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Coupling socioeconomic factors and cultural practices in production of einkorn and emmer wheat species in Turkey

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Abstract
Wheat, a basic food source in Turkey and the world, provides calories, protein, and energy to many people. Wheat has evolved from primarily domesticated hulled wheats. Of them, einkorn (*Triticum monococcum* ssp. *monococcum*) (EIW) and emmer (*Triticum dicoccon*) (EMW), with their cultural heritages from the past until the present, are popular ones, and they are still grown in patches across Turkey. In this study, the main material consists of the data obtained through a questionnaire with 53 emmer- and einkorn-related people—producers, sellers, etc., from five largely einkorn- and emmer-growing provinces (Bolu, Kastamonu, Karabük, Sinop, and Samsun) in the western Black sea region. The main aim was to determine the valuation and usage of einkorn and emmer in the survey area. While 78.0% of the farmers were producing einkorn, 22.0% of them were producing emmer wheat. Most of the farmers (86.0%) did not sell or trade hulled wheat because of the difficulties in harvesting and processing. There is no perfect market to sell them and find the quality seed to produce again. Because of these, einkorn and emmer are being produced by the farmers as in subsistence farming (traditional type) and being valued by using traditional home consumption techniques. The popularity of einkorn and emmer wheats is increasing, and health concerns of the public are accelerating interest in them. Therefore, increased acreage should be devoted to these wheats in Turkey to meet predicted market demand.

Keywords Einkorn · Emmer wheats genetic resources · Farmers' behavior · Socioeconomic structure

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1 Introduction

Wheat is a fundamental food source for humankind (Zohary and Hopf 2000). Food demand, consequently, the demand for wheat and its products, increases sharply due to the fast-growing human population, especially in developing countries (FAO 2019). Rapid population growth, speedy industrialization, changing lifestyles, and limited arable land require a more efficient and a higher quality wheat production (Sencar et al. 1997). Besides its undeniable economic importance, wheat has social and cultural as well as historical and even archaeological value in Turkey. Wheat is not only a plant which lives on the land of this country but also a living symbol of culture (FAO 2018). Wheat represents fertility, it is a holy product, it must not be wasted, it composes human's main food item, and it does fill everyone in the society (Sarıtaş 2011; FAO 2018). Wheat which takes its place either at a table on the ground or a lavish meal is our main food and an indispensable part of our life. Anatolian wheat culture is not limited to bread alone, but also includes "yufka, kadayıf, bulgur, erişte, kuskus, makarna, and keşkek"[1] as popular products (FAO 2018).

Wheat in its present-day form has gone through a long and interesting evolution process. The origin of the genus *Triticum* (wheat) was found in western Asia, known as Fertile Crescent (Fig. 1) (Dvorak et al. 1998; Arzani and Ashraf 2017; Pourkheirandish et al. 2018), and some parts of Africa, where stretches from Syria to Kashmir, and southward to Ethiopia (Belderok 2000). Agriculture wheat ancestors, einkorn (*Triticum monococcum* ssp. *monococcum*) and emmer (*T. dicoccon*) which had emerged 10–13 thousand years ago around Karacadağ in Southeastern Anatolia, Turkey, were seen potential genetic resources for higher and better quality today (Heun et al. 1997; Kilian et al. 2007; Šramková et al. 2009; Arranz-Otaegui et al. 2016). Recent studies have, furthermore, broadened our knowledge about the agricultural origins in southwest Asia by highlighting the multiregional and protracted nature of plant domestication. *T. monococcum* ssp. monococcum descends from wild populations with a more northerly distribution than emmer, and northern Fertile Crescent sites provided more data, although einkorn reached at least as far south as Tell Qarassa, while the earliest site, Qaramel, has unexpectedly high levels of non-shattering, approximately 22%, prior to 10,000 BC, although dates have wide error margins and could be up to 1000 years later. Later sites, including Jerf el Ahmar and Dja'de, seem to be completely shattering, although cultivation is indicated at these sites by other lines of evidence (Allaby et al. 2017). The evaluation archaeobotanical indication showed that during Pre-Pottery Neolithic A (PPNA), farming of wild cereal species was communal in regions such as the southern-central Levant and the Upper Euphrates area, but the plant-based subsistence in the eastern Fertile Crescent (southeast Turkey, Iran, and Iraq) focused on the exploitation of plants such as legumes, goatgrass, fruits, and nuts (Amaia et al. 2016).These ancestral hulled wheats were one of the earliest domestic plants on Eurasia extending from the British Isles to Central Asia and were artificially untouched and naturally improved plants for thousands of years (Nesbitt and Samuel 1996). They are the greatest heritage from the past

[1] Yufka is a thin, round, and unleavened flat bread in Turkish cuisine. It is similar to lavash. Kadayıf or Tel kadayif, flour obtained by mixing flour and water, is made into fine tin, which final product is obtained. It is mostly consumed sweetly in the Balkans, Turkey, and the Middle East. Bulgur is a cereal food made from the cracked parboiled groats of several different wheat species, most often from durum wheat. Erişte is type of macaroni. Kuskus is a type of semolina originating from North Africa, consisting of granules of crushed durum wheat. Keşkek is a traditional Turkish ceremonial dish prepared for wedding ceremonies, circumcisions, and religious holidays.

