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Diversity and Frequency of Studies on Crop plants in Conducted Studies on Intercropping in Iran

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ABSTRACT

Agrobiodiversity is a basic feature of agricultural systems all over the world. Biodiversity in natural ecological systems is usually studied at the genetic, species, and ecosystem levels. In this research, the diversity and frequency of using crop plants in experiments on intercropping in Iran was studied by reviewing 89 articles found using the Google Scholar search engine. Results showed the highest percentage of studies was carried out on corn and beans, with 27.52 and 22.36 percent, respectively, and the lowest (0.86 percent) on onion, lentil, and Cucurbita peppo. Of the total number of studies on intercropping, 65.62% were conducted on crop plants, 3.12 percent on industrial crops, 25% on medicinal plants, and 6.24 percent on vegetables. Considering the acreages under cultivation of crop plants, industrial crops, medicinal plants, and vegetables in the country, it seems studies carried out on intercropping do not conform to the needs of the farmers.

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INTRODUCTION

Biodiversity refers to all species of plants, animals, and microorganisms that interact with each other in an ecosystem (Vandermeer and Perfecto,1995). Agrobiodiversity is a basic feature of agricultural systems all over the world (Thrupp, 2000). Biodiversity in natural ecosystems is usually studied at the genetic, species, and ecosystem levels, and their equivalents in agronomic ecosystems are varietal, generic, and agronomic ecosystem diversity (Foly *et al*., 2011). This concept also includes habitats and species outside of agricultural systems that are useful for agriculture and improve ecosystem performance.

Nowadays, with the increased inclination for single-crop production, the range of genetic diversity in agricultural ecosystems has declined, and in most parts of the world production of crop plants is based on a very small number of agronomical varieties. Considering the large-scale perspective of agriculture, we find that agriculture has become dependent on intensive farming methods such as excessive use of pesticides, chemical fertilizers, widespread irrigation, producing many crops per year, and heavy machinery, resulting in the destruction of agricultural and semi-wild habitats and in the reduction of biodiversity in these large areas (Koochaki *et al*., 2004). Although Iran enjoys high genetic wealth and there was a high level of diversity in genotypes, plant races, and plant populations, this diversity has declined and a small number of agronomic cultivars produce the greatest part of all the crops (Foly *et al*., 2011). As a result, in recent decades, many plant species have turned into rare species due to intensification of agricultural activities and because of the decrease in the size of semi-natural landscapes (Robinson and Sutherland, 2002). Natural and agronomic ecosystems, because of their multi-functional nature, in addition to producing food, fodder, clothing, fuel, and medicine, provide various valuable services the economic importance of which have remained unrecognized (Cairns, 1997). In this research, the diversity and frequency of various crop plants used in studies conducted by researchers on intercropping were studied.

MATERIAL AND METHODS

The Google Scholar search engine was used to find, download, and study 89 articles on intercropping. The studied factors carefully extracted from these articles included various crop plants used in intercropping and the studied indices and factors including the land equivalent ratio, the effects of intercropping on pests, diseases, and weeds, yield and yield components, absorption ability, use of resources, etc. Considering all crop plants

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used in intercropping and the frequency of studies conducted on them and the fraction of the entire population made up of each crop plant species used in all intercropping studies, the Shannon diversity index was calculated based on the planted agronomic species. In this research, the Shannon-Weiner Diversity Index was used, and the following equation was employed for calculating it:

$H = - \sum N/ni * \text{Log} (N/ni)$

In the above equation, N is the frequency of all studies on the species, and “ni” the frequency of studies on species i).

Results:

Forty of the studies were conducted using the alternative method, 36 using the additive method, and 13 using both the additive and the alternative methods. Only four of the 89 studies were conducted on triple intercropping. The studied factors and the number of studies are listed in Table 1. As is shown in the table, 57 of the studies investigated the profitability index, 37 the yields and their components, and 26 the intraspecies and interspecies competition, which shows researchers were more interested in studying these factors.

