ABANT IZZET BAYSAL UNIVERSITY
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGY

DETERMINATION OF GEOGRAPHIC DISTRIBUTION AND MACRO - MICRO ELEMENT CONTENT VARIATION OF EINKORN (*TRITICUM MONOCOCCUM* SSP. *MONOCOCCUM*) AND EMMER (*TRITICUM DICOCCUM* SCHRANK.) WHEATS IN WESTERN BLACK SEA REGION

MASTER OF SCIENCE

HURİ MELEK YAMAN

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DECLARATION

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Huri Melek YAMAN

ABSTRACT

DETERMINATION OF GEOGRAPHIC DISTRIBUTION AND MACRO - MICRO ELEMENT CONTENT VARIATION OF EINKORN (*TRITICUM MONOCOCCUM* SSP. *MONOCOCCUM*) AND EMMER (*TRITICUM DICOCCUM* SCHRANK.) WHEATS IN WESTERN BLACK SEA REGION
MSC THESIS
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ABANT IZZET BAYSAL UNIVERSITY GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF BIOLOGY
(SUPERVISOR: PROF. DR. NUSRET ZENCİRCİ)

BOLU, JANUARY 2018

In this study, we have collected nine populations of einkorn (*Triticum monococcum* ssp. *monococcum*) and emmer (*Triticum dicoccum* schrank.) wheat from five provinces (Bolu, Kastamonu, Karabük, Sinop, Samsun) of the Western Black sea region in July-August 2016, one bread wheat (*Triticum aestivum* L.), and one durum wheat (*Triticum durum* Desf.) for comparison. Economic, marketing, and social structures in these areas of cultivation were identified by the help of 53 questionnaires. The data were evaluated by SPSS program. *In situ* cultivation and natural harvesting of einkorn and emmer wheat were observed in all five provinces but larger in Kastamonu İhsangazi and Bolu Seben district. The most important feature that distinguishes old einkorn wheat from modern wheat is the difficulties in processing. However, nowadays, the importance of cultivation and the cultivation areas are increasing especially in İhsangazi and even exported abroad because of the increase in demand for natural nutrients**.**

In wheat samples we collected, macro (N, P, K) and micro elements (Fe, Mn, Zn, Cu), energy, carbohydrate, protein, starch, fat, fiber, sugar, crude ash and protein analyses were run in Special Food Control Laboratory at Konya Laboratory and Storage, Agriculture, Food, Energy A.C. Furthermore, saturation, salt, pH, $CaCO_3$ (lime), active lime, K_2O (Potassium Oxide), P_2O_5 (Phosphorus Pentoxide), electrical conductivity (EC), nitrogen, sodium, potassium, magnesium, iron, manganese, zinc, copper and organic matter in were determined in Soil and Leaf Analyses Laboratory Bolu Food, Agriculture and Animal Husbandry Province Directory. According to ANOVA results, N, P, K, Fe, Zn and Mn values were significant in terms of element content of, the wheat samples and Cu was not significant. In terms of other properties, 1000 grain weight, crude protein, energy, crude cellulose, crude oil, hectoliter, carbohydrate, starch, sugar are significant, but raw ash has not significant. According to ANOVA analysis, soil samples significantly differed for N, Na, K, Fe, Cu, Ca, Zn, Mn, and Mg. Other properties were significant for saturation, pH, $CaCO_3$ (lime), active lime, K_2O (potassium oxide), P_2O_5 (phosphorus pentoxide) but not for salt and EC. In wheat samples according to Least significant difference (LSD) table; differentiated population-4 the highest for P, K, Cu, Fe and Mn, Kunduru-1149 the highest for 1000 grain weight, crude protein, energy, raw cellulose, and hectoliter, population-8 had the highest energy,

crude oil, carbohydrate, and starch. In soil samples according to LCD table; population-5 had the highest in terms of Cu, Ca and Mg, population-8 of N, Fe, and Mn. Population-2 had the highest N and Zn elements and other contents of $CaCO_3$, active lime, EC, K_2O, organic matter, P_2O_5, and salt is the front plan compared to other populations. Correlation in 11 wheat samples were highly significant between N-Cu (0.926), P-Mn (0.838), P-K (0.788), carbohydrate-starch (0.975), energy-starch (0.817), energy-carbohydrate (0.762); significant between Zn-Mn (0.634), crude protein-starch (-0.605), crude protein-carbohydrate (-0.706), crude protein-crude cellulose (0.609), crude cellulose-sugar (-0.687), hectoliter-starch (-0.691), hectoliter-carbohydrate (-0.626) while the others were not significant. Correlation in soil samples between Fe-Mn (0.802), total N-Mn (0.736), $CaCO_3$-active lime (1.000), saturation-salt (0.829), organic matter-P_2O (0.789), $CaCO_3$-K_2O (0.750), active lime-K_2O (0.749) were highly significant; between total N-Zn (0.725), Cu-Mg (0.704), Cu-Ca (0.608) were significant while the others were not significant. Two main groups were formed in the dendogram for 11 wheat samples; ten samples were in the first main group and population-4 alone in the second group. Two main groups were formed for 11 soil samples in the dendogram, the first main group were consisted of five populations and the second main group were consisted of six populations.

KEYWORDS: Western Black Sea, Einkorn, Emmer, Soil Analysis, Macro and Micro Elements.

ÖZET

BATI KARADENİZ BÖLGESİ SİYEZ (*TRITICUM MONOCOCCUM* SSP. *MONOCOCCUM*) VE GERNİK (*TRITICUM DICOCCUM* SCHRANK.) BUĞDAYLARININ COĞRAFİ DAĞILIMI İLE YETİŞTİĞİ TARLALARIN VE DANELERİNİN MAKRO VE MİKRO ELEMENT İÇERİK ÇEŞİTLİLİKLERİNİN BELİRLENMESİ
YÜKSEK LİSANS TEZİ
HURİ MELEK YAMAN
ABANT İZZET BAYSAL ÜNİVERSİTESİ FEN BİLİMLERİ ENSTİTÜSÜ
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(TEZ DANIŞMANI: PROF. DR. NUSRET ZENCİRCİ)

BOLU, OCAK - 2018

Biz bu çalışmada Batı Karadeniz Bölgesi'nin beş ilinden (Bolu, Kastamonu, Karabük, Sinop, Samsun) Temmuz-Ağustos 2016'da topladığımız dokuz adet siyez buğdayı (*Triticum monococcum* ssp. *monococcum*) ve çatal siyez buğdayı (*Triticum dicoccum* schrank.) ile kıyaslama yapmak için bir adet ekmeklik buğday (*Triticum aestivum* L.) ve bir adet makarnalık buğday (*Triticum durum* Desf.) aldık. Bu alanlardaki ekonomik, pazarlama ve sosyal yapılar 53 ucu açık anket yardımı ile belirlenmiştir. Veriler SPSS programı ile değerlendirilmiştir. Siyez ve çatal siyez buğdayı yerinde yetiştirme ve doğal hasatı beş ilin hepsinde gözlemlendi, ama Kastamonu İhsangazi ve Bolu Seben bölgelerinde daha büyüktü. Eski siyez buğdayını modern buğdaydan ayıran en önemli özellik işleme zorluklarıdır. Ancak, günümüzde özellikle İhsangazi'de ekim alanları ve ekimin önemi artmakta ve yurtdışına ihraç edilmektedir çünkü doğal besin maddelerine talep artmıştır.

Topladığımız buğday örneklerinde makro elementler (N, P, K), mikro elementler (Fe, Mn, Zn, Cu), enerji, karbonhidrat, protein, nişasta, yağ, lif, şeker, ham kül, ham protein, % protein, hektolitre, 1000 dane ağırlığı ile ilgili analizler Konya Laboratuvar ve Depoculuk, Tarım, Gıda, Enerji A.Ş. Özel Gıda Kontrol Laboratuvarı'nda yaptırılmıştır. Ayrıca, toprak örneklerinde satürasyon, tuz, pH, kireç ($CaCO_3$), aktif kireç, K_2O (potasyum oksit), P_2O_5 (fosfor pentoksit), elektrik iletkenliği (EC), azot, sodyum, potasyum, kalsiyum, magnezyum, demir, mangan, çinko, bakır ve organik madde tespiti Bolu Gıda, Tarım ve Hayvancılık İl Müdürlüğü Toprak ve Yaprak Analiz Laboratuvarı'nda yaptırılmıştır. Analizler sonucu elde ettiğimiz verilerin istatistikleri yapılarak sonuçlar değerlendirilmiştir. ANOVA tablosuna göre buğday örnekleri element içeriği açısından N, P, K, Fe, Zn ve Mn anlamlı, Cu anlamsız çıkmıştır. Diğer özellikler açısından 1000 tane ağırlığı, ham protein, enerji, ham selüloz, ham yağ, hektolitre, karbonhidrat, nişasta, şeker anlamlı, hamkül anlamsız çıkmıştır. ANOVA tablosuna göre toprak örnekleri elementler açısından N, Na, K, Fe, Cu, Ca, Zn, Mn ve Mg anlamlı sonuç vermiştir. Diğer özellikler; satürasyon, pH, $CaCO_3$ (kireç), aktif kireç, K_2O (potasyum oksit), P_2O_5 (fosfor pentoksit) açısından anlamlı, fakat tuz ve elektrik iletkenliği açısından anlamsız sonuç vermiştir. LSD tablosuna göre buğday örneklerinde; populasyon-4 P, K, Cu, Fe ve Mn açısından ön planda, Kunduru-1149 1000 tane ağırlığı, ham protein, enerji, ham selüloz ve hektolitre açısından ön planda, populasyon-8 ise enerji, ham yağ, karbonhidrat ve nişasta açısından ön plandadır. LSD tablosuna göre toprak örneklerinde; populasyon-5 Cu, Ca ve Mg, populasyon-8 N, Fe ve Mn elementleri açısından ön planda. Populasyon-2 N ve Zn elementleri ve diğer içerikler $CaCO_3$, aktif kireç, elektriksel

iletkenlik, K_2O, organik madde, P_2O_5, tuz açısından diğer populasyonlara göre ön plandadır. Korelasyon hesaplarında 11 buğday örneğinde N-Cu (0.926), P-Mn (0.838), P-K (0.788), karbonhidrat-nişasta (0.975), enerji-nişasta (0.817), enerji karbonhidrat (0.762) yüksek anlamlı, Zn-Mn (0.634), ham protein-nişasta (-.605), ham protein-karbonhidrat (-.706), ham protein-ham selüloz (0.609), ham selüloz-şeker (-.687), hektolitre-nişasta (-.691), hektolitre-karbonhidrat (-.626) anlamlı çıkmış, diğerleri anlamlı çıkmamıştır. Toprak örneklerinde korelasyon; Fe-Mn (0.802), total N-Mn (0.736), $CaCO_3$-aktif kireç (1.000), saturasyon-tuz (0.829), organic madde-P_2O (0.789), $CaCO_3$-K_2O (0.750), aktif kireç-K_2O (0.749) yüksek anlamlı, total N-Zn (0.725), Cu-Mg (0.704), Cu-Ca (0.608) anlamlı çıkmış, diğerleri anlamlı çıkmamıştır. Öbekağacı grafiğinde 11 buğday örneği için iki ana grup oluşmuş 10 örnek ilk ana grupta toplanmış, populasyon-4 tek başına ikinci grupta kalmıştır. Öbekağacı grafiğinde 11 toprak örneği için iki ana grup oluşmuş ilk ana grup beş, ikinci ana grup altı populasyondan oluşmuştur.

ANAHTAR KELİMELER: Batı Karadeniz, Siyez, Gernik, Toprak Analizi, Makro ve Mikro Elementler.

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LIST OF ABBREVIATIONS ANDSYMBOLS

%	**:** Percent
°C	**:** Centigrade Degree
º	**:** Degree
'	**:** Minute
"	**:** Second
AACC	**:** American Association of Cereal Chemists
AAS	**:** Atomic absorption spectrophotometry
ANOVA	**:** Analysis of variance
Ca	**:** Calcium
$CaCO_3$	**:** Calcium carbonate
cm	**:** Centimetre
Cu	**:** Copper
DF	**:** Degrees of freedom
EC	**:** Electric Conductivity
EN	**:** European Norm
Fe	**:** Iron
GLC	**:** Gas-liquid chromatography
H_2SO_4	**:** Sulfuric acid
HCl	**:** Hydrochloric acid
ISO	**:** International Organization for Standardization
K	**:** Potassium
K_2O	**:** Potassium oxide
Kg	**:** Kilogramme
KW	**:** Kernel weight
LSD	**:** Least significant difference
Mg	**:** Magnesium
Mn	**:** Manganese
Mr.	**:** Mister
Mrs.	**:** Mistress
MS	**:** Mean squares
ms	**:** Microsiemens
Na	**:** Sodium
NaOH	**:** Sodium hydroxide
N	**:** Nitrogen
NMKL	**:** Nordisk metodikkomite for levnedsmidler
P	**:** Phosphorus
P_2O_5	**:** Phosphorus pentoxide
SPSS	**:** Statistical Package for the Social Sciences
Ssp.	**:** Sub-species
TS	**:** Technical Specification
Zn	**:** Zinc

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1. INTRODUCTION

Wheat is a major source of food grain in Turkey and in the World. It is increasingly needed because of the fast growing human population in developing countries. It is the main ingredient of most foods, especially daily bread and also a source of animal feed. This is why wheat we use is a good source for food security. Thinking of this way, we carried out research on hulled einkorn and emmer wheat, which had emerged 10-13 thousand years ago around Karacadağ in South-eastern Anatolia. The Neolithic East Mound at Çatalhöyük is also one of a number of large early farming settlements from the 8th millennium BC in south-west Asia. It had also been expected to be a part of the Central Anatolian Neolithic cultural complex (Gerard and Thissen 2002; Düring 2006). In other words, wheat is the main source of culture from the past to now.