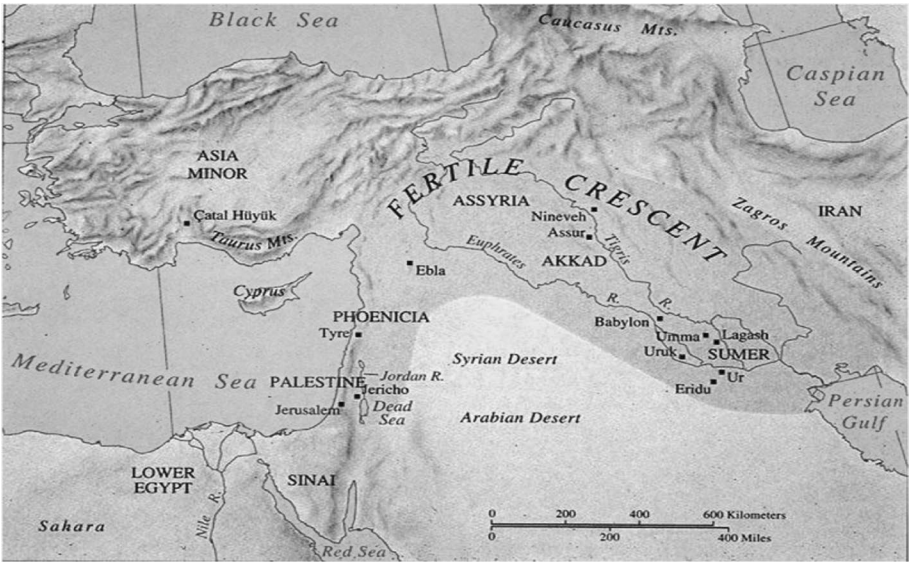

Fig. 1 Fertile Crescent in relation to the modern day locations. Adapted from Britannica (2019)

by hiding and sharing their own seeds with each other for very long years. The increasing popularity of local products, natural, and organic products today has led to a renewed interest in the hulled wheat populations/varieties today (Arzani 2019).

Hulled wheats have higher nutritional value, a healthy and durably resistant to disease and insect structure, without any artificial genetic touches (Dinu et al. 2017; Curná and Lacko-Bartošová 2017). Some studies also proved that old common wheats (included ancient ones) are better than modern ones in terms of their higher mineral micronutrient contents (Garvin et al. 2006; Fan et al. 2008; Shewry et al. 2016; Arzani and Ashraf 2017; Curná and Lacko-Bartošová 2017) They are grown in highlands, where highly exposed to frost and drought, and on barren and less-fertile soils. They are more durable to climate change than bread and durum wheats thanks to their hulled grain structure, convenient to store, resistant to diseases, and pesticides. Today, demand for natural and healthy products is increasing, and hulled wheats are potentially promising among these foodstuffs.

Although einkorn and emmer wheats were the first planted in settlements, later they are replaced by high yielding, easily harvested and processed wheat species. This einkorn and emmer have adapted well to high and mountainous areas, cold and hot weather conditions, and infertile soils. They have naturally evolved up today. Einkorn is mostly cultivated in Kastamonu and Bolu and emmer in Karabük, Samsun, and Sinop. Einkorn wheat products of bulgur, flour, bread, pastry, tarhana, pasta, cookies are specially made in Kastamonu, İhsangazi (Kan et al. 2016a). The region is in north Turkey, starts from the western edge of Kızılırmak delta and extends to the east of Adapazarı and Bilecik. Generally, mountainous region is about 2000 m above sea level in the west (Coğrafya Dünyası 2019). The mountains which are parallel to the sea coast limit the size of agricultural areas. Having too many slopes in the mountains makes mechanized agriculture difficult. The animal and human power in the region is still needed. The region has various dark, humus-rich acidic washed soils due to climatic conditions (Sönmez et al. 2018). The provinces in the region are Bolu, Karabük, Sinop, Kastamonu, and

Fig. 2 Survey area and distribution of einkorn wheat (EIW) and emmer wheat (EMWP) by provinces in Turkey. Adopted from HGM (2019)

Bilecik (Fig. 2). It is moreover consumed as animal feed in Turkey. Emmer is known to be used also in the production of bulgur and bread; but today it is only used as bulgur and animal feed. Since einkorn and emmer were low yielding and hardly harvested and processed, the cultivation areas have gradually decreased.

Emmer has been cultivated for centuries by farmers in the Italian mountains (Apennines) and in western Black sea region in Turkey under harsh environmental conditions because of higher adaptability. With the introduction of modern wheats, emmer almost disappeared, and its cultivation was reduced in the 1970s (Di Napoli and Marino 2001) and later increased in Italy by a combination of interventions to promote emmer (Padulosi et al. 1996). The reasons for the rediscovery of emmer include growing interest in its nutritional content (Grausgruber et al. 2004; Serpen et al. 2008). Emmer production and conservation were supported by national research initiatives on ex situ and in situ conservations, value addition, and sustainable marketing (Hoeschle-Zeledon et al. 2009). Emmer flour can substitute wheat flour in most bakery products for bread, pasta, sweet and savory biscuits, and cakes (Stallknecht et al. 1996).

