 10, the counties of Ilam Province are classified into three groups. Badreh, Sirvan, Dehloran, and Mehran are placed in the first group. These counties had the lowest diversities and were placed in the lower ranking in terms of the plyometric index in comparison with other groups. All the counties in this group are located in a hot and dry climate. The second group consists of Eyvan, Darreh Shahr, Chardavol, Malekshahi and Abdanan counties. Three of these counties are located in cold and temperate mountainous climate and the others in hot and dry climate. This group is intermediate in terms of diversity. Ilam was placed in the third group, which had the higher rank in terms of diversity in agricultural systems.

Determinant factors in the diversity of agricultural systems

The determinant factors in the diversity changes in agricultural systems of Ilam Province were specified using the stepwise recursive analysis and linear multivariate regression.

$$SDI = 1.12 + (0.14 \times A) + (0.25 \times B) + (0.01 \times C) + (1.22 \times D) + (0.72 \times E) + (0.31 \times F) - (0.42 \times G) - (0.002 \times H) - (1.06 \times I) - (0.32 \times J) - (0.12 \times k)$$

Where SDI is Shannon diversity index, A: minority percentage, B: age of the farmer, C: number of fami-

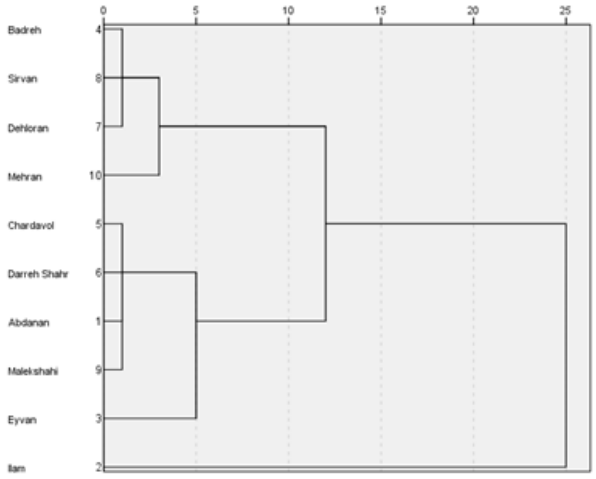

Fig. 3- Dendrogram for cluster analysis of counties of Ilam Province, clustering is based on the crop diversity in 2004- 2016

ly members, D: number of villages with inhabitants, E: number of cooperatives, F: number of production units, G: number of dusty days, H: literacy rate, I: average annual net income of a rural household, J: agricultural land areas and K: the amount of urea fertilizer.

According to the equation, the diversity in agricultural cultures in various counties of Ilam Province increased with the increase of minority percentage, age of the beneficiary, number of family members, number of villages with inhabitants, number of active agricultural cooperatives working under the Co-op administration and the number of production units (cultivation, gardening, greenhouse, animal husbandry, poultry breeding, and honey bee breeding). This confirmed the positive effect of these factors on the diversity of agricultural systems. However, the diversity decreased with the increase in the number of dusty days, literacy rate, average annual net income of a rural household, agricultural land areas and the amount of urea fertilizer in the county. The considerable point in this equation is that geographical, climatic and ecological factors do not have a determinant effect on the diversity of agricultural systems, yet sociocultural, economic and management factors had a considerable effect on the final amount of diversity. Sociocultural and economic factors played a significant role in the optimal management and determining methods that are selected to produce agricultural products by the farmer.

Conclusion

This study was conducted to investigate the trend of diversity changes in agricultural systems between different counties in the Ilam Province and identify the factors affecting it in a 12-year time period. The results of this study indicated that the area under cultivation of wheat, barley, vegetables, and rapeseed was significantly increased over time. The level of diversity in the agricultural systems of various counties in Ilam Province decreased in most counties except for Ilam and Dehloran. A large part of the changes in the diversity trend was explained through the changes in the percentage of cereal, wheat and barley cultivation in different counties. A collection of socio-cultural, economic and management factors was effective on the diversity of agricultural systems. Increasing the minority percentage, age of the beneficiaries, number of the farmer's family members, number of villages with inhabitants, number of active agricultural cooperatives and number of production units increased the diversity. On the other hand, the number of dusty days, literacy rate, average annual net income of the rural household, agricultural land areas and the amount of urea fertilizer consumption decreased the diversity.

The government should increase investments in education, services, and welfare because these are acceptable political tools that will significantly increase the diversity of agricultural systems. Also, pricing policies can increase product diversity by increas-

ing the price of vegetables and cucurbits and providing alternate industries in regions with industrial plant cultivation. Investing in the field of research on motivational policies in order to develop valuable products (like vegetables) not only provides opportunities to export products to neighboring countries like Iraq and Turkey but also increases the income and efficiency in agriculture. Providing welfare services for the prosperity of villagers, proper asphalt roads for easy passage, providing low-interest loans to beneficiaries in order to buy lands and using agricultural promoters among beneficiaries in order to introduce them to biodiversity and its advantages can improve the diversity in agricultural systems.