The Western Black Sea Region starts from the western edge of Kızılırmak delta and extends to the east of Adapazarı and Bilecik. The region is in the North of Turkey. The name is after the Black Sea. The region is generally mountainous. Forestry and forest products are important income sources. The elevation of the mountains extending along the Black Sea is about 2000 m in the West. Mountains' elevation and direction also affect transportation, climate, and agricultural activities. The mountains which are parallel to the sea cost limit the size of agricultural areas. Having to much slope in the mountains make mechanized agriculture difficult. The animal and human power in the region are still needed. In the region, there are various dark, humus-rich acidic washed soils due to climatic conditions. Climatic conditions in the Black Sea region are influential. Every season is rainy. Annual temperature difference is small. The summers are cool and the winters are warm. The provinces here in the Black Sea region mostly follow regional characteristics.

Bolu is located between 40º 06' and 41º 01' northern latitudes and 30º 32' and 32º 36' east longitudes. The avarage altitude is 1000 m and the central district altitude is 725m. Bolu's climate is a transitional one between the sea climate and the inner central Anatolian one. Both climates have an impact in the province. In the places

near the Black Sea, summers are cool and winters are warm. There is little differences between summer and winter. In the interior, the temperature highly differs between night and day. In this part, the winters are cold and snowy. The annual rainfall is between 535-1084 mm. More than half of Bolu average is forested.

Karabük is a basin surrounded by high mountains and hills, about 250-500 m. high. The northern rivers arising from the mountains area in the North have formed an alluvial filling with the materials they carry towards the city. The avarage altitude is 260 m. It is located between 40° 57' and 41° 34' north latitudes and 32° 04' and 33° 06' east longitudes.

Sinop city is located on the Boztepe foreland and peninsula, where the Black Sea coastline stretches to the north most extensively. It is located between 41º 12' and 42º 06' north latitudes and 34º 14' and 35º 26' east longitudes. It has a rainy area, there are lots of valleys and streams. All of the valleys and streams are used in the irrigation and transportation of forest products through the Black Sea. It is rich in forests and vegetations because of its frequently higher rainfall.

Samsun city is located in the middle part of the Black Sea coastline between Yeşilırmak and Kızılırmak rivers, which pour into the Black Sea. It is located between 37° 08' and 34° 25' east latitudes and 40° 50' and 41° 45' north latitudes. It is rich in natural vegetation. It is very rich in terms of water and has many natural and dam lakes as well as ponds.

Most of the districts of Kastamonu province in the Black Sea region of Turkey is a higher mountainous zone covered by forests. Most of the districts inthe province are situated between 600 m and 1200 m altitude (Giuliani et al. 2009). Kastamonu is very convenient for growing einkorn and emmer wheat in its conditions. It is located between 35° 45' and 42° 00' north latitudes and 32° 43' and 34° 37' east longitudes. Kastamonu is a river, mountain, forest, and sea province. The altitude is 775m.

Bilecik is located on the cut-off points of the Marmara, Black Sea, Central Anatolia and Aegean Regions in the south-east of the Marmara Region. 39° 31' and

40° 31' north latitudes and 29° 43' and 30° 41' east longitudes. It is surrounded by Bolu and Eskişehir from the east, Kütahya from the south, Bursa from the west and Sakarya from the north. The altitude is 526 m. There are 3 types of climatic types in the passage area of Bilecik, parallel to the water sources and different topography.

1.1 Wheat (*Triticum* spp.)

A considerable part of the energy and protein needs of people living on Earth are met with cereal products. Among these products, wheat is the most important nutrition source, a strategic product, and an indispensable product in the food industry. The recent food crises has caused consumers to look for more authentic and safer foods. Organic food production is considered better for the environment, more friendly, more controlled, better for animal welfare and human health (Rembiałkowska, 2007). In order to protect our health, it has become imperative to orient ourselves to natural nutrients. One healthy food today is hulled and/or pimary old wheats. In the mid-19th century, wild einkorn (*Triticum boeoticum*) was discovered in Turkey and treated as a domesticated einkorn wheat till 1900. This situation has showed that wheat was the most important nutrient source that emerged from the past in Turkey and reached to the world. Half of the nutrients we consume are derived from wheat. These are mostly flour, bulgur, tarhana, pasta, cookies and other pastries, especially bread. Furthermore, some of wheat are consumed as animal feed.

Turkey ranks first in terms of wheat wild relatives hosted in the world. All of the relatives of modern wheat are found in Turkey. The location in where Turkey is located is suitable for growing a wide variety of species because of soil characteristics, location patterns, and the climate.

1.1.1 Origin of ancient wheats

The hulled wheat was one of the earliest domestic plants on the Eurasia extending from the British Isles to Central Asia, and was an untouched plant for

thousands of years. It is our greatest heritage from our past by our ancestors who left us by hidingand sharing their own seeds with each others for those long years. In the figure 1.10 the phylogeny of the domestication species of *Triticum* ssp. shown. Here, the einkorn, emmer, spelt, durum, and common wheat are mentioned.

The Fertile Crescent (Cradle of Civilization) is a crescent-shaped area in the Middle East that was known as the birthplace of several ancient kingdoms. The important rivers and marshlands in the Fertile Crescent (Figure 1.9), the area was also important because of its physical location as an area that bridged the three continents of Africa, Europe and Asia. As people from these areas began to explore other areas and develop trade routes, the Fertile Crescent flourished as a hub of travel and trade. Changes over the past 30 years, though, have made the traditional Fertile Crescent much less fertile.

Archaeobotanical findings in regions outside Egypt are not based on Hillman's emmer storage hypothesis. For example, in the Iron Age region of Assyros, the dry summer climate of Greece, emmer was stored in emmer spikelets (Jones 1981; Jones et al.1986). Emmer, in an earlier period, was stored as spikelets at the 4th millennium BC at Chalcolithic site of Kuruçay in western Anatolia (Nesbitt 1996). The evidence from the ancient eastern Mediterranean region is still uncertain but it is for sure that the hulled wheat is stored both as spikelet and grain. The tools shown in Figure 1.11 are about the processing of cereals in the 20th century on pounding with pestles in a mortar, sieving, and ismilling with a saddle quern set.

Table 1.1 Plant remains from archeological excavations

Date (BC)	Site	Plant Remains
7500	AşıklıHöyük	Einkorn, emmer, hard wheat
7200-6500	Çayönü	Einkorn, emmer, wild einkorn
6750	Hacılar	Wild einkorn, cultivated emmer
6500	Can Hasan	Wild einkorn, cultivated einkorn
6000-5000	Çatalhöyük	Einkorn, emmer
6000-5000	Erbaa	Einkorn, emmer

(Harlan 1995; Karagöz et al. 2010)

1.1.2 Hulled wheats (*Triticum monococcum* ssp. *monococcum* and *Triticum dicoccum* Schrank.)

Emmer (*Triticum dicoccum* Schrank.) and einkorn (*Triticum monococcum* ssp. *monococcum*) were probably domesticated in Southeast Turkey, but genetic diversity points are more than one area of domestication (Heun et al. 1997; Kilian et al. 2007; Luo et al. 2007; Özkan et al. 2002). The following table 1.2: *Triticum* species and Turkish names are shown on Turkey. Table 1.3 below shows the cities where hulled wheat grows and how many hectares it grows in Turkey. Also in table 1.4, hulled wheat is generally referred to as ploidy level, common and botanical names, wild or domesticate, and genome.

Table 1.2 *Triticum* species in Turkey

Ploidy level	Species	Name
Diploid (2x=14)	*Triticum boeoticum* Bois.	Wild einkorn
	Triticum monococcum L.	Einkorn
	Triticum urartu thumanjn ex gandilyan	Urartu
Tetraploid (4x=28)	*Triticum carthlicum* Nevski	Acem wheat
	Triticum dicoccoides	Wild emmer
	Triticum dicoccon	Emmer
	Triticum durum Desf.	Durum wheat
	Triticum polonicum L.	Polish wheat
	Triticum timopheevii Zhuk. Var. *araraticum*	Russian wheat
	Triticum turgidum L.	Turgidum
Hekzaploid (6x=42)	*Triticum aestivum* L.	Bread wheat

(Cabi 2010; Güner et al. 2012; Özberk et al. 2016)

Table 1.3 The hulled wheat planting provinces and their planting areas (ha) in Turkey

Province	Cultivation area (ha)
Kastamonu	8280
Zonguldak	3200
Samsun	2192
Bolu	646
Sinop	300
Kayseri	50
Çankırı	20
Total	**14688**

(Bulut S 2016)

Table 1.4. Common and botanical names of wild and domesticated hulled wheats, arranged by genetic characteristics

Ploidy level	Common name	Botanical name	Wild or domesticated	Genome
Diploid	Wild einkorn	*T. boeoticum* Boiss.	Wild	AA
		T. urartu Thum. ex Gandil.	Wild	AA
	Einkorn	*T.monococcum* L.	Domesticated	AA
Tetraploid	Wild emmer	*T.dicoccoides*	Wild	AB
		T. araraticum	Wild	AG
	Emmer	*T. dicoccum* Schrank.	Domesticated	AB
		T. palaeocolchicum	Domesticated	AB
		T. ispahanicum	Domesticated	AB
		T. timopheevi	Domesticated	AG
Hexaploid	Spelt	*T. spelta* L.	Domesticated	ABD
		T. macha	Domesticated	ABD
		T. vavilovi	Domesticated	ABD
		T. zhukovskyi	Domesticated	AAG

(Dorofeev and Migushova 1979)