The einkorn and emmer still exist on the different parts of Turkey and are known generally as Siyez, IZA (einkorn) and Gernik (emmer) by local people. There is no statistical database showing the production area and total production quantity of hulled wheat in Turkey. Kan et al. (2016a) stated that the share of the Siyez and Gernik production area in wheat landraces collected in Turkey between 2009 and 2014 years is about 2.6% and 0.1% (the share of wheat landraces is about 1% in total wheat production area in Turkey), and hulled wheats concentrated in specific places such as Balıkesir, Bilecik, Bolu, Bursa, Karabük, Kars, Kastamonu, Samsun, and Sinop provinces. These wheats are called as in different local names (Gernik, Iza, Kaplıca, Kavılca, Mal, Mahsul, and Siyez). Today, they are still used for home consumption such as Siyez, Iza, and Kavılca Bulghur, and wheat flour for home consumption (Giuliani et al. 2009; Kan et al. 2017) and animal feed in some areas (Nesbitt and Samuel 1996; Zencirci and Birsin 2004; Tanno and Willcox 2006; Giuliani et al. 2009; Kaplan et al. 2014; Kan et al. 2017) Except Siyez wheat in Kastamonu, the marketing and public recognition are very limited but their popularity is getting increased day by day. There are some actions to provide their public recognition at national and international levels such as geographical

indication signs (Siyez, Iza, etc.), exhibitions, and fairs (Kastamonu for Siyez, Bolu for Iza).

An obstacle to global food security is the extinction of genetic resources in the wild, and Turkey is facing these problems as well. Modern agriculture, conventional breeding, and the liberal use of high inputs have resulted in the loss of genetic diversity and the stagnation of yields in cereals in less favorable areas. Increasingly, landraces are being replaced by modern cultivars and unfortunately disappeared, at least, in some sites. Undeniably, plant genetic resources have globally important role on food security, and ex situ and in situ studies have an important role on conservation of them. Unfortunately, enough fund is not allocated globally to conserve genetic resources that are important for agricultural food security (Dulloo and Maxted 2019). Mean time, there are some beliefs that there is no effective in situ conservation of crop wild relative (CWR) populations in nature (Maxted et al. 2016) and global 72% of CWR taxa require additional ex situ collections (Castañeda-Álvarez et al. 2016). However, the efforts of plant genetic resources both in ex situ and in situ conservation should not be ignored in coming years (Dempewolf et al. 2013).

In Turkey, plant genetic resources conservation activities were started by the establishment of the Crop Research and Introduction Center in 1964, and the activities were reorganized in 1976 within the framework of the National Plant Genetic Resources Research Program with the objective of ex situ and in situ conservations. But it can be also said that Turkish in situ conservation efforts were started in the 1950s. In situ protected areas have been designated under various levels of protection including national park, Nature Park, nature conservation area, natural site, wildlife development area, special environment conservation area, and internationally significant wetlands. Today, there are two gene banks (Ankara and İzmir) and 6.8 million ha in total, corresponding to about 8.6% of Turkey's surface area, which have been established in situ protected area (FAO 2018).

There are significant progress and interest towards the conservation and use of plant genetic resources because these methods are parts of solutions tostruggle the challenges such as climate change, genetic erosion, pest, and disease epidemics. Although in the last few decades significant progress toward effective conservation has been made, there is a limitation on database, socioeconomic situation of farmers producing plant genetic resources, behaviors of the farmers, and the factors affecting their decision on production. Because of that this study was planned in five provinces of the Western Black Sea Region to determine einkorn and emmer wheat producer's behaviors on production, storage, and usages (valuation) of them to determine the main limitations to provide sustainable products and conserve them.

2 Materials and methods

The main material of the study constituted the data getting from a survey study in 2018 year. The survey was conducted in eight districts selected from the five provinces where emmer and einkorn wheats restrictedly but still largely produced in the Black sea region (Bolu, Karabük, Kastamonu, Sinop, and Samsun provinces). Due to the lack of a specific database on the producers engaged in the production of emmer and einkorn hulled wheat landraces in Turkey, preliminary interviews with relevant experts were done, and accordingly, purposive sampling techniques were applied in eight districts. The "Purposive Sampling Technique," also called judgment sampling, is the deliberate choice of an informant due to the qualities the informant possesses. It is a nonrandom technique that

does not need underlying theories or a set number of informants. Simply put, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience (Bernard 2002; Lewis and Sheppard 2006). A similar approach to this issue was previously applied in the study conducted in Turkey with wheat landraces by Kan et al. (2015).

In the study, in-depth interviews and observation methodologies were used to get data and determine the farmer's behaviors on the production of emmer and einkorn wheats by face-to-face survey method. In-depth interviewing is a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation. In-depth interviews are useful when you need detailed information about a person's thoughts and behaviors or require to explore new issues in depth (Boyce and Neale 2006). During the in-depth interviews, structured and semi-structured questionnaires were used. Demographic and economic variables (such as age, education, household size, and regular salary) and agricultural variables (such as farm size, land property, production pattern, EIW and EMW production area, yield, and production type) were collected with structured questionnaires. The information on storage practices, valuation, processing techniques and practices, and marketing opportunities of EMW and EIW was gathered via semi-structured questions. Observational research methods are important for understanding people's actions, roles, and behavior. Observational data collection methods (ODCM) span research paradigms, and qualitative approaches contribute by their focus on 'natural' settings which allow the explanation of social processes and phenomena (Walshe et al. 2012). In the research, ODCM was used to get information on the valuation and processing practices of EMW and EIV. In-depth interviews and observations were made by the researchers (authors) in the research area. The producers were reached either through the Provincial/District Directorate of Agriculture and Forestry or through the Village Headmen (Mukhtar), the legal representative of the village.