Moreover, the calculated Shannon diversity index was 2.92, which indicated the extent of intercropping research in the country. The highest percentage of studies were conducted on corn and beans, with 27.52 and 22.36 percent, respectively, and the lowest on onion, lentil, and Cucurbita peppo with 0.86 percent. Crops such as soybean, barley, sorghum, and sesame were the most often-studied crops after corn and beans (Table I, Figure 1).

Of the total number of intercropping studies, 65.62% were conducted on crop plants, 3.12% on industrial crops, 25% on medicinal plants, and 6.24% on vegetables (Table I). Thirty-eight agronomic species were planted in the country 21 of which, that accounted for 88% of the total acreage under cultivation, were cereals and legumes (Gurr *et al*., 2003). Of the 34 cultivated wheat varieties, 10 varieties were grown in 84 percent of the land under wheat cultivation. This led to a low spatial diversity of agronomic varieties in the country according to Shannon diversity index, and this index did not exceed 1.5 and 1.7 even for wheat and rice (though these two crops enjoyed the highest varietal richness) (Foley *et al*, 2011). On the other hand, with wheat yield exceeding four tons per hectare, the total value of ecosystem services declined while the cost of the negative environmental consequences increased linearly with rises in the value of provision services (food and fodder) (cains., 1997).

Furthermore, 28 species of medicinal vegetables were grown in Iran, with eggplant contributing 29.27% of the total area under their cultivation. The total area under medicinal vegetable cultivation in Iran was 192428 hectares. Mazandaran Province with 19.30% of the total area devoted to growing medicinal vegetables in the country ranked first in their production and produced 12 main species of these crops (Bannon and Cooke, 1998). The Shannon diversity index for medicinal vegetables in Iran in relation to the total number of vegetable species (H') was 2.82. Therefore, the area under cultivation of vegetables in Iran enjoyed a suitable distribution. The value of this index in relation to the total number of agronomic species was 2.277, and we can infer that the diversity of medicinal vegetables in the agronomic ecosystems of the country was low, while, contrary to industrial crops, an acceptable number of studies were carried out on intercropping medicinal plants and crop plants.

About 56 medicinal and aromatic species were grown in Iran and the Shannon index for them was 64. The ratio of acreage under medicinal and aromatic plant cultivation to the total area cultivated in Iran was 87 percent. Of the total acreage under the cultivation of these crops, about 6.44 percent was devoted to the 2 species of saffron and cumin, and about 5.43% to multi-purpose medicinal plants. Therefore, less than 12 percent of the acreage under cultivation of medicinal and aromatic plants was devoted to species that were produced only for medicinal purposes (Donald, 2006).

Considering the areas under cultivation of crop plants, industrial crops, medicinal and vegetable crops in the country, it seems research that was carried out on intercropping does not conform to the needs of farmers.

Conclusions

Protecting biodiversity is unavoidable because biodiversity is a heritage of mankind and people cannot decide on the presence or lack of presence of species (Koochaki, 2006). Agrobiodiversity improves ecosystem stability (Pimentel, 1961), reduces pests (Hassanzade-Aval *et al*., 2012) and diseases (Koochaki *et al*., 2014), attracts natural enemies (Östmanl, 2001), controls weeds (Szumigalski and Van Acker, 2005), improves soil fertility (Russell, 2002), and regulates the environment in agricultural ecosystems at field and landscape levels (Letourneau *et al*., 2011). These effects result in increased stability of agricultural systems. The effects of biodiversity in agricultural ecosystems depend on the presence of various agronomic species.

The role agriculture can play in protecting biodiversity turns it into a key matter for consideration. Implementing ecological principles in agriculture; for example, adopting efficient management attuned to the environment with an emphasis on more diverse agronomic systems (Nassiri Mohallati *et al*., 2005) can greatly improve productivity, help close the gap in yield (Koochaki *et al*., 2014), and lead to the promotion of planting

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crops with ecological adaptability (Tscharntke *et al*., 2011). Although many factors including climatic, ecological, and economic conditions must be taken into account when selecting crops for intercropping, conducting applied experiments conforming to the needs of the country can result in greater stability of agricultural ecosystems, in addition to expanding agrobiodiversity.