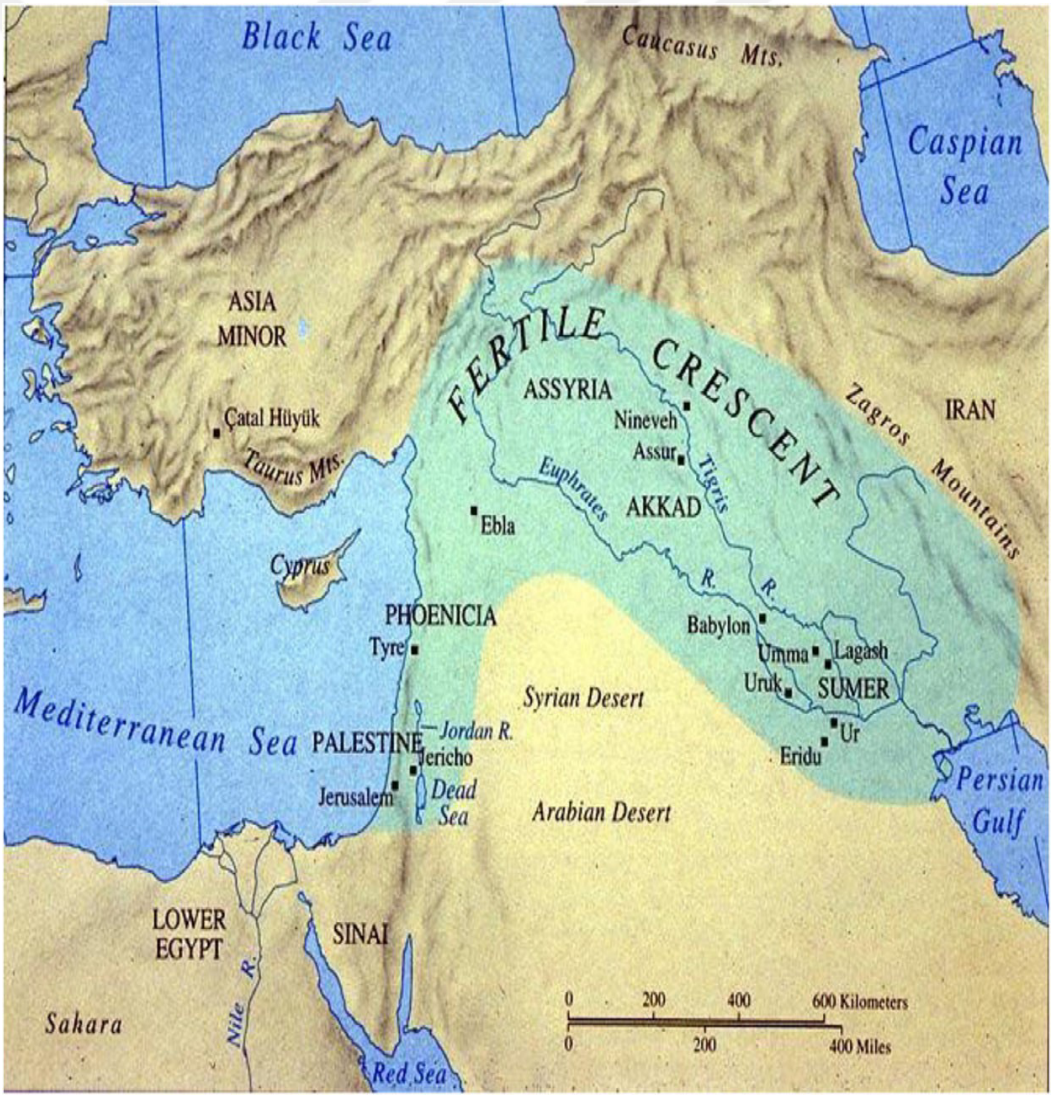


Figure 1.1 The Fertile Crescent in relation to the modern day locations

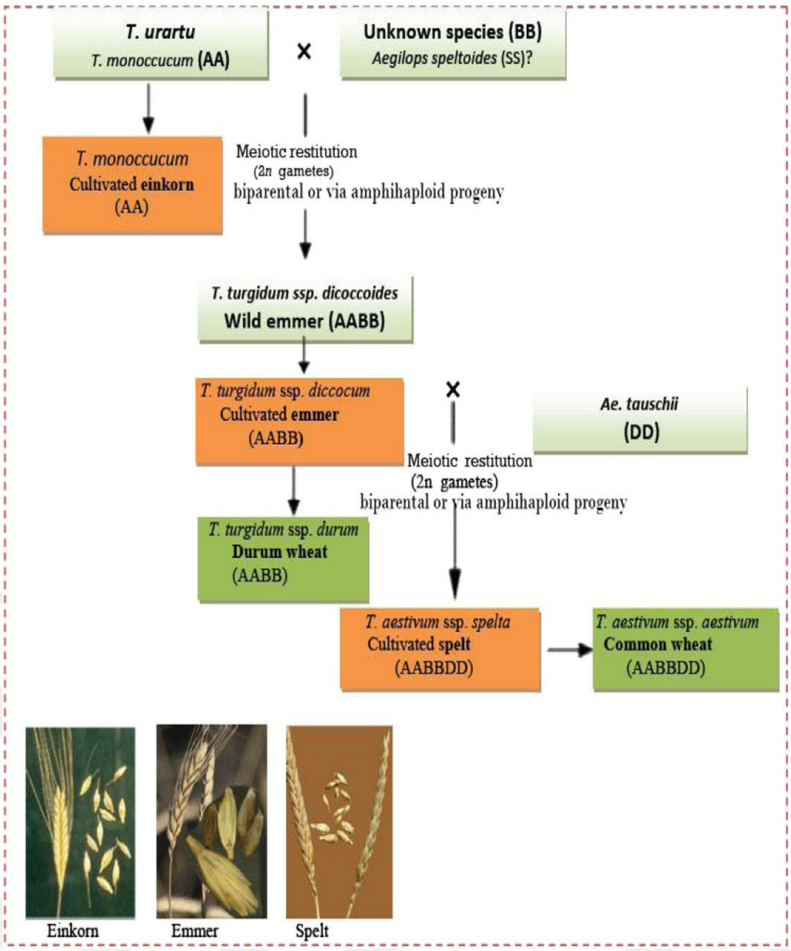


Figure 1.2 Phylogeny of domesticated species of the *Triticum* spp., including einkorn, emmer, spelt, durum, and common wheat (Ashraf and Arzani 2017).

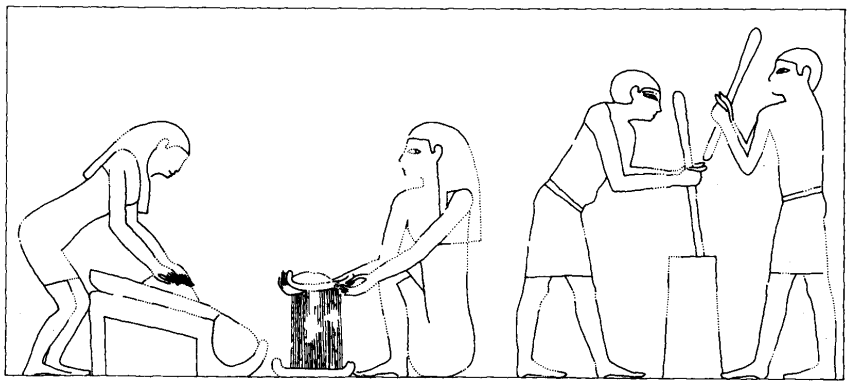


Figure 1.3 Part of a baking and brewing scene from the tomb of Intef-inker at Thebes, dating to the early 12th Dynasty (20th century BC). From the right, two men are pounding with pestles in a mortar, a woman is sieving, and another woman ismilling with a saddle quern set into an emplacement. Although the tools and basic actions are clear, the sequence and precise activities are by no means obvious (Samuel 1993; Davies and Gardiner 1920; Kemp 1989).

Wheat and barley farming is widely accepted today for the first time in the "Fertile Crescent" region between the rivers of Euphartes and Tigris, which consists Iran, Iraq, Turkey, Syria, Lebanon, Israel and Palestine (Lev-Yadun et al. 2000).

The earliest cultured wheat samples unearthed in Europe were obtained from Greece. They date back to 5900 years (Nesbitt and Samuel 1996), and the Hittites, the oldest and first empire located at Hattuşaş near Çorum in Anatolia, had 4200-5900 tons of silosin the 13th century (Seeher 2001).

As known, Turkey is in the genetic diversity center of wild wheats. It is located in the Middle East and its Mediterranean periphery and West Asia where 22 wild wheat species are spreading (Van-Slageren 1994).

The increasing popularity of organic farming and healthy food products have led to a renewed hulled wheat varieties. As the name suggests, the main character that distinguishes the hulled wheats from the freethreshing wheats is the persistent enclosing body. Hulledness in wheat includes other important characteristics. The thick, hard containers of hulled wheats provide excellent protection to the grains in the field and in storage (Nesbitt and Samuel 1996).

The origin of wheat is unknown and some solid evidence about the distrubition of einkorn (*Triticum monococcum* ssp. *monococcum*) comes from the arid areas of Anatolia and the other form emmer (*Triticum dicoccum* schrank.) from the mountainous regions of Syria and Palestine (Elgün and Ertugay 2002).

The cultivated hulled are wheats einkorn *(Triticum monococcum* L. diploid: 2n=2x=14 chromosomes, AA genome), emmer (*Triticum dicoccum* Schrank. tetraploid: 2n=4x=28 chromosomes, AABB genome) and spelt (*Triticum spelta* L. hexaploid: 2n=6x=42 chromosomes, AABBDD genome) (Szabo and Hammer 1996). Also, macha (*Triticum aestivum* subsp. *macha* hexaploid: 2n=6x=42 chromosomes, AABBDD genome) and vavilovi (*Triticum aestivum* subsp. *vavilovi* hexaploid: 2n=6x=42 chromosomes, AABBDD genome).

In some countries, there is renewed increasing interest in recent years for improved health benefits, because fewer traditional hulled wheats for traditional foods can be grown, but it is suggested that the rich bioactive components are the source and therefore suitable for producing high value food products (Ruibal-Mendieta et al. 2005; Lachman et al. 2013; Shewry and Hey 2015). Hulled wheats are at the top of traditional healthy foods. Agriculture is a day-to-day ancestral tradition. It is a heritage of a culture and seeds that pass from father to son.

1.1.2.1 Einkorn wheat (*Triticum monococcum* ssp. *monococcum*)

Einkorn wheat (*Triticum monococcum* ssp. *monococcum*) is primitive but primary kind of plant. Figure 1.1 shows wild einkorn wheat green spike and Figure 1.2 shows einkorn wheat spike and grain. Winter and spring forms occur. Spikes are narrow, slender, awned, flattened, and fragile. Spikelets contain only one fertile flower and thus produce only one seed. The seeds are pale red, slender, flattened, almost without wrinkled, and remain the spikelets after threshing.

The einkorn name, a single grain wheat variety, comes from German. Also known as small spells (*Triticum monococcum* ssp. *monococcum*) (Ivancic 2002; Szabo et al. 1996), *Triticum monococcum* are known in our country as hot spring or einkorn wheat.

It was taken by the Hittites and the Phrygians. The “Siyez” name is based on the Word “zız” which is the name in Hittite. Siyez wheat is a different species from wheat, which is called “Emmer” or “Speltatoides” by Europeans, and *Triticum dicoccum* L. Species “Gernik “ which grows in Anatolia. It is known in our country as gernik. In Germany, two grains, stripped wheat, meaning. *Triticum dicoccum* is called emmer and its origin is near east (Nevo 1988).

Einkorn wheat species which are faced with the danger of extinction determined by the Slow Food Foundation in Italy is a species selected from Turkey. It was one of the most cultivated species in the first agricultural villages, about 11000 years ago.

Einkorn is a biotic or abiotic stress resistant plant. It is almost like a wild species that can live and growing poor soils, where today's wheat can not be thought of never growth. The genom, the type, and the order of its genes in its cells remained unchanged throughout the ages (Petko 2015).

Figure 1.4 Wild einkorn (*T. boeoticum*) Courtesy of Alptekin Karagöz.

Einkorn was first identified in the world as cultivated in Karacadağ. Extensive studies were carried on its speices. For example, 1400 wild and cultivated einkorn species were subjected to DNA studies (Hidalgo and Brandolini 2014).

On the other hand, Einkorn is rich in vitamins A, B, and E proteins and minerals (zinc, mangan, manganese, and phosphorus). Einkorn has antioxidant properties, stimulates metabolism, helps remove toxins from the organism, activates the kidney activity, and improves digestion and blood circulation, and it's fat content is higher and contains more lutein than bread wheat. Lutein plays an important role in preventing eye, skin, cancer, heart and vascular diseases and decreasing the risk of illness (Turkey's wheat map 2016).

Studies conducted about the relationship between einkorn and celiac diseses are contradictiary. In one study, it is reported that the presence of the AA genome coding for prolamin in the einkorn wheat reduces the inflammatory effect in celiac disease by reducing the diversity of glüten protein (Agnello et al. 2016). In another

study, proteins in einkorn wheat found to have a negative role in celiac disease or subsequent toxicity (Abdel et al. 1995).

Figure 1.5 Einkorn (*T. monococcum* ssp. *monococcum*) (Gvatsa Zanduri), (Jorjadze M, Berishvili T and Shatberashvili E 2014).

Nutritional value of einkorn is high. It has 1580 KJ. energy in its 100 gr. It has a potassium amount of 3960 mg, sodium of 110 mg, magnesium of 1320 mg, calcium of 220 mg, phosphorus of 4200 mg, carbohydrates of 70.19-74,94, proteins of 11.80%, fats of 2.43-2.88, fibers of 7.65-10.7%, iron of 26 mg, zinc of 0.34 mg, vitamins of 0.37 mg, vitamin of B5 0.80 mg, vitamin PP of 5.20 mg in 1 kg of einkorn (Petko 2015).

1.1.2.2 Emmer wheat (*Triticum dicoccum* schrank.)

Emmer (*Triticum dicoccum* schrank.) is another the most ancient cultivated cereal. It is either winter or spring habit Leaves are generally hairy. Spikes are very dense and flattened laterally, and spikelets are genarally contain two flowers. Emmer wheat is awned.

Figure 1.6 Emmer (*Triticum dicoccum* schrank.) spike and grains (Photo by Aslı).

Emmer is a tetraploid species, derived from wild *Triticum dicoccoides*. Emmer is produced in the provinces of Kars, Kastamonu, Karabük, Sinop, Samsun a small amounts. It is and mostly used for animal feeding but also as “Bulgur”. (Karagöz 1996; Kan et al. 2015). It is called "Kavilca", too. The cultivated emmer wheat (*Triticum dicoccum* schrank.) is one of the oldest products in the world and has been a major crop for thousands of years (Zohary and Hopf 1993; Nesbitt and Samuel 1996; Damania 1998).

Neolithic age had the basic plants in agriculture and their domestication was a determining factor for the start of agriculture (Zohary 2004). Emmer was, in that context, cultivated in antiquity, especially in Egypt and recently, in various countries, Turkey, Bulgaria, Greece.

Emmer is particularly appreciated in terms of resistant starch, fibre, carotenoids, and antioxidant compounds (Serpen et al. 2008). Starch, the main storage carbohydrate in the wheat kernel, constitutes 61 – 68% of the grain and 2-3%

of the sugar (Abdel-Aal and Hucl 2005; Han et al. 2007; Lacko-Bartošová 2010; Lacko-Bartošová and Rédlová 2007).

Emmer is an important mineral source as well (Hussain et al. 2010). Emmer flour is preferred instead of bread wheat flour in most bakery products such as bread, pasta, sweet and savory biscuits, and cakes (Stallknecht et al. 1996). Modern chefs have rediscovered the full flavor of whole-grain emmer pasta and bread, and gathered soft dishes in a number of famous restaurants (Hoeschle-Zeledon et al. 2009). In many countries, Germany and Italy, various products of emmer are consumed.

1.1.2.3 Macha wheat (*Triticum aestivum* subsp. *macha*)

Macha wheat (*Triticum aestivum* subsp. *macha*) is a tall, hollow stem, and a late maturing winter wheat. Spike density is from open to dense, with short awns. Kernels still remain in the spikelets after threshing. They are red, elliptical, and intermediate in hardness. It flowers from June to July. Its seeds ripen from August to September. The flowers are hermaphrodite (having both male and female organs) and are wind pollinated. Macha is a winter wheat. Among its desirable features are; adaptation to humid environments, high resistance to diseases and pests, ability to produce higher biomass. It needs shallow soil, has a high stalk, higher grain protein content of 18%, good bread quality, and a higher yield potential in humid environments where other wheat speices become susceptible to fungal diseases.

Figure 1.7 Spike and seeds of *Triticum macha*, (M. Jorjadze, T. Berishvili and E. Shatberashvili 2014).

1.1.2.4 Vavilovi wheat (*Triticum aestivum* subsp. *vavilovi*)

Vavilovi wheat (*Triticum aestivum* subsp. *vavilovi*) is winter type with moderate maturity with thick and strong, stems. Spikes are intense to loose. Kernels remain in the spikelets after threshing. Spike is erect and narrowly cylindrical. Glume apex of lateral glumes truncates with two-three teeth. Glumes are densely covered with silky adpressed pubescence and longer hairs. Lemmas of lateral spikelets, apex of lateral lemmas with a sharp tooth up to 5 mm long. Lemmas of apical spikelets, apex of apical spikelet lemmas extendinto a long, flat awn of 5-10 cm long, diverged curving outward with or without teeth at the base.