Total randomly selected 50 farmers (39 Siyez/IZA-EIW, and 11 Gernik-EMW producers) were included in the study, and the questionnaire forms were fulfilled by face-to-face method. Statistical Package for Social Sciences 20 (SPSS 20) was run on the data collected by the surveys. The data were analyzed by separating the farmers into two groups as emmer wheat producers (EMWP) and einkorn wheat producers (EIWP). All the analyses were done according to the separated producers' groups.

The qualitative data of the research were gathered from questionnaire forms. Simple factual questions (such as Yes/No) and complex factual questions (such as How many times…?) were used in the study. In addition, the information obtained from field by observations and in-depth interviews with the stuff of Provincial Directorate of Agriculture and Forestry were used to interpret the results in the study.

Pearson's Chi-square was used to assess two types of comparison tests of independence. A test of independence evaluates whether paired observations on two variables, expressed in a contingency table, are independent of each other. The equation of the test statistic is given as follows: (Kesici and Kocabaş 2007).

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

where χ^2 = Pearson's cumulative test statistic, which asymptotically approaches a χ^2 distribution, O_i = an observed frequency; E_i = an expected (theoretical) frequency, asserted by the null hypothesis; and n = the number of cells in the table.

The maximum 20% of total cells' frequency values should be less than 5 in created cross-tables to accept the Chi-square analysis results as reliable, and no cell frequency should fall below 1. If this limit is exceeded, the reliability of the results obtained from the Chi-square analysis will be questioned (Bayazit and Oguz 1998). When the Chi-square analysis is deemed unreliable, the "Likelihood Ratio" value is used. The data were tested in 90%, 95%, and 99% confidence intervals.

The *t* test was used to compare the means from two independent variables. This test was used to compare two small sets of quantitative data when samples were collected independently of one another. The criterion of this test is that the samples must be collected from two different populations or from randomly selected individuals from the same population at different times. "Levene's test" was used to compare the equality of the variances of two groups. If the result of Levene's test was $p < 0.05$, the variances were not equal in each group, and in this case, the *t* test was used in the absence of equal variance (Buyukozturk 2010; Ergün 1995). When the assumptions were not provided in the study, the nonparametric tests were used to compare two independent samples. One of them is the Kolmogorov–Smirnov test (K–S-*Z* value), and it is a nonparametric test of the equality of continuous, one-dimensional probability distributions that can be used to compare a sample with a reference probability distribution (one-sample K–S test), or to compare two samples (two-sample K–S test). The other one is Mann–Whitney *U* test, and it is the nonparametric alternative test to the independent sample *t* test. It is a nonparametric test that is used to compare two sample means that come from the same population and used to test whether two sample means are equal or not. Usually, the Mann–Whitney *U* (M–W-*U*) test is used when the data are ordinal or when the assumptions of the *t* test are not met (Kesici and Kocabaş 2007).

2.1 Geographical condition of study area

Emmer production is generally carried out in the western Black sea region—Karabük, Samsun and Sinop provinces of Turkey (Fig. 2). In these provinces, the cultivation and production of emmer have already been reduced to none. In the past, it was known that the villagers produced bread from emmer wheat, but the local people have changed it toward modern wheat, which is easier to transport, with its higher yields, easier harvest, and processing. Emmer is today used only as animal feed, to the most extent, by the farmers. Emmer is preferred because it is resistant to high mountainous areas and cold conditions. The altitude of the samples from these three provinces varied between 800 and 1300 m. However, it is not possible to transport agricultural equipment, especially tractors, and combine harvesters to these areas. Therefore, cultivation has gradually decreased. However, the demand for ancestral and natural products has been increasing in recent years for their better nutrition contents. For this reason, Turkey also increased production in the last year as in Italy.

Einkorn production of Turkey is mostly carried out in Kastamonu and Bolu provinces in the western Black sea region of Turkey (Fig. 2). It is cultivated between 780 and 1260 m in mountainous areas. Einkorn cultivation and usage in Turkey is higher than emmer. Recently, einkorn production is increasing in Kastamonu-İhsangazi and Bolu-Seben districts. Many factors are affecting the situation such as cooperation among the farmers, national and international interest, universities, governmental organizations' supports, international fairs, and celebrations. The most popular product of einkorn wheat is Siyez Bulghur, and there are many initiatives to market, protect it to unfair trade (Geographical

Table 1 Education level of EIWP and EMWP

Education level	EIWP		EMWP		Total	
	Count	%	Count	%	Count	%
Primary school	26	68.42	10	90.91	36	73.47
Secondary school	3	7.89	1	9.09	4	8.16
High school	9	23.68	0	0.00	9	18.37