Table I: Frequency of studied factors in research on intercropping systems in Iran.

Studied factors	*Number of studies*
Dry matter yield	3
Analysis of plant growth	10
Species composition	1
Profitability index	52
Efficiency in absorbing and utilizing sunlight	16
Intraspecies and interspecies competition	26
Vertical distribution of dry matter	2
Plant density	17
Yield, yield components	37
Diversity, density, population, biomass, weed control	13
Efficiency in absorbing and utilizing nitrogen	1
Plant density	8
Agronomic and economic studies	1
Seed protein content and fodder yield	5
Morphological features	1
Leaf chlorophyll	5

Table II: Diversity and frequency of studied crop plants in experiments on intercropping in Iran.

	Percent of total studies	*frequency*	*Sientific name*	*Crops*
Shannon-Wiener Diversity Index =2.92	*4.3*	*5*	*Heliantus annus L.*	*SunfIower*
	3.44	*4*	*Pennisetum spp.*	*millet*
	1.72	*2*	*Matricaria spp.*	*Chamomil*
	0.86	*1*	*Solanum melongena L.*	*Egg plant*
	1.72	*2*	*Vicia faba L.*	*lupin*
	0.86	*1*	*Allium cepa L.*	*Onion*
	7.74	*9*	*Hordeum vulgare*	*Barley*
	1.72	*2*	*Lathyrus sativus*	*Green pea*
	1.72	*2*	*Cucumis satvus L*	*Cucumber*
	27.52	*32*	*Zea mays L.*	*Corn*
	5.16	*6*	*Ocimum basilicum L.*	*Basil*
	2.58	*3*	*Crocus sativus*	*Saffron*
	6.02	*7*	*Sorghum spp.*	*Sorghum*
	9.46	*11*	*Soybean spp.*	*Soybean*
	1.72	*2*	*Solanum tuberosum L.*	*Potato*
	1.72	*2*	*Cannabis sativa L.*	*Cannabis*
	3.44	*4*	*Trifolium resupinatum L.*	*Clover*
	0.86	*1*	*Lens culinaris*	*Lentil*
	0.86	*1*	*Cucurbita pepo L.*	*Cucurbita peppo*
	2.58	*3*	*Brassica napus L.*	*Rapseed*
	6.02	*7*	*Sesamum indicum L.*	*Sesame*
	0.86	*1*	*Brassica oleraceae*	*Kill*
	3.44	*4*	*Borago officinalis L.*	*Borage*
	0.86	*1*	*Hypericum Perforatum*	*Hypericum*
	4.3	*5*	*Triticum aestivum*	*Wheat*
	22.36	*26*	*Phaseolus spp.*	*Bean*
	2.58	*3*	*Vigna radiate L.*	*mong bean*
	5.16	*6*	*Vicia panonica*	*Vetch*
	0.86	*1*	*Origanum vulgare*	*Marjoram*
	0.86	*1*	*Satureja hortensis L.*	*Savory*
	2.58	*3*	*Cicer arietinum L.*	*Pea*
	3.44	*4*	*Medicago spp.*	*Alfalfa*
		162	*Total*	

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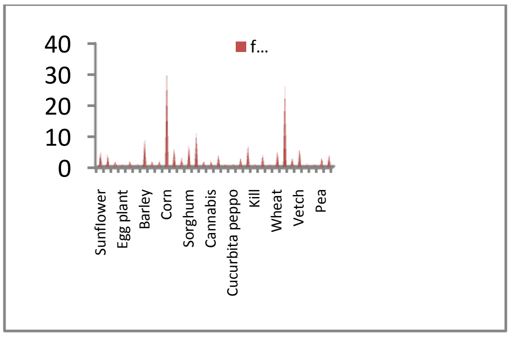

Fig. 1: Percentages of studies on crop plants from the total number of studies on intercropping in Iran.

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