Figure 1.8 Spikes of vavilov wheat (*Triticum aestivum* subsp. *vavilovi)* (https://www.google.com.tr/brian-speaks.com)

1.1.2.5 Spelta wheat (*Triticum aestivum* subsp. *spelta*)

Spelta wheat (*Triticum aestivum* subsp. *spelta*) has a long and narrow spike. It is either awned or awnless. Spikelets are closely pressed to the rachis or central stems. Kernels are long, red, flattened, with a sharp tip and a narrow shallow crease. Spelta has a rather interesting history. It was described as far back in the 18th century by Linne and was considered as the species diffusion in the West Europe. Several spikes of this rare spelta speices were found in fields sawn to Tetri Doli wheat in the

village of Nichbisi, Mtskheta district in 1967 (M. Jorjadze, T. Berishvili and E. Shatberashvili 2014).

Figure 1.9 Spike and seeds of spelta wheat (*Triticum spelta* L.), (M. Jorjadze, T. Berishvili and E. Shatberashvili 2014).

1.1.3 Modern wheat

On the average, 40% of Turkey's daily energy needs are met by wheat products. Wheat is a single annual herbaceous plant grown almost every where in the world. It contains carbohydrates, protein, fat, minerals, enzymes, and vitamins. The quantities of these substance in wheat grain vary depending on the cultivar and the region in which wheat is grown. Wheat breeding improved the wheat in years. Modern durum wheat has 28 and bread wheat has 42 chromosomes.

1.1.3.1 Durum wheat (*Triticum durum* Desf.)

Durum wheat (*Triticum durum* Desf.) generally has pithy internal stems are and relativly broadleaves. Spikes are intermediate in width and lenght. The long, rough white, yellow or black awns are almost always present.

Figure 1.10 Spike and seeds of durum wheat (*Triticum durum* Desf.), (M. Jorjadze, T. Berishvili and E. Shatberashvili 2014).

Durum wheat is tetraploid (2n=4X=28 chromosomes, AABB genome). It has a very different and special position from hexaploid (2n=6x=42 chromosomes, AABBDD genome) wheat in terms of its quality characteristics and usage areas. Macaroni is the main use of durum wheat. Durum wheat is generally grown in cooler and semi-arid climates. The most important durum wheat growing countries; Russia, USA, Canada, Italy, France, Turkey, Argentina, and North African countries (Yıldırım et al. 2010).

Durum wheat is generally evaluated in different colors. The red ones are mostly used as animal feeds and are not a prescription for macaroni industry. This type of wheat is grown more in Argantina and some Taurus mountains araound Çukurova, Turkey. Amber ones are preferred and used in the macaroni industry. The hardest wheat is of this type. The amount of protein varies depending on the environment but is generally higher. Thousand grain and hectoliter weight are higher. The amount of ash in the endosperm is also higher (Finney et al. 1987; Morris 2004; Sissons 2004). Durum wheat is also used in producing couscous and bulgur.

1.1.3.2 Bread wheat (*Triticum aestivum* L.)

Bread wheat (*Triticum aestivum* L.) is the most cultivated plant in the world and covers the widest agricultural area. Bread wheat trade is more than the sum of all other agricultural products in the world. It is allohexaploid (6x), which regularly comes from 21 pairs of chromosomes (2n=42). These chromosomes are subdivided into 3 closely related groups of chromosomes (AABBDD) (The Biology of *Triticum aestivum* L. em Thell (Bread Wheat) http://www.ogtr.gov.au).

Figure 1.11 Spike and seeds of bread wheat (*Triticum aestivum* L. (Ipkli, Khulugo, Doli 2014), (M. Jorjadze, T. Berishvili and E. Shatberashvili 2014).

Bread wheat can generally be classified into four different types;

1. According to grain hardness:
   - Hard wheat
   - Soft wheat
2. According to grain color:
   - White wheat
   - Red wheat
3. According to awn structure:
   - Wheat with awn
   - Wheat without awn
4. According to plant growing type or growing habits:

- Summer wheat
- Winter wheat
- Facultative wheat

Bread wheat is a cereal for a temperate climates. The minimum temperature for germination of bread wheat seeds is between 3 and 4°C. Flowering starts above 14°C.

The hulled character is the result of two differences in the structure of the spike: the semi-brittle joints between the rachis internodes, and the toughened glumes. Hulledness in wheat involves other important characteristics. The thick, tough glumes of hulled wheats give excellent protection to the grains in the field and in storage. The fact that hulled wheats are mainly grown in mountainous areas today is not simply a result of their isolation; hulled wheats do seem especially resistant to poor soil conditions and a range of fungal diseases (Castelvecchio 1995). Due to its hulled structure, it is one step ahead of modern wheat in terms of quality.

The archaeological evidence has provided information about ancient Egyptian tools and their function. Ethnographic analogy gives some indication of how they must have been used.

The main factors affecting the quality of wheat are variety and environment, and the environmental factor causing the change is gathered in two groups as predictable and unpredictable factors. Factors that can be predicted are soil and general climate characteristics, seed type and amount, sowing time, harvest method and other agronomic methods. Unpredictable methods are deviations in the climatic conditions (Allard ve Bradshaw 1964).

Wheat is used as raw material in the production of bread, pasta, biscuits and bakery products. For this reason, starting from the factors related to genetics and environment of wheat as quality elements, all the factors which are effective in grinding and final product production should be investigated. The most important of these investigations are physical, chemical, nutritional and technological tests.

Measuring Wheat Quality

Botanik Measure:

- *T. aestivum*
- *T. compactum*
- *T. durum*

Agricultural Measure:

- Land riding
- Rust diseases
- Smut

Physical Measure:

- 1000 Grain Weight
- Grain shape and size
- Grain hardness
- Color
- Foreign materials
- Grinding ability
- Density

Chemical Measure:

- The amount of water
- The amount of ash
- The amount of protein
- Free acidity
- Raw fiber

Technological Measure:

- Age of the essence (Gluten) amount
- Gluten index value
- Sedimentation value
- The number of falls
- Flour tester
- Pastry tester

Wheat grain formation:

- Milk death (protein accumulation)
- Yellow death (accumulation of starch)
- Physiological death (all deaths) (http://www.unihracati.com)

It has been reported that although the genetic structure is more effective on quality characteristics of wheat, the effect of cultivation techniques is also important (Cook and Veseth 1991; Peterson et al. 1992).

In previous studies, it has been reported that the most important factors determining quality in wheat are protein amount and composition. The amount of protein varies depending on genetic, agrotechnical, and environmental factors (Borghi et al. 1997; Miadenow et al. 2001).

The amount of protein has been significantly affected by the climate and the ratio of avaliable nitrogen to the soil. Depending on the weather conditions, if the maturation period becomes is longer, the starch accumulates in the grain; the amount of protein in the grains decreases relatively (Özkaya and Kahveci 1990).

Quality is a factor that depends on the grain weight, grain density, and grain size as well. Because of the high ratio of endosperm in large and dense grains, flour yields are high but protein is low. The weight of a grain of bread wheat varies between 20-40 gr and varies depending on the cultivar, climate and soil conditions (Özkaya and Kahveci 1989).

The amount of ash is an important factor in determining the quality of wheat and flour, too. The amount af ash and its composition varies depending on the amount of minerals in the soil grown by the wheat, the availability of wheat, and the fertilization status. The amount of ash in the wheat in our country is between 1.3-2.5% (Ünal 1991).

Grain hardness is one of the important factors in determining quality and bread flour is mostly obtained from hard wheat. It was determined that wheat yields of hard wheat were higher than soft wheat and the amount of wheat protein was

decreased during grinding. The hard wheat was found to have water absorption and bread volume.

2. AIM AND SCOPE OF THE STUDY

Our aim is to determine hulled wheats cultivation areas, why it is being planted, planting area, conditions affecting efficiency, whether or not it is demending, the socio-economic situation in places where they are planted and processed, difficulties in production, they can be done in this topic of the einkorn and emmer wheat with open frontier 53 questionnaires in 5 provinces of the Western Black Sea Region.

In addition, nutrient values and macro-micro element contents will be examined in 9 samples of five einkorn and four emmer wheat collected from five provinces of Western Black Sea region (Bolu, Karabük, Kastamonu, Samsun, Sinop Provinces). Parallel to this study, soil samples taken from the fields where we collect wheat samples will also be analyzed. In order to compare, einkorn and emmer to modern wheat, Bezostaja 1 bread wheat and Kunduru-1149 durum wheat will be included in the whole analysis.

3. MATERIALS AND METHODS

Hulled wheats have higher nutritional value, a healthy and durable structure, without any artificial genetic touchs. Especially they rich in protein, fiber and minerals: especially phosphorus, calcium, zinc, iron, copper, manganese, sulfur, and selenium. Hulled wheats are the ancestors of today's modern wheat. They are grown in highlands, highly exposed to frost and drought, and on barren and less-fertile soils. It has been observed that the hulled wheats are more durable to global warming than bread and durum wheats. Today, demand for natural and healthy products is increasing. This, therefore, led to this research on hulled wheats in Black Sea region of Turkey.

Study area

We prepared an open questionnaire with 53 people who cultivated einkorn (*Triticum monococcum* ssp. *monococcum*) and emmer (*Triticum dicoccum* Schrank.) wheats in the Western Black Sea Region. We have collected answers to questions such as sowing areas, how much cultivating, harvest season, product handling, economic importance in this areas, yielding, seeding and harvesting difficulties, how long has this product, storage conditions, marketing, demand, needs, education, income, etc.

Research surveys were conducted to randomly selected people from potential hulled wheat production sites in the Black Sea region. Volunteer respondents after they were informed about the purpose of the study and assured about their anonomty gave expectedly non-biased answers to questionnaries. They are also informed that the data collected from them would be published.

Table 3.1 Number and percentage of questionnaries replied by participants in Bolu, Karabük, Kastamonu, Sinop, and Samsun provinces

Province	Questionnaires (n)	Percentage (%)
Bolu	17	32
Karabük	1	2
Kastamonu	25	47
Sinop	8	15
Samsun	2	4
Total	**53**	**100**

Table 3.2 Province and counties where questionnaries applied to participants

Province	County	Number of questionnaires
Karabük	Safranbolu	1
Kastamonu	İhsangazi	22
Kastamonu	Araç	3
Samsun	Ladik	1
Samsun	Havza	1
Sinop	Durağan	8
Bolu	Seben	15
Bolu	Merkez	2
Total		**53**

In the second part of the study, we have collected five einkorn (*Triticum monococcum* ssp. *monococcum*) and four emmer (*Triticum dicoccum* schrank.) wheats from five cities of Western Black Sea Region (Bolu, Kastamonu, Karabük, Samsun, and Sinop) in July-August 2016. Furthermore, we included Bezostaja 1 bread wheat (*Triticum aestivum* L.) and Kunduru-1149 durum wheat (*Triticum durum*) in order to compare the hulled wheat (einkorn and emmer wheat) and modern durum and bread wheat cultivars. Table 3.3 shows the provinces in which we collected einkorn, emmer, durum, and bread wheat, and their altitude, latitude, longitude, soil structure, and geographical characteristics. Emmer and einkorn usually grow in high areas, dry conditions and poor soil competitiveness is high but yield is low. Irrigation is not done. Harvesting is usually done by hand as it grows in high areas, rugged and forested areas. It is grown in limited areas due to difficult harvesting and post harvest processing. Since it is difficult to process after harvesting, farmers only process the product as much as their own consumption and consume the rest as animal feed.

The kind and environment in which wheat is grown are the most important factors affecting quality. The environmental factor causes the wheat quality to very from year to year and from field to field (Pomeranz 1971).

Images in work areas

Figure 3.1 Removing foreign substances and stones from einkorn wheat, in Bolu Seben (Photo by HM Yaman)

Figure 3.2 Boiling einkorn wheat before moving to the mill in Bolu Seben (Photo by HM Yaman).

Figure 3.3 Ended boiling of einkorn wheat in Kastamonu İhsangazi (Photo by H.M. Yaman)

Figure 3.4 Seperation of milled einkorn, by electrical stone mill, into parts of chaffes and dehulled and broken grains in Kastamonu, İhsangazi (Photo by HM Yaman)

Table 3.3 Geographic information on einkorn and Emmer. (Kunduru-1149 and Bezostaja were included as checks in the all anlayses).