Likelihood ratio 5.15, *D.F.* 2, p 0.008, φ 0.27

Table 2 Regular salary owned situation of EIWP and EMWP

Income	EIWP		EMWP		Total	
	Count	%	Count	%	Count	%
Stable	12	30.77	0	.00	12	24.00
Instable	27	69.23	11	100.00	38	76.00

Likelihood ratio 6.96, *D.F.* 1, p 0.008, φ 0.30, Fisher's exact test p 0.05

Table 3 Situation of animal production by EIWP and EMWP

Animal production	EIWP		EMWP		Total	
	Count	%	Count	%	Count	%
Yes	15	38.46	9	81.82	24	48.00
No	24	61.54	2	18.18	26	52.00

Likelihood ratio 6.83, *D.F.* 1, p 0.009, φ −0.36, Fisher's exact test p 0.02

Indication) and local development (Kan et al. 2016b). Siyez Wheat Bulgur is also supported by Slow Food Foundation (Slow Food 2019).

3 Results and discussion

3.1 Demographic and economic characteristics of the farms

According to survey results, it was found that most of the farmers had graduated from primary school (Table 1). This constituted 75.5% of the study sample. The others were high school or secondary school graduates, respectively. There was not any university graduate. The education level of the farmers is changing by the wheat-type production statistically. EIWP education level is higher than EMWP (Table 1).

In the study area, EMWP producers are generally based on their life as depending on crop and animal production income. Their agriculture activity is subsistence farming rather than trade-based activity or income activity providing a regular salary. As shown in Table 2, while 30.77% of the farmers producing EIW had a regular salary (such as retirement pension and worker/officer pension), none of the farmers producing EMWP had a

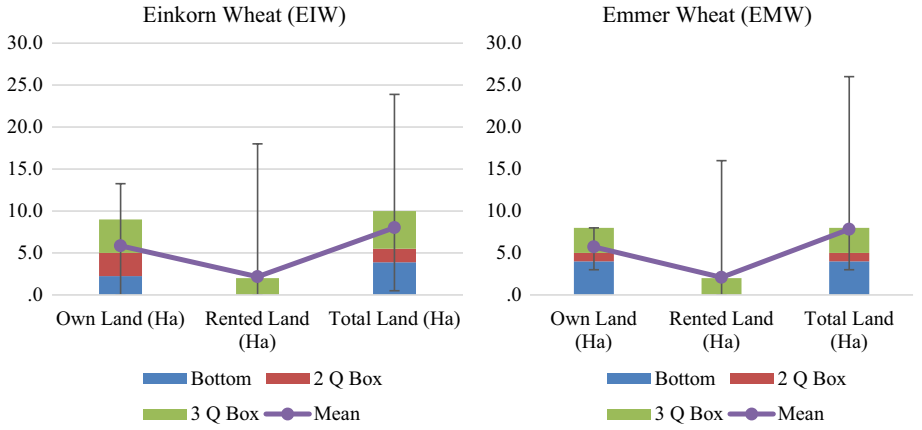

Fig. 3 Land property and farm size of EIWP and EMWP (hectare)

regular salary in the survey area. This difference was found statistically important at 95% confidence level in the research (Table 2).

A total of 48.00% of farmers in the survey were engaged in livestock farming and 52.00% on non-livestock farming (Table 3). The percentage of livestock and non-livestock was very close. As there was no fixed income, they were also engaged in animal husbandry as well as crop farming. Animal husbandry provided a steady revenue stream. Animal products were also important in organic nutrition and health. The remaining stalks (straw) and barks of agricultural products were also regarded as animal feed. In particular, EMWP were engaged with livestock activity rather than EIWP. They use the emmer wheats for their animal feeding. Because of that EMWP are carrying out their agricultural activity as both crop and animal production together. This difference is statistically important at 95% confidence level. Production type is an important indicator of animal production in the region. Similar studies in Turkey show that the probability of landrace cultivation increases with household ownership of animal (Meng 1997; Kruzich and Meng 2006; Kan et al. 2015). Generally, wheat landrace producers use residues (especially straw) for a feed from wheat landraces. There are also some records on hulled wheats which are used by the producers for animal feed (Nesbitt and Samuel 1996; Zencirci and Birsin 2004; Tanno and Willcox 2006; Kaplan et al. 2014; Kan et al. 2016a).

There is a positive relationship between farm size and the adoption of modern varieties (Perrin and Winkelmann 1976; Feder et al. 1985; Kan et al. 2016a). Larger farmers may benefit from economies of scale. These types of farms are able to dedicate to produce more marketable and profitable crops. Landraces are preferred by the farmers generally for home consumption or their straw or seed for animal feeding. In the study, most of the EMWP and EIWP cultivated their own land (97.87%). The share of producers who are renting land was 29.79%. The average farming size was found as 7.97 ha, and 73.15% of it was own land of the farmers (Fig. 3). The differences of the calculated proportions between EIWP and EMWP are not important statistically at 95% confidence level (K–S-$Z_{ownland}$ 0.80; K–S–$Z_{rentedland}$ 0.30; K–S-$Z_{totalland}$ 0.60). The farming sizes of both farming system were similar and mainly have depended on the rain-fed production system. These results show similarity to the study done before in Turkey by Kan et al. (2015).