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ارزیابی تنوع زیستی در نظام‌های کشاورزی استان ایلام در سال‌های ۸۱ تا ۹۳

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سابقه و هدف: تنوع در نظام کشاورزی به دلیل فرصت هایی که برای مدیریت ریسک بیان می کند، برای مواجهه با شرایط تولید ناهمگن و افزایش تولید درآمد از طریق ورود به بازارهای جدید یک استراتژی مهم برای غلبه بر چالش هایی که بسیاری از کشورهای در حال توسعه با آن مواجه هستند در نظر گرفته می‌شود. یکی از مفاهیمی که در زمینه توسعه پایدار در کشاورزی مطرح است حفظ تنوع زیستی می باشد. توجه بیش از اندازه به جنبه های تولیدی و استفاده بیش از حد از نهاده های برون مزرعه ای بدون در نظر گرفتن دیگر کارکردهای بوم شناختی این بوم نظام ها، سبب شده تنوع زیستی کشاورزی با روند روبه کاهش در همه سطح ها مواجه شود. در این شرایط وجود یک برنامه جامع در راستای پایش تنوع زیستی کشاورزی و همچنین ارزیابی عامل های مؤثر بر آن ضروری می‌باشد. بر این اساس، این مطالعه با هدف ارزیابی تغییر های زمانی و مکانی تنوع نظام‌های زراعی استان ایلام و شناخت عامل های مؤثر بر آن در بازه زمانی ۳۸۳۱ تا ۵۹۳۱ اجرا شد.

مواد و روش ها: داده ها از سالنامه‌های آماری، گزارش‌های سازمان برنامه و بودجه و سازمان جهاد کشاورزی جمع‌آوری گردید. از روش تجزیه رگرسیونی گام به گام پس رونده برای ارزیابی عامل های مؤثر بر تغییرهای تنوع زیستی محصول های آبی استفاده گردید. برای ارزیابی تغییرهای مکانی تنوع زیستی کشاورزی موجود در بوم نظام های آبی و عامل های مؤثر بر آن سنجه تنوع زیستی شانون-وینر محاسبه شد. بر اساس فرض ها، عامل های مؤثر بر تغییرهای مکانی تنوع به گروه عامل های جغرافیایی، عامل های اقلیمی و اکولوژیکی، عامل های فرهنگی - اجتماعی، عامل های اقتصادی و عامل های مدیریتی تقسیم شدند و اثر هر کدام از این عامل ها بر روی تنوع سنجیده شد. سپس عامل هایی که اثر آن ها بر روی تنوع زیستی معنی دار برآورد نشد از مدل حذف شدند، و در نهایت مهم ترین عامل های مؤثر بر تغییر های تنوع بین شهرستان های مختلف استان در مدل باقی ماندند.

نتایج و بحث: نتایج نشان داد که در طول دوره دوازده ساله روند کلی تغییر های تنوع نظام‌های تولید کاهشی بود و تنوع در تمام شهرستان‌ها به استثنای ایلام و دهلران کاهش یافت. از این بین بیشترین میزان سنجه تنوع شانون واینر در بازه زمانی مورد مطالعه مربوط به شهرستان ایلام با میزان عددی ۰۹.۱ در سال زراعی ۵۹-۴۹۳۱ بود. عامل اصلی این افزایش تنوع، افزایش تعداد گونه های سبزیجات و گیاهان جالیزی و کاهش سطح زیر کشت و محصول های غالب (گندم و جو) بود. مهم‌ترین عامل های تعیین کننده تنوع در نظام‌های کشاورزی استان ایلام بترتیب تعداد آبادی دارای سکنه، متوسط درآمد خالص سالانه یک خانوار روستایی، تعداد شرکت‌های تعاونی، روزهای همراه با گردوغبار، وسعت زمین های کشاورزی، تعداد واحدهای تولیدی، سن بهره‌بردار، درصد خرده مالکی، میزان کود اوره، تعداد افراد خانواده و نرخ باسوادی بود. بررسی نقطه های بحرانی نظام‌های زراعی استان ایلام نشان داد برای بهبود پایداری و افزایش تنوع آن‌ها، آموزش کشاورزان، کمک به ثبات اقتصادی آن‌ها، اصلاح مدیریت تولید محصول و مدیریت منبع های آب از اولویت برخوردار هستند.

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نتیجه‌گیری: بررسی نقطه های بحرانی نظام‌های زراعی استان ایلام نشان داد برای بهبود پایداری و افزایش تنوع آن‌ها، آموزش کشاورزان، کمک به ثبات اقتصادی آن‌ها، اصلاح مدیریت تولید محصول و مدیریت منبع های آب از اولویت برخوردار هستند.

واژه های کلیدی: تنوع زیستی کشاورزی، پایداری، سنجه غنای گونه ای، کشت بوم، عامل های اجتماعی - اقتصادی.