Entries	Species	Origin	Altitude (m)	Latitude	Longitude	Soil structure	Forest/ Not forest	Flat / Rugged
Population-1	Emmer	Karabük, Safranbolu	811	41º25' 15"	32º48' 4"	standard	Half forest	Rugged
Population-2	Einkorn	Kastamonu, İhsangazi, Akkaya Vil.	787	41º 13' 0"	33º 28' 58"	Clay soil	Not forest	Flat
Population-3	Einkorn	Kastamonu, İhsangazi, Çatalyazı Vil.	1258	41º 9' 37"	33º 37' 17"	Standard	Half forest	Rugged
Population-4	Einkorn	Kastamonu, İhsangazi, Enbiya Vil.	820	41º 12' 52"	33º 30' 52"	Standard	Half forest	Flat
Population-5	Emmer	Samsun, Ladik, Çamlıköy	1055	40º 52' 39"	35º 45' 27"	Hard soil	Little forest	Rugged
Population-6	Emmer	Sinop, Durağan, Kirencik Vil.	1295	41º 25' 37"	35º 21' 23"	Hard, stony soil	Little forest	Rugged
Population-7	Einkorn	Bolu, Seben	911	40º 21' 38"	31º 30' 50"	Clay soil	Little forest	Flat
Population-8	Emmer	Sinop, Durağan, Gölgerişi Vil.	1116	41º 26' 14"	35º 23' 1"	Standard	Little forest	Rugged
Population-9	Einkorn	Bolu, Seben, Musosoflar Vil.	920	40º 21' 38"	31º 30' 47"	Clay soil	Little forest	Rugged
Bezostaja-1	Bread wheat							
Kunduru-1149	Durum wheat							

In this samples we collected, analyzes related to macro elements (N, P, K), micro elements (Fe, Mn, Zn, Cu), energy, carbohydrate, protein, crude protein, starch, fat, fiber, sugar, crude ash, 1000 grain weigth, % protein, hectoliter were carried out in Konya Laboratuvar ve Depoculuk, Tarım, Gıda, Enerji A.Ş. Özel Gıda Kontrol Laboratuvarı. Saturation, salt, Ph, lime, phosphorus, potassium, calcium, magnesium, iron, manganese, zinc, copper, and organic matter in the soil samples taken from where the wheat samples obtained in parallel with these analyzes were determined in Bolu Gıda, Tarım ve Hayvancılık İl Müdürlüğü Toprak ve Yaprak Analiz Laboratuvarı.

3.1 The methods we used in hulled and modern wheat analyses

Nitrogen and crude protein were anlaysed by ISO 1871 method, crude oil and crude cellulose by AACC 32-25 method, crude ash by AACC 08-01 basic method, hectoliter by TS EN ISO 7971-3 method, thousand grain weight by TS 2974 method, starch (%) by TKB method, sugar (%) by NMKL 148 method, carbohydrate and energy calculation method, Cu, Fe, Mn, Zn, K and P by NMKL 161.

3.1.1 Nitrogen and crude protein analyses by ISO 1871 method

ISO 1871 analysis method was applied to measure nitrogen and crude protein. ISO 1871 gives general guidelines on the determination of nitrogen by Kjeldahl method. This applies to food and feed products containing nitrogen compounds that can be detected directly by the Kjeldahl method. This measuring principle does not add nitrogen from nitrates and nitrites. The analyses are of products of animal or plant origin, such as those used in food and feed products.

Method; the amount of nitrogen by converting nitrogen contained in organic materials containing nitrogen into ammonia. Weigh 0.5 g of urea. 10 ml of distilled water and 0.5 ml of H_2SO_4 are added. It is heated for 15 minutes. After the dropwise addition of 2 drops of phenolphthalein indicator, 5 ml of additive is made from 8% NaOH to color pink. Neutralization is thus achieved. The solution does not rinse to avoid ammonia flow during the process. The sample is heated again. Place an erlenmeyer 0.1 M 50 ml HCl. Continue heating until the bubble is exhausted. Titration is performed by dropwise addition of 2 drops of phenolphthalein with 0.1 M NaOH (https://cevre.files.wordpress.com).

Gram N = VHCl x CHCl-VNaOH x CNaOH) 10-3 x 14

= 50 ml x 0,1 M – 35,8 ml x 0,1 M

= 1,42 mg

% N = (1,42 mg / 500 mg) x 100

= % 0,28 N

The most commonly used method for protein identification is the Kjeldahl method developed by the Danish chemist Johan Kjeldahl. Since all nitrogen containing compounds such as amine, amide and ammonium, which are not in protein form by Kjeldahl method, are identified as protein, this method is called crude protein assay (Raw Protein Determination in Food Ankara 2011).

3.1.2 Crude oil and crude sellulose analyses by AACC 32-25 method

AACC 32-25 analysis method was applied to measure raw oil and crude cellulose. The method comprises the selective and enzymatic removal of starch using a thermostable alpha-amylase and an amyloglucosidase; precipitation of soluble polysaccharides with 80% ethanol; hydrolyzing amylase-resistant polysaccharides with sulfuric acid; and then quantifying the neutral sugars liberated as alditol acetates by gas-liquid chromatography (GLC). The uronic acids in the acid hydrolyzate are determined by colorimetry and the acid is calculated gravimetrically as insoluble residue after the lignin (sulphuric acid lignin) has been smoothed. The method determines the total food fiber as the sum of neutral sugar residues, uronic acid residues and Klason lignin in the food raw material and its products. This method can be applied in cereal and vegetable products.

3.1.3 Crude ash analysis by AACC 08-01 method

The raw ash content was determined according to AACC 08-01 method. This method determines the content of flour and bread ash. The content of ash in bran is almost 30 times higher than the endosperm. For this reason, in small amount, the bran flour significantly affects the ash content. The mills are expected to produce flours with low ash content as indicated by the customers.

3.1.4 Hectoliter by TS EN ISO 7971-3 method

TS EN ISO analysis method was applied to measure the hectoliter. According to this method; determination of bulk density, referred to as mass, per hectoliter –

part 3: Routine method – ISO 7971-3: 2009 specifies a routine method for determining the bulk density of grain, referred to as grain, "grain per hectoliter" using mechanical, electrical or electronic mass per hectoliter measuring instruments.

3.1.5 Thousand grain weight by TS 2974 method

TS 2974 analysis method was applied to measure the weight of 1000 grain. This method of analysis includes whole grains and legumes. Grains are important in terms of weight, fullness, slenderness, and flour production. Species and varieties vary depending on their genetics and the conditions of growing. In the same kind, usually a thousand grains are in direct proportion to the amount of starch, inversely proportional to the amount of protein. Grains are harder than soft wheat in hard wheat. For the calculation, the wheat sample is first extracted from the foreign materials. 15 gr of the cleaned wheat is weighed and counted. The resulting number is rounded to 1000 by proportion. Considering the % moisture content, a thousand grain weight is expressed in terms of grams of dry substance basis.

3.1.6 Starch (%) by TKB method

The TKB method is done in 3 ways;

- Polarimetry
- Titrimetry
- Hydrolysis

Polarimetry method is done as follows;

Materials;

- 4% Ammonium Molybdate Solution

(4 grams Ammonium Molybdate is weighed and dissolved in 100 ml of pure water)

- 1% HCl Solution

(3.1 ml of 33% HCl is diluted with 100 ml of distilled water)

Procedure of analysis;

- Weigh 5 gr sample,
- Add 50 ml of 1% HCl solution over,
- Mix in boiling water for 1-2 minutes and wait for 15-20 minutes,
- Add 25 ml of purified water and cool under the fountain,
- After cooling, add 10 ml of Ammonium Molybdate solution,
- It is added and mixed,
- Add 100 ml of purified water until complete,
- Filter with strainer paper,
- The filtration is carried out by placing it in the polarimeter tube,
- Calculations are made.

% Starch = read value x 20 x 100 / A x 200

A = Specific rotation grade

A value for Wheat Starch: 182,7

3.1.7 Carbohydrate and energy by calculation method

Carbohydrate and energy amount were determined by calculation method.

Calculation of carbohydrate and energy value;

While carbohydrate values are calculated, ash, protein, fat and moisture analyzes of the sample are performed first. The value found are summed and subtracted from 100, so that the carbohydrate value is found.

While carbohydrate values are calculated, ash, protein, fat and moisture analyzes of the sample are performed first. The value found are summed and subtracted from 100, so that the carbohydrate value is found.

Carbohydrate = 100- (Moisture+ Fat + Protein + Ash)

% carbohydrate = [100 - (% moisture +% protein +% fat +% ash)]×100

Energy (kcal / 100 g) = 4 (% carbohydrate +% protein) + 9 (% fat)

3.1.8 Sugar, carbohydrate and energy calculation methods

The carbohydrates of the sample are dissolved in water and diluted the suitable concentrations. The final dilution is performed so that the solvent composition corresponds to that of the mobile phas. The carbohydrates are separated isocratically on an amino column and detected with a refractive index detector.

3.1.9 Cu, Fe, Mn, Zn, K and P analyses by NMKL 161 method

NMKL analysis method is to determine the amount of Cu, Fe, Mn, Zn, K, and P. In this method, quantitative value of the metals: lead, cadmium, zinc copper, and iron in various types of foods, with the exception of oils, fats and extremely fatty products were determined. The method employs atomic absorption spectrophotometry (AAS) after microwave oven digestion under pressure. The methods have been tested on dry materials only, can be used for samples under certain conditions containing water.

The sample is wet digested with nitric acid and hydrogen peroxide in a plastered container heated by microwaves. The sample solution is diluted with water and the concentrations of the metals are graphite furnace AAS.

4. RESULTS AND DISCUSSIONS

4.1 Statistical studies according to survey results

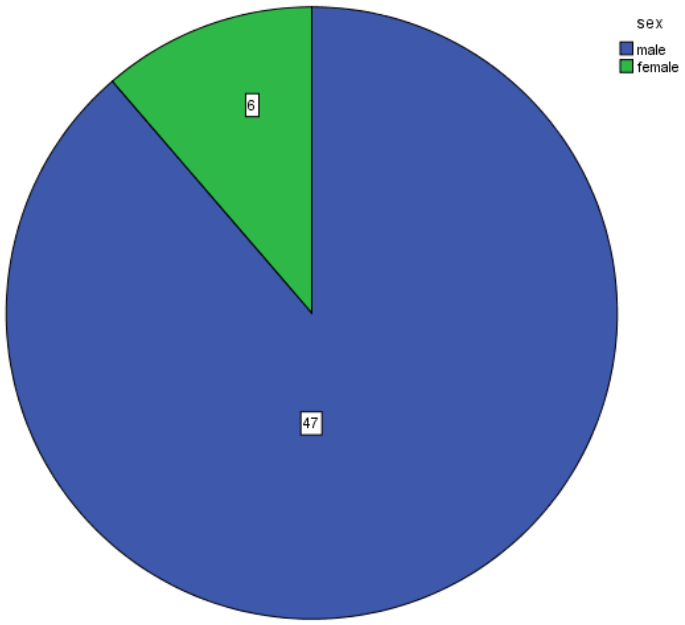
A total of 53 open-ended questionnaires were applied to farmers who dealth with einkorn and emmer in the Western Black Sea region. With the help of these surveys, we have determined how this species are cultivated, what the socio-economic structure of the farmers are, what the education levels are, what their income is, what the contribution to their family is, what the amount of sowing is and how seeds are procured etc.

Table 4.1 Gender frequency and percent of the participants in the survey

Sex	Frequency	Percent (%)
Male	47	88.7
Female	6	11.3
Total	53	100

The gender of those who deal with wheat was determined (Table 4.1; Graphic 4.1). In general, men were engaged in farming. The number of women engaged in farming is low and all were struggling to survive on their own. The percentage of women was 11.23%, while that of men was 88.7%.

There are no refunds of up to 30 thousand TL for women farmers launched in 2016. Unfortunately, as shown in the above table 4.1 and graphic 4.1, the success is very low if many studies and projects such as this are tried to be taken into the foreground in farming. There is a difficult rate of adjustment between male and female farmers.

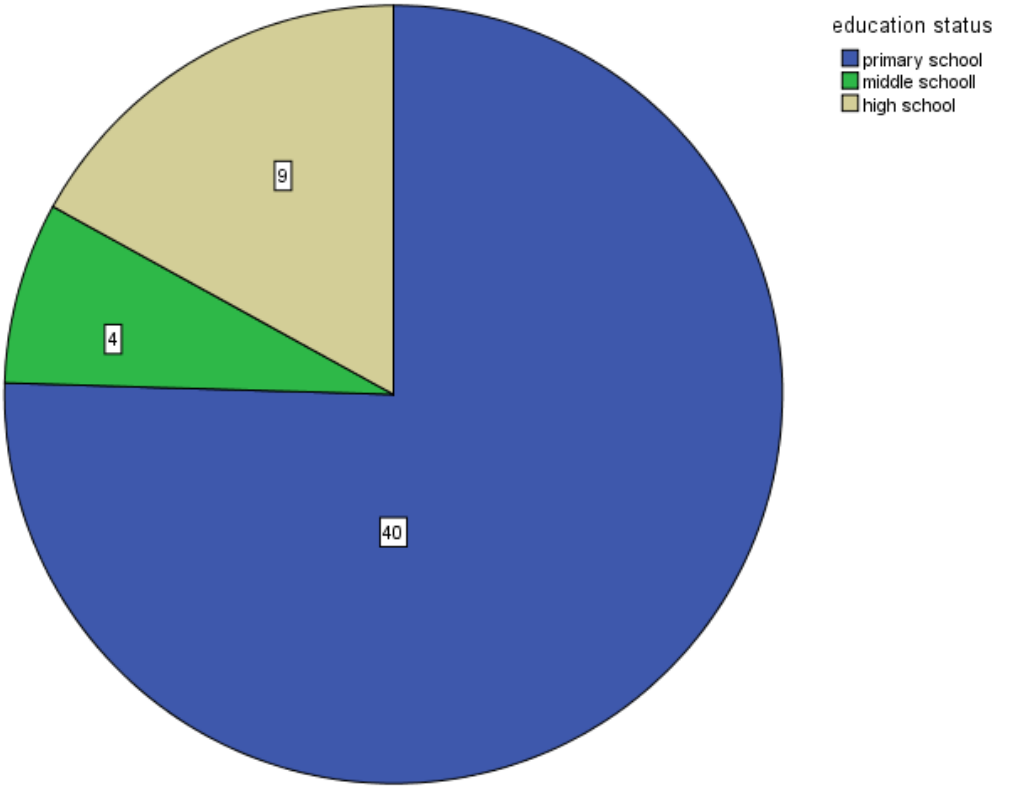


Graphic 4.1 Male and female sex ratio

Table 4.2 Educational status of participants in the survey

Education status	Frequency	Percent (%)
Primary school	40	75.5
Secondary school	4	7.5
High school	9	17.0
Total	53	100.0

Most of the participants were primary school graduates (Table 4.2; Graphic 4.2). This constituted 75% of the sample. The others were high school and secondary school graduates, respectively. There was not any graduate. As we can understand from this, we like education, especially in the field of farming is very low. It is necessary for women farmers to be supported and educated especially for the development of breeding and proper production.