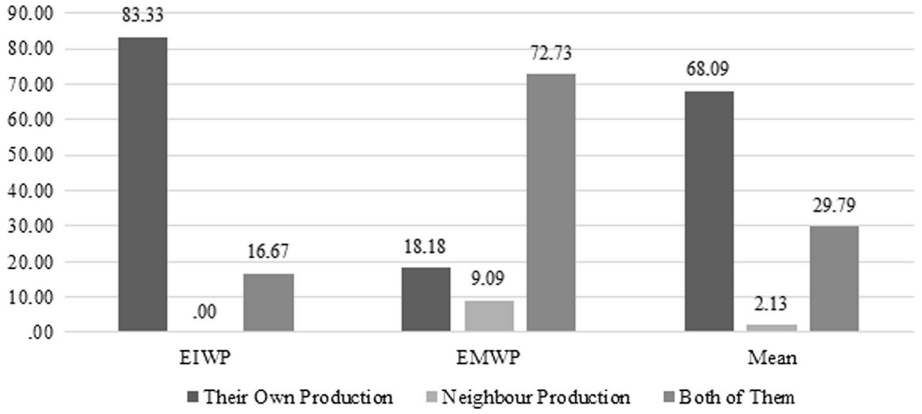

Fig. 4 Seed sources of einkorn wheat (EIWP) and emmer wheat productions (EMWP) (%)

According to the observation and in-depth interview with the farmers, the most produced crops were determined as wheat, barley, and oat. It is another indicator showing that the rain-fed production system is dominant in the research area. Barley and Oat are other animal feed sources, and in the region, animal husbandry is an important source of living. The economic dynamics of the region are based on plant production and animal production, and the subsistence farming system is dominant.

3.2 Production, storage, and usage practices of EIWP and EMWP

Production practices and the farmer's behaviors are important indicators to understand the culture and tradition depending on wheat. Wheat is not only food for Turkish people, but it is also a part of the culture. Wheat is the main staple crop and an indispensable part of Turkish life. Besides its significant economic importance, wheat has social and cultural as well as historical value. Turkish people have added wheat and their products (such as local bread, bulgur, and erişte) to their life and have dedicated as a holy symbol that should not be disrespectful against it. In this case, it has shared the fact that Turkey is one of the gene centers of wheat. Emmer and einkorn wheats are known as the ancestor of wheat when compared to the other wheat landraces; humanity came across them long before. In the research area, most of the farmers (85.11%) could not give exact date for emmer and einkorn wheats (producing since their great fathers). This result is also indicating that the farmers have not changed their seeds for long times. According to the survey results, this theory has been proved. Figure 4 shows the seed source of EIWP and EMWP. According to Fig. 4, it was calculated that the difference between EIWP and EMWP on seed sources was found statistically important at 99% confidence level (Likelihood ratio 17.06, p 0.00). EIWP use only their own seeds more than EMWP (83.33% and 18.18%, respectively). It means that seed exchange and informal seed marketing are more common among EMWP. It can be seen from figure that the EMWP prefer both their owned seeds and neighbor seeds (72.73%). The reason is able to be dedicated that EMWP produce emmer wheat generally for their animal feed. Therefore, they do not pay much attention to the seed cleaning of the emmer wheat they grow. The harvested wheat obtained by EMWP may be more mixed with foreign substances, soil, straw, foreign seeds, grains of cereals, and stones. For this reason, EMWP has chosen to find clean seed from their neighbors instead of using

Table 4 Production system of EIWP and EMWP

Production system	EIWP		EMWP		Total	
	Count	%	Count	%	Count	%
Rain-fed	29	74.36	11	100.00	40	80.00
Irrigated	7	17.95	0	.00	7	14.00

Likelihood ratio 4.09, *D.F.* 1, p 0.043, φ −0.23, Fisher's exact test p 0.18

their own seed. It was found that EIWP did not change their seed and use generally their own seed. It means that seed cleaning activity was performed by the EIWP more. Different cleaning styles are able to be used in the region. More common ones are cleaning by hand and sieves.

Landraces are generally more adaptive to dry conditions and could also be produced under rain-fed conditions. But extending irrigation capacities to more farmers could actually lead to genetic erosion, since farmers generally prefer modern and more profitable varieties, instead of landraces (Kan et al. 2015). Einkorn and emmer wheats are more suitable for poor and infertile soils on higher altitude. In the study, it was determined that emmer and einkorn productions were being done mostly in rain-fed condition of the research area. As shown in Table 4, einkorn wheat was able to be irrigated because of its use in human consumption as well as its commercial potential. A total of 17.95% of the EIWP in the research region is irrigated in their production. EMWP avoid the irrigation due to the fact that they produce it mostly for animal feeding, maintain this production under harsh conditions (not so fertile soil, high place, small plots, etc.) and do not have suitable areas for irrigated agriculture. The differences between EMWP and EIWP on production system were found as statistically important at 95% confidence level (Table 4). The results are similar to Kan et al. (2015) study and found that the wheat landraces were produced by the farmers mostly in rain-fed conditions in Turkey (87.22%).

Wheat landraces, when compared to commercial wheat varieties, have low yield potential (Ehdaie et al. 1988; Blum et al. 1989). Wheat landraces have been largely displaced by high-yielding cultivars in many developing countries and are rarely cultivated in developed countries because of their low yield potential when compared with high-yielding cultivars under high external input farming systems (Jaradat 2012). The yield performance of emmer and einkorn wheats in this study is shown in Fig. 5. The real amount of seed used by the farmers was accepted as average 260 kg/ha for EIW, and 276 kg/ha for EMW which is obtained by in-depth interview, observation, and the study done by Kan et al. (2015). The farmers do not know the exact yield but they use local terminology according to the seed amount which they use in production. This terminology is a ratio showing the yield being calculated from the seed amount such as 1/6, 1/7, etc. The overall regional average yields in good, normal, and bad years were calculated by using average seed usage of EMWP and EIWP and were found to be 2452 kg/ha, 1891 kg/ha, and 1386 kg/ha. These amounts changed between EMWP and EIWP, and in a good and normal year, they are statistically important at 95% and 90% confidence level (M–W-U $\text{Value}_{\text{good year}}$ 101, p 0.013; M–W-U $\text{Value}_{\text{normal year}}$ 128, p 0.065; M–W-U $\text{Value}_{\text{bad year}}$ 165, p 0.298). The yields vary between 1040 and 2760 kg/ha according to production techniques, geographical conditions, and wheat types (emmer and einkorn) in a normal year. They can be said that EMW is more yielding than EIW. Some studies done in Turkey showed that the average emmer yield was determined as 1.2 t/ha (Giuliani et al. 2009), 2127 kg/ha (average yield of emmer wheats

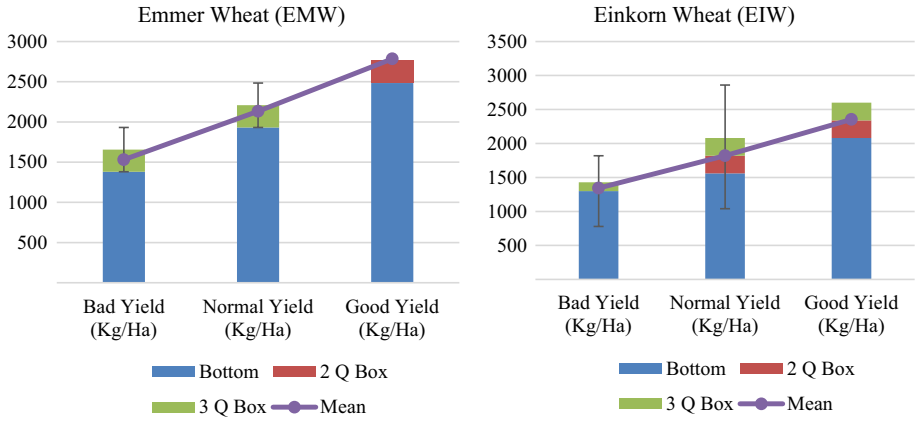

Fig. 5 Good, normal, and bad year average yield of einkorn wheat (EIW) and emmer wheat (EMW) (kg/ha)

in different used local names such as Gernik, Kaplıca, Kavılca, Mal, Mahsul wheats) (Kan et al. 2015), and einkorn yield was 1804 kg/ha (Average Iza and Siyez wheats) (Kan et al. 2015) in a normal years and the averageeinkorn yield was determined as 1804 kg/ha (average yield of einkorn wheats in different used local names such as Iza and Siyez wheats) (Kan et al. 2015) in normal years.

Hulled wheats are mostly stored in wooden cellars or sacks. The hard shell structure provides excellent protection in the field and storage (Nesbitt and Samuel 1996). In the study, it was determined that almost half of the farmers, 52.8%, stored in sacks, and the remaining 47.2% in warehouses. The product was likely suitable for storage because of its hulled structure. Farmers also stored in sacks and warehouses according to the availability of the facilities.

The most difficult point we noticed in the study was the difficulties in the post-harvest of the hulled wheat during processing. One of these processes is the procedure for bulgur. In the following photographs (Fig. 6), some process of bulgur, end products of EIW and EMW (flour and bread), and some practices were shown. Bulgur and flour are limited wheat products processed in the research region, unfortunately, do not meet the demand. The main reason behind this was that the young working population in the rural areas has migrated to the cities because of financial insufficiency in the villages.

Access to markets appears to play an especially important role in the farmer's decision to cultivate wheat landraces. As known that wheat landrace producers generally do not produce these crops and their product for marketing anywhere (Kan et al. 2015). If they decide to market them, they generally want to reach the closest places to market them. These places are mostly in niche market character, and in the places, if the market is not known the people from outside, the profit of the local products are very few. Figure 7 shows how the percentage of household wheat sales varied by wheat types. As seen in the figure, most of the farmers (86.00%) did not sell or trade the hulled wheat products in the market. As a result of this, growers were cultivating in the limited acreages because the processing of these hulled wheats was difficult. They were only grown for own consumption. Because of the difficulties in harvesting and processing of hulled wheat, farmers grow, and allocate seeds for next year production as much as their ownneeds for family consumption and animal feeding. Very few people were selling at the local market for a little sum of income.