Graphic 4.2 Educational status of participants

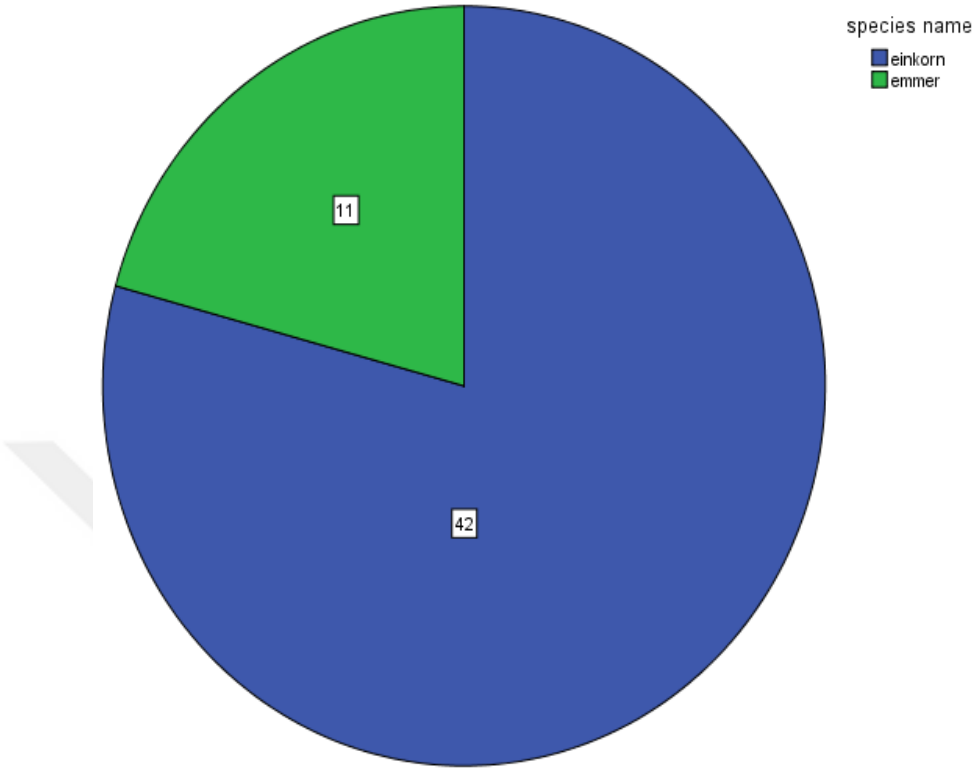
Table 4.3 Frequency and percentage of species in the survey

Species name	Frequency	Percent (%)
Einkorn	42	79.2
Emmer	11	20.8
Total	53	100.0

Most participants (79.2%) grew einkorn (Table 4.3; Graphic 4.3). Einkorn is cultivated Bolu and Kastamonu and flour, bread, tarhana, and various pastry works are being performed, especially bulgur. Hulled parts and poor grains are consumed as animal feed. Emmer is grown in Sinop, Samsun and Karabük and is not processed as a nutrient but used only as animal food. Emmer can be trained on farmers in terms of nutritional value, health benefits and processing.

Wheat in its present-day form has gone through a long and interesting evolution. The origin of the genus *Triticum* (wheat) was found in Asia, in the area known as the Fertile Crescent (Figure 1.9), and parts of Africa, in the area that stretches from Syria to Kashmir, and southwards to Ethiopia. The genetic relationships between einkorn and emmer indicate that the most likely site of

domestication is near Diyarbakir in Turkey (Šramková Z, Gregová E and Šturdík E 2009).

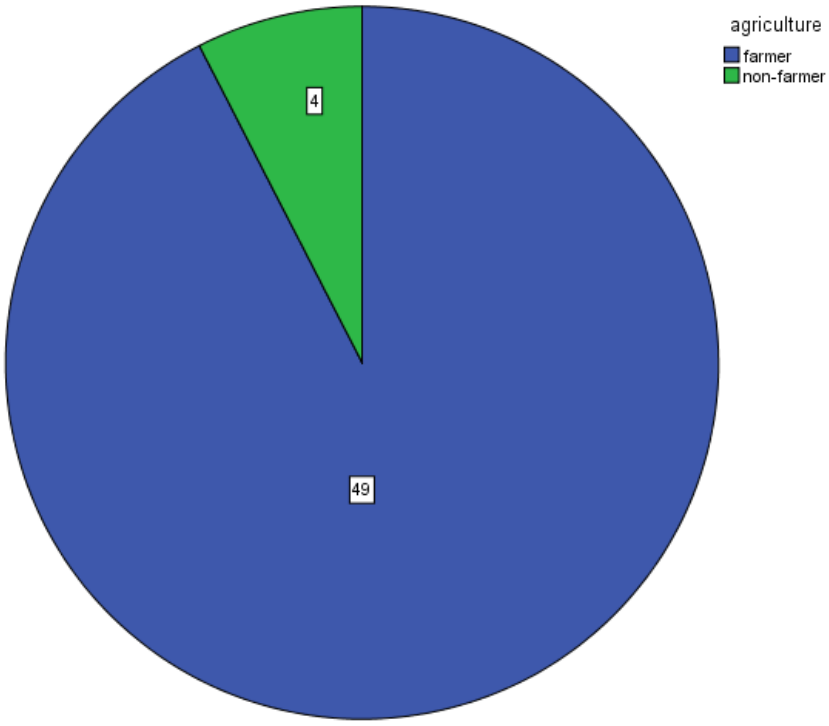


Graphic 4.3 Growing species name and ratios

Table 4.4 Einkorn and emmer farmer and non-farmer participants in the survey

Agriculture	Frequency	Percent (%)
Farmer	49	92.5
Non-farmer	4	7.5
Total	53	100.0

Most of the participants (92.5%) in the survey cultivated einkorn and emmer. The other 7.5% dealt with marketing and trade Table 4.4; Graphic 4.4). Surveys were generally done with people who were cultivating einkorn and emmer or who were dealing with sales. It is apparent that the number of those who deal with old wheat is very small compared to the general village population. Most of them have even left it and now the team mates are thinking about leaving it in the lot. Farmers complain about this indifference. Major troubles; the fuel-oil is expensive, the lack of seed sales, the lack of training, the lack of sales area of the product, the difficulty of harvesting and processing because of the hulled.

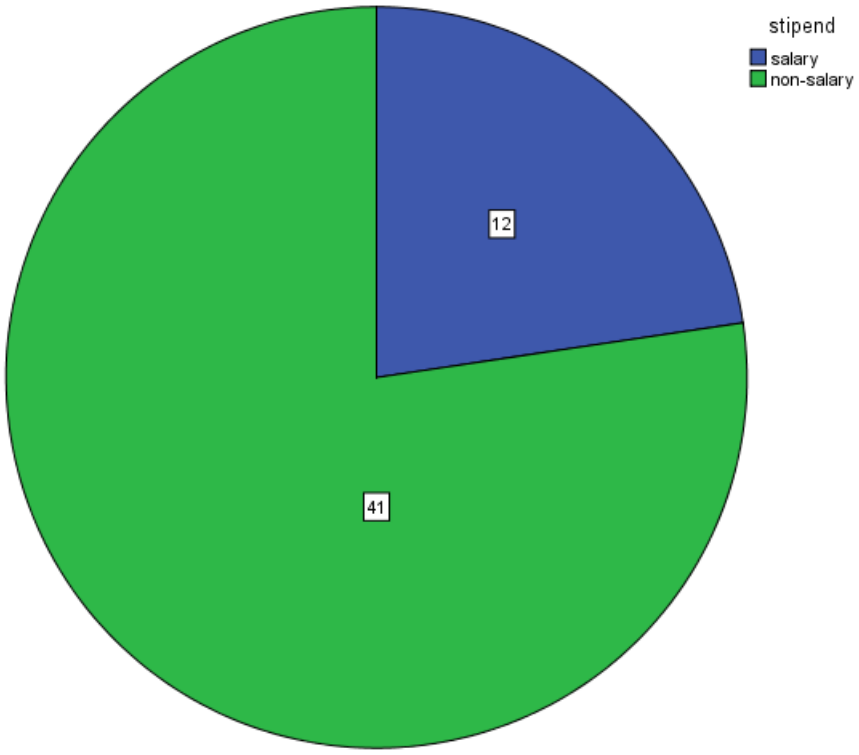


Graphic 4.4 The percentage of farmers and non-farmers who participated in the survey

Table 4.5 Salary or non-salary status of participants in the survey

Stipend	Frequency	Percent (%)
Salary	12	22.6
Non-salary	41	77.4
Total	53	100.0

The survey indicated that 77.4% of our farmers had no regular salary income and only madea living with some income from farming and livestock (Table 4.5; Graphic 4.5). Therefore, we have to keep up with the local values of our farmer product, we have education in this, and we support the efficiency upgrade and sales. We do fail to enrich our community about this issue and lose our local values if we do not have our farmers. Farmers have trouble with salary. Because it is not a fixed income, he is trying to manage for a year with the income from agricultural products he has made in the summer season.

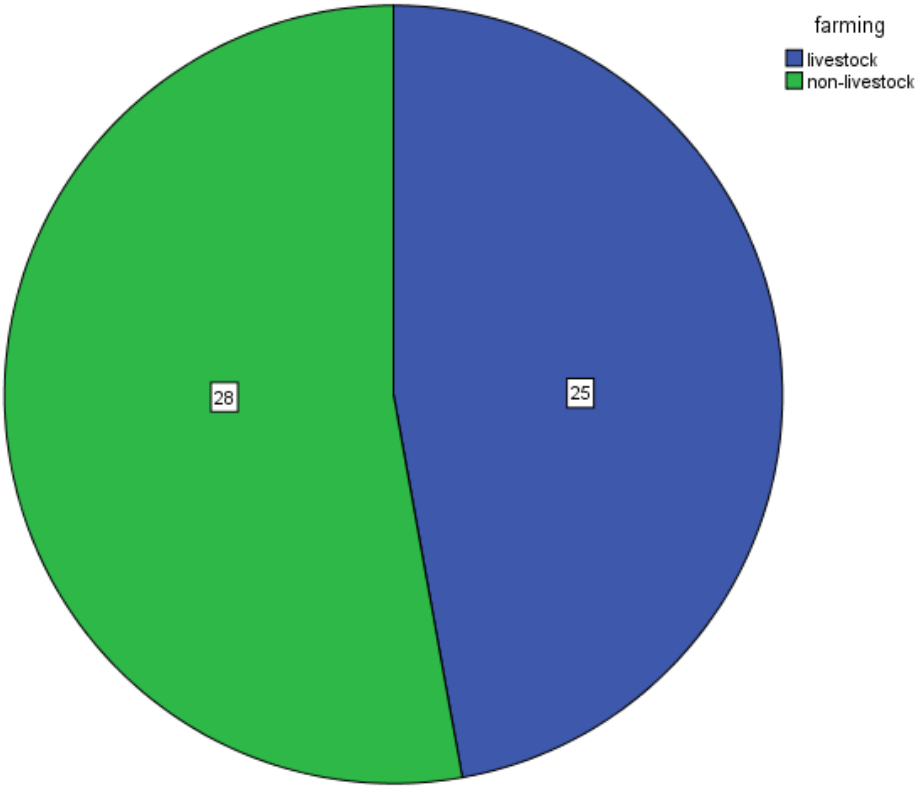


Graphic 4.5 The percentage of salaried and non-salaried participants

Table 4.6 Farming status participants in the survey

Farming	Frequency	Percent (%)
Livestock	25	47.2
Non-livestock	28	52.8
Total	53	100.0

Out of all participants, 47.2% in the survey were engaged in livestock farming and 52.8% are non-livestock farming only Table 4.6; Graphic 4.6). The ratio between livestock and non-livestock is very close. As there is no fixed income, they are also engaged in animal husbandry as well as farming. Animal husbandry provides a steady revenue stream. Animal products are also important in organic nutrition and health. The remaining stalks (straw) and barks of agricultural products are also regarded as animal feed.

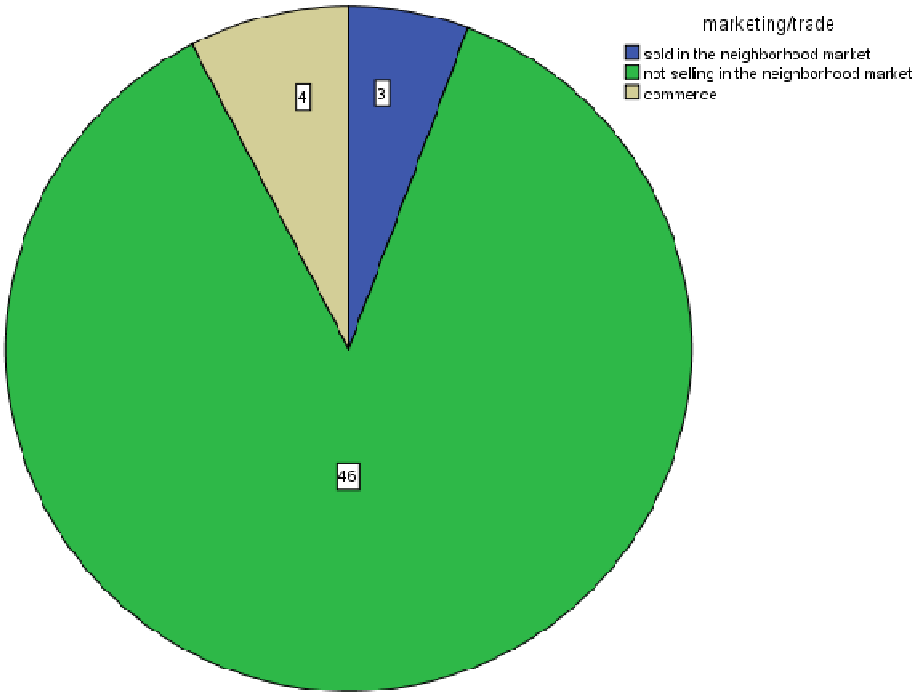


Graphic 4.6 The percentage of farming status participants in the survey

Table 4.7 How do the participants value the product in survey

Marketing/Trade	Frequency	Percent (%)
Sold in the neighborhood market	3	5.7
Not selling in the neighborhood market	46	86.8
Commerce (Trade)	4	7.5
Total	53	100.0

Most of the participants (86.8%) did not sell or trade. ng. As a result of this, growers were cultivating in the limited acreage of field because this hulled wheats were difficult to process. It was only grown for own consumption (Table 4.7; Graphic 4.7). Because of the difficulties in harvesting and processing of hulled wheat, farmers grow their crops as much as their own needs and allocate seeds as much as their own needs. Very few people are selling at the local market to make a little income. The other little person is totally engaged with this work and the product is sold as local products both in and out of the country by crew, mowing, various processes.

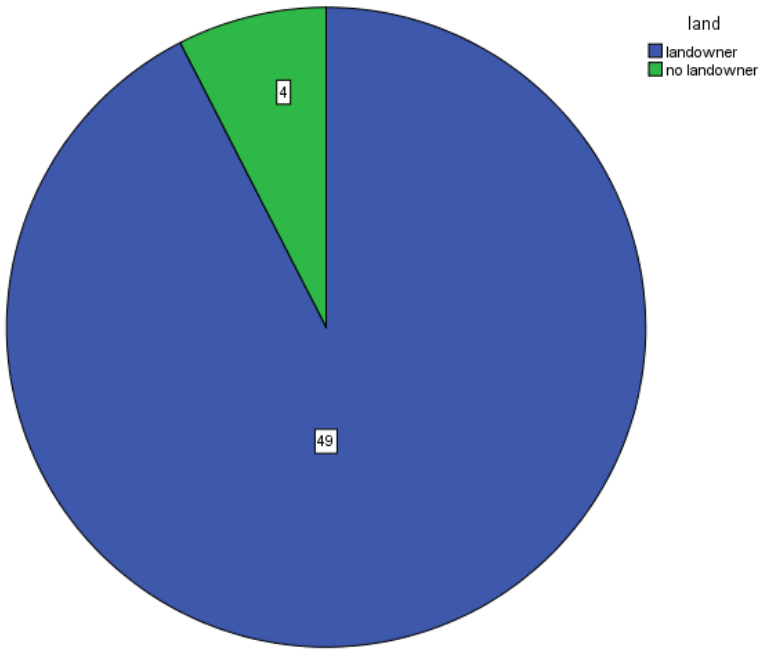


Graphic 4.7 How survey participants can evaluate the product

Table 4.8 Landowner or non-landowner status participants in the survey

Land	Frequency	Percent (%)
Landowner	49	92.5
Non-landowner	4	7.5
Total	53	100.0

Most of the participants (92.5%) cultivated their own land and 7.5% rented Table 4.8; Graphic 4.8). Farmers usually plant their own fields. Land used for rent is few. Since the villagers do not have young population and the remaining elderly population does not have as much workforce as the remaining elderly population, the rate of land areas is decreasing. Farming is of great importance in terms of supporting the labor force and developing agricultural equipments.

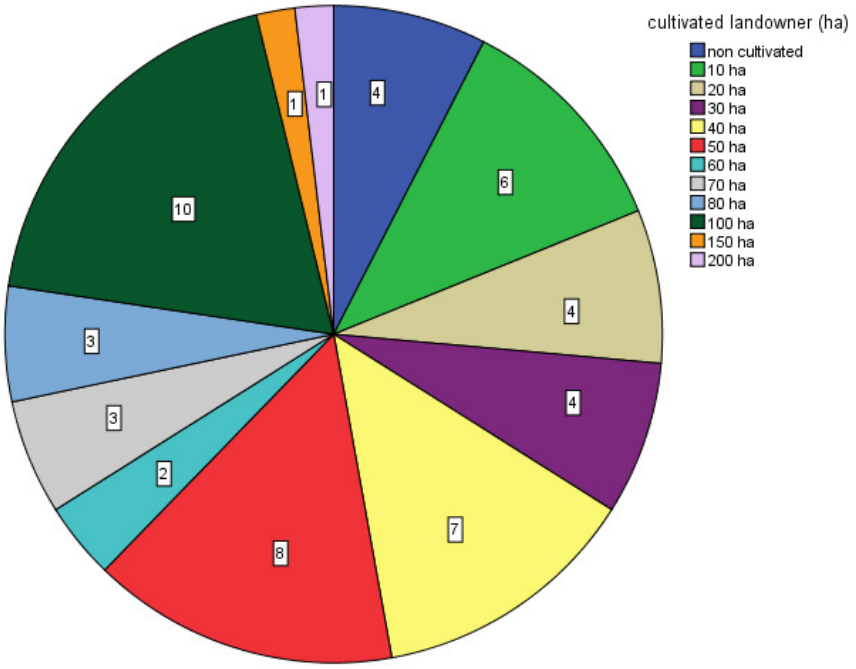


Graphic 4.8 The percentage of landowner or non-landowner status participants in the survey

Table 4.9 Non- cultivated participants and participants with various levels of land ownership (ha)

Cultivated landowner (ha)	Frequency	Percent (%)
Non-cultivated	4	7.5
10 ha	6	11.3
20 ha	4	7.5
30 ha	4	7.5
40 ha	7	13.2
50 ha	8	15.1
60 ha	2	3.8
70 ha	3	5.7
80 ha	3	5.7
100 ha	10	18.9
150 ha	1	1.9
200 ha	1	1.9
Total	53	100.0

Of the participants 18.9% had 100 ha of land in bread, followed by 15.1% with 50 ha and 13.2% with 40 ha (Table 4.9; Graphic 4.9). The farmer as much as he has the land, and the products he obtains are considered as income source, own needs and animal feed. He also avoids making extra costs because renting a land is a certain departure.

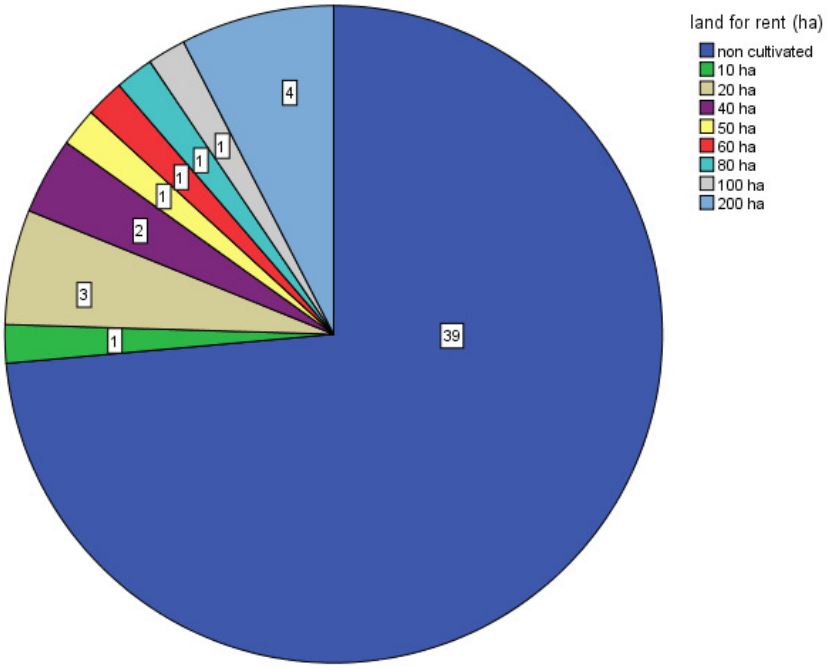


Graphic 4.9 The percentage of non- cultivated participants and participants with various levels of land ownership (ha)

Table 4.10 Cultivated land for rent (ha) of people who participant in survey

Cultivated land for rent (ha)	Frequency	Percent (%)	Valid percent	Cumulative percent
Non-cultivated	39	73.6	73.6	73.6
10 ha	1	1.9	1.9	75.5
20 ha	3	5.7	5.7	81.1
40 ha	2	3.8	3.8	84.9
50 ha	1	1.9	1.9	86.8
60 ha	1	1.9	1.9	88.7
80 ha	1	1.9	1.9	90.6
100 ha	1	1.9	1.9	92.5
200 ha	4	7.5	7.5	100.0
Total	53	100.0	100.0	

Most participants, 73.6%, did not rent lend. 7.5% had an average of 200 ha of land for rent, 5.7% use 20 ha of land forrent (Table 4.10; Graphic 4.10). Very few of the farmers are renting land. Some of them rent because they do not have a land. At the other end he rents because he's in good income. Much of the villages are left empty because of lack of human power. Most places are widespread in land reclamation, leaving a year of abandon.

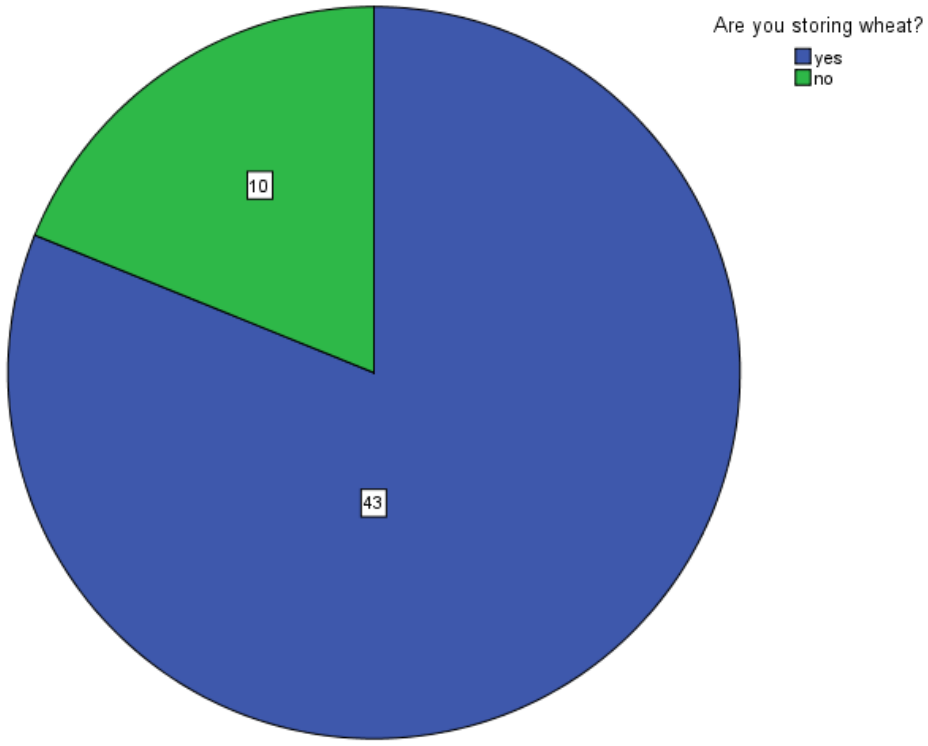


Graphic 4.10 The percentage of cultivated land for rent (ha) of people who participant in survey

Table 4.11 Do the participants store wheat

Storing wheat	Frequency	Percent (%)
Yes	43	81.1
No	10	18.9
Total	53	100.0

Most participants, 81.1%, stored the harvest (Table 4.11; Graphic 4.11). The purpose of storage was to use the product as seed and animal feed in the coming years. Non-storage people met their seed or feed needs from their relatives and neighbors. Because einkorn and emmer seeds are not sold. That's why storage is a must. Most of the farmers are storing the product according to the possibilities. The product keeps good quality and coarse grains for seed, and weak and hollow grains for use as animal feed.



Graphic 4.11 Do survey participants store the product

Table 4.12 How are wheat stored by participants

How to store	Frequency	Percent (%)
Sack	28	52.8
Warehouse	25	47.2
Total	53	100.0

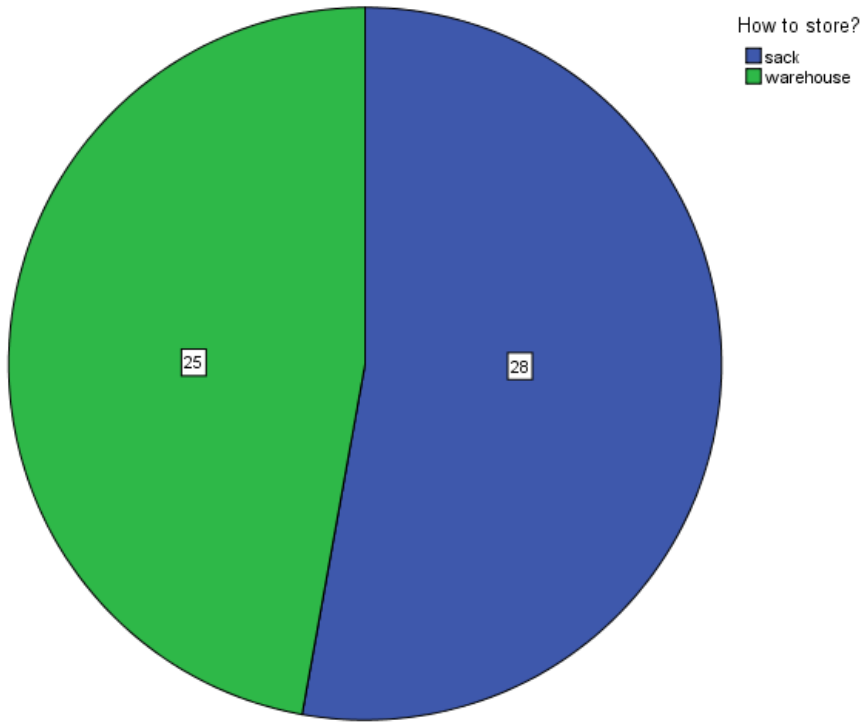
Almost half of participants 52.8% stored in sacks the remaining, 47.2% in warehouses (Table 4.12; Graphic 4.12). The product was likely suitable for storage because of its hulled structure. Farmers also store sacks and warehouses according to the facilities available.

The basics to be considered during storage of cereals;

- The moisture content of the stored grains should be low (wheat 12-14%). If necessary, the grains must be dried before storage,
- Cereals must be free from broken, damaged grains and foreign seeds and grains, etc.,
- Before the storage, the grains should be free from molds and pumice grains as far as possible,
- Infected and infected grains containing cereals should treated be medicines,

- The characteristics of grain and local climate should be taken into account in storage and warehouse selection,
- The building to be used as warehouse; must be dry, airy and luminous without moisture,
- Deposits and silos should be constructed for well ventilation,
- The moisture and temperature of stored cereals and storage air should be continuously checked,
- Precautions should be taken not to allow harm to the grain storage,
- Storage areas should be very well insulated so that they do not enter into the storage area of ionized water in concrete and soil soils,
- The granules should be put in the form of wiping in order to provide a uniform temperature inside the storage containers,
- The best temperature for storage areas should be + 4 ° C,
- At least 1.5 m^2 area (for wheat) should be calculated for a ton product (Dizlek H, Gül H, Kılıçdagı R 2008).

If we store the product in compliance with these conditions, we will keep the loss of the product at the lowest level.



Graphic 4.12 How do survey participants store the product

Table 4.13 How do the participants irrigate

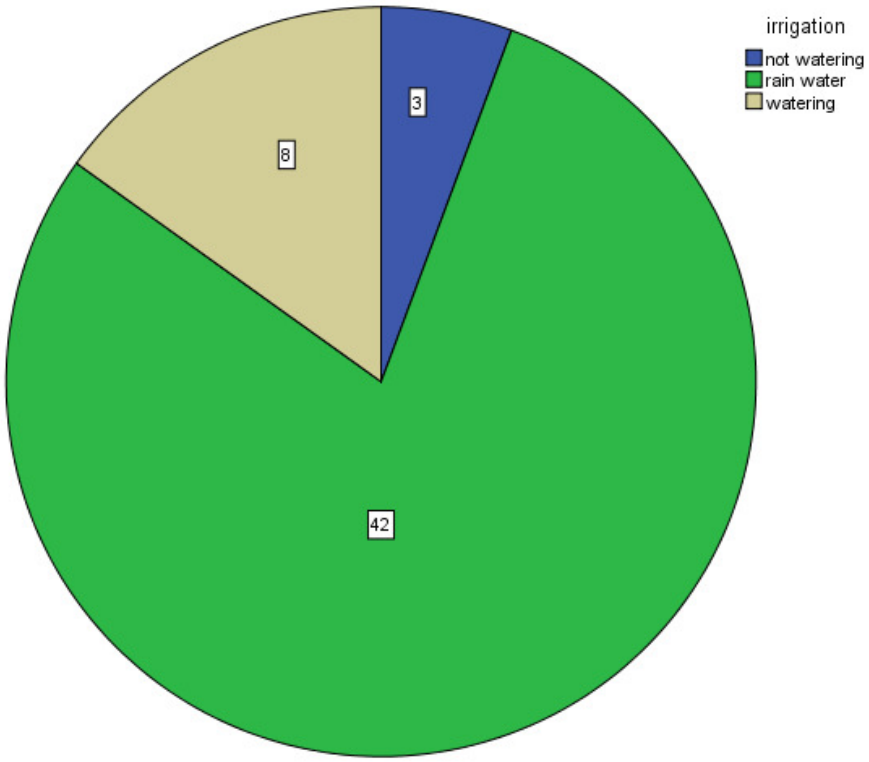
Irrigation	Frequency	Percent (%)
Not watering	3	5.7
Rain water	42	79.2
Watering	8	15.1
Total	53	100.0

Most participants, 79.2% did not irrigated, only benefited from rain water. 15.1% watering product. 3% are not watering. Einkorn and emmer are more suitable for poor and infertile soils on higher altitude so only 15.1% of the farmers irrigate (Table 4.13; Graphic 4.13). For einkorn and emmer, rainwater is largely sufficient.

It is already seen that it will be difficult to find irrigation water which can be used in agriculture fields in the future, considering that the drinking water is gradually decreasing in our country and our country. The first thing to do in this phase is to avoid excess water, to give water to the plant at the desired time and amount, and to do so in the most appropriate way.

Irrigation methods are generally divided into 3

- Surface irrigation methods
- Pressure irrigation methods
- Underground irrigation methods (Aras 2007).

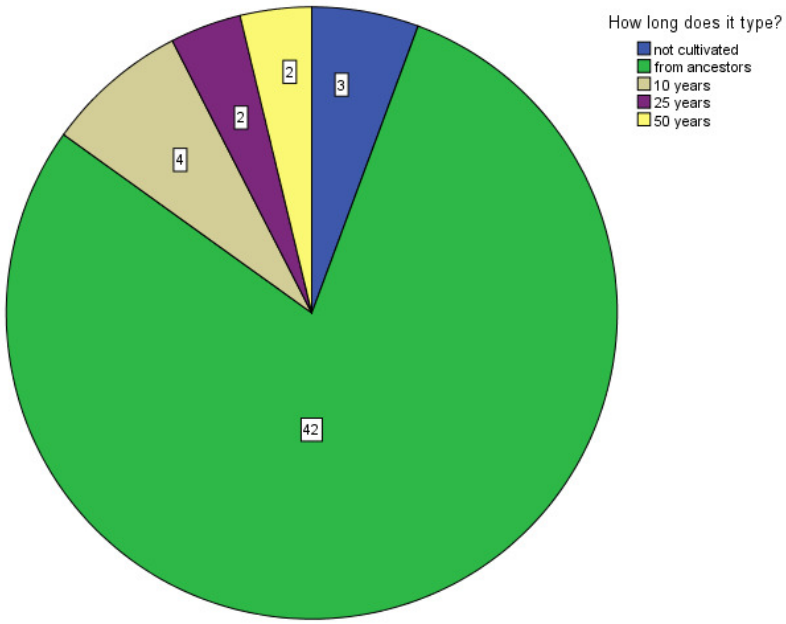


Graphic 4.13 How to irrigate

Table 4.14 How long have the participants cultivated this product

How long is species cultivated	Frequency	Percent (%)
Not cultivated	3	5.7
From ancestors	42	79.2
10 years	4	7.5
25 years	2	3.8
50 years	2	3.8
Total	53	100.0

Out of all participants. 79.2%, cultivated this product from the time of their ancestors (Table 4.14; Graphic 4.14). This emphasized the cultural value of the product. These speices are our daily cultural heritage from the past. The first types of wheat cultivated in agricultural villages are einkorn and emmer. The hulleds of these grains and the fragility of their stalks have increased the bread and durum wheat cultivation these days. But since the majority of our farmers have been einkorn and emmer, the seed has been the most important influence on this day's coming of the day. Einkorn and emmer are our greatest heritage from our ancestors.



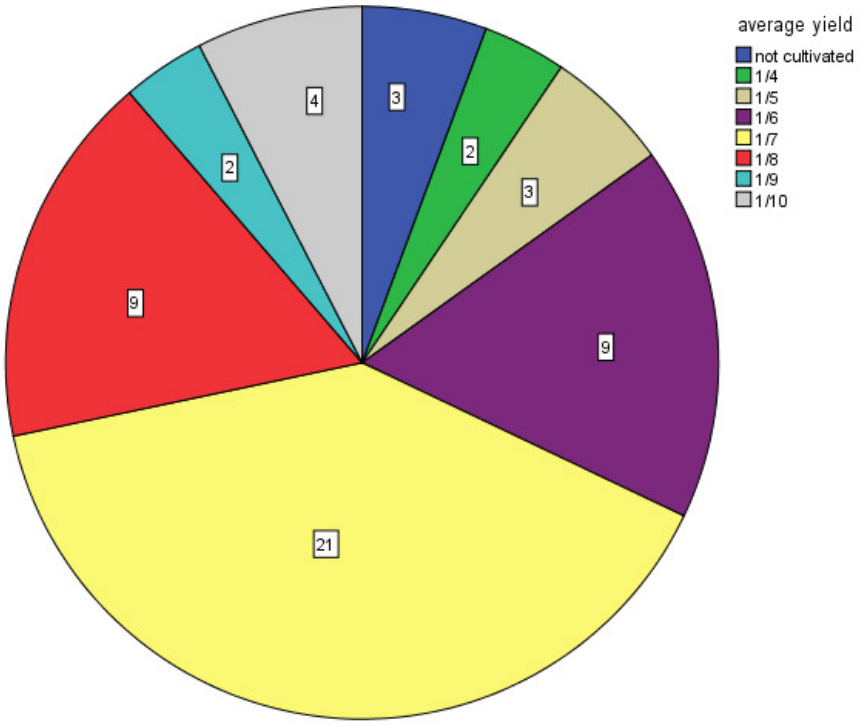
Graphic 4.14 How long has this product been added

Table 4.15 What is the average yield given by participants

Average yield	Yield (Kg / ha)	Frequency	Percent (%)
Not cultivated	-	3	5.7
One to four	1000	2	3.8
One to five	1250	3	5.7
One to six	1500	9	17.0
One to seven	1750	21	39.6
One to eight	2000	9	17.0
One to nine	2250	2	3.8
One to ten	2500	4	7.5
Total		53	100.0

According to 21 participants, the yield of the product was one to seven (1750 kg/ Ha) (Table 4.15; Graphic 4.15). Einkorn and emmer yields are but nutrients high. Einkorn and emmer wheat are low compared to modern wheat.

Factors directly affecting wheat yield; sowing time, planting depth, seeding method, seed quality, amount of seeds thrown, fertilization, harvesting time and time, irrigation, climatic conditions, soil structure and restoration, and which products were planted in the previous year. If cultivation is carried out in accordance with these conditions, it will directly increase in yield.

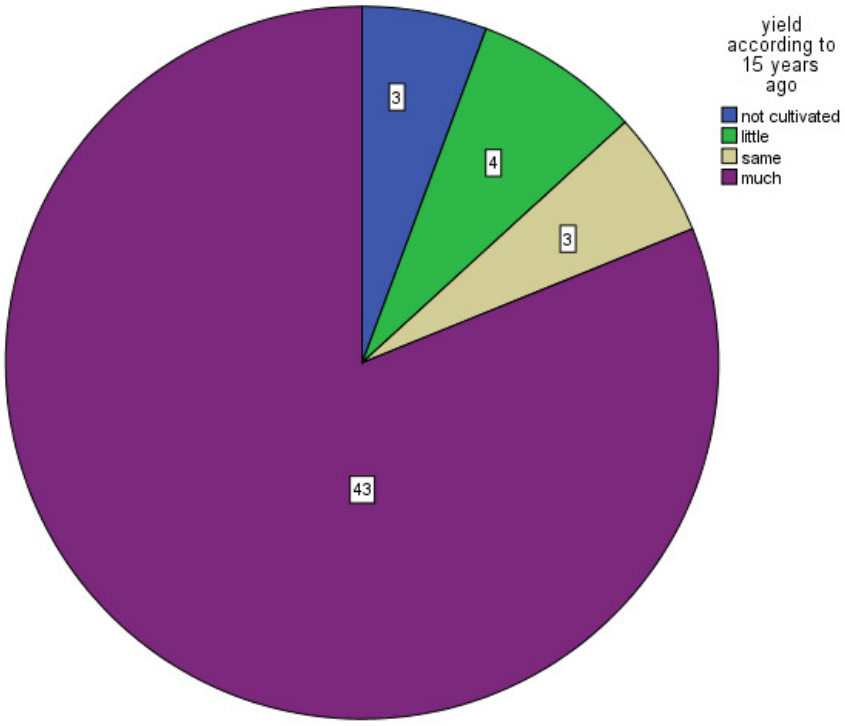


Graphic 4.15 What is the average yield

Table 4.16 How is the average yield compared to 15 years perceived by the participants?

Yield according to 15 years ago	Frequency	Percent (%)
Not cultivated	3	5.7
Lower	4	7.5
Same	3	5.7
Higher	43	81.1
Total	53	100.0

The yield was higher according to 81.1% of the participants when compared to 15 years ago (Table 4.16; Graphic 4.16). Because increased daily experience and knowledge of the famers and better farming equipment aids to increase that yield. According to the results of the survey, it is seen that the yield has increased in recent years. This shows that our farmers are increasingly conscious. The product also uses the right techniques for sowing.