Fig. 6 Some practices (storage, bulgur making, flour and bread making) and photographs belonging to hulled wheats. Photographs by H. M. Yaman

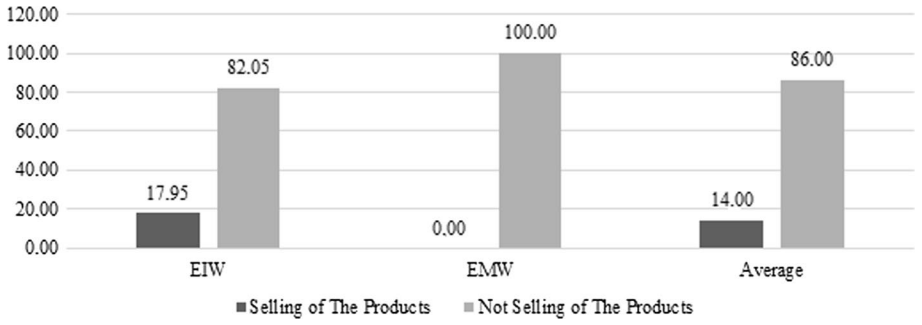

Fig. 7 Percentage of people engaged in selling/not selling einkorn wheat (EIW) and emmer wheat (EMW) products in the market (%)

Few other people are totally engaged with this work, and the product was sold as local products both in and out of the country. In the research area, EMWP were producing their product for their own need (Likelihood ratio 3.79, p 0.05). EIWP could find a chance to market their crop or their products in the market. There are many factors affecting in this situation. In particular, Iza and Siyez, which are EIW, are well-known by the consumers with a higher demand to their product (Bulgur, bread, macaroni, etc.) and are very popular in Turkey and also in the world.

4 Conclusions and recommendations

In our age, the working hours of the people have increased and the feeding time has become limited. The practical and fast food style has been the foreground today to feed. Illnesses are increasing as a result of these unhealthy nutritions. The natural and reliable food we eat greatly improves our health. In recent years, it has formed a particularly strong interest in local and organic products both in Turkey and in the world. This positive correlation between healthy nutrition and local product increases the interest in local products day by day. In this case, it is able to create a great opportunity for Turkey having an important potential in terms of biodiversity, genetic resources, and local products. Becoming the homeland of wheat which is the world's most important food for humanity for Turkey is multiplying this opportunity. EIW and EMW are the important wheat landraces, and they are very rich in terms of nutritional value, even though its yield is low compared to modern wheat, and it is difficult to harvest. Growing einkorn and emmer wheats are inevitable if we consider the increasing natural and healthy nutrition demand. The increasing demand for natural and high-quality health products has increased the interest in these einkorn and emmer ancestral wheats, and their cultivation areas have widespread.

Today, it is known that one of the most important risks faced by developed countries is genetic erosion. Undeniably, the wonders of crop improvement have resulted in the erosion of genetic diversity of many crops in farmers' fields, including wheat, due to the replacement of landraces and farmers' old cultivars with modern high-yielding cultivars. To conserve local wheat types in the natural environment and to leave them as a heritage for future generations, we should increase public awareness and provide possibilities for small-scale farmers. We know that the main actor on the conservation of genetic resource is small-scale farmers and the farmers living in remote areas such as mountainous areas and far away from marketing facilities. The farmers producing wheat landraces are maintaining this farming system under difficult conditions. Therefore, when policy makers are establishing policy in rural areas, they should establish different policies for specific areas, as well as general policies.

The publicity campaigns are the important steps to increase public awareness. There are some attempts to advertise the EIW in Turkey. An initial attempt at a public awareness action was the first Hulled Wheat Bulgur Festival organized in August 2008 by the Municipality of İhsangazi (Kastamonu Province), which is foreseen as a regular event. Such advertisements and organizations share a great deal in terms of promotion. Another celebration has been held in Bolu province and Seben county of Bolu for IZA (einkorn), starting in 2018. And now, the institutions have started to use another tool to promote local foods and landraces—Geographical Indications (GI's). Siyez bulgur, Iza buğday, and Kavılca bulgur are some samples known that there are some attempts in

their region to get GI certificates. It is showing that the culture aiming to embrace their cultural values is getting form slowly but decisively in Turkey.

The socioeconomic structure of the farming operations is an important factor in the protection and production of local varieties involved in situ conservation under farmer conditions. To know the conditions, practices, behaviors, problems, and difficulties of these farmers, it will be easy to create special policies for them. The study has shown that the ancestor of wheat—EMW and EIW—are still produced by the farmers, but they do not aware of their value. We should create the value-added project to provide maintaining these type varieties in farmers' condition. One of the main tools to conserve the genetic resource and prevent genetic erosion is to touch the farmers' economy. If the farmers earn money from them, they will be tight-knit with these types of landraces such as EMW and EIW.

Wheat is not only a crop for Turkish people, but it is also a culture. In Turkish cuisine, there are many wheat products such as bulgur, tarhana, special bread peculiar to different regions, erişte, and keşkek. These are reflections of our cultures coming from our ancestors. In the research, it was found that we have not lost our genetic heritage (the ancestor of wheat—EMW and EIW) yet, but we must conserve them by supporting the farmers producing this type of special crops. As seen in the research, these farmers are poor and are engaged in subsistence farming. The government should support collection, conserving, and usage activities of landraces more by not damaging biodiversity and environment. Access to the markets, processed of the hulled wheat, especially having turned to the added value products and cooperation of the farmers are essential tools for local food-based development of the area.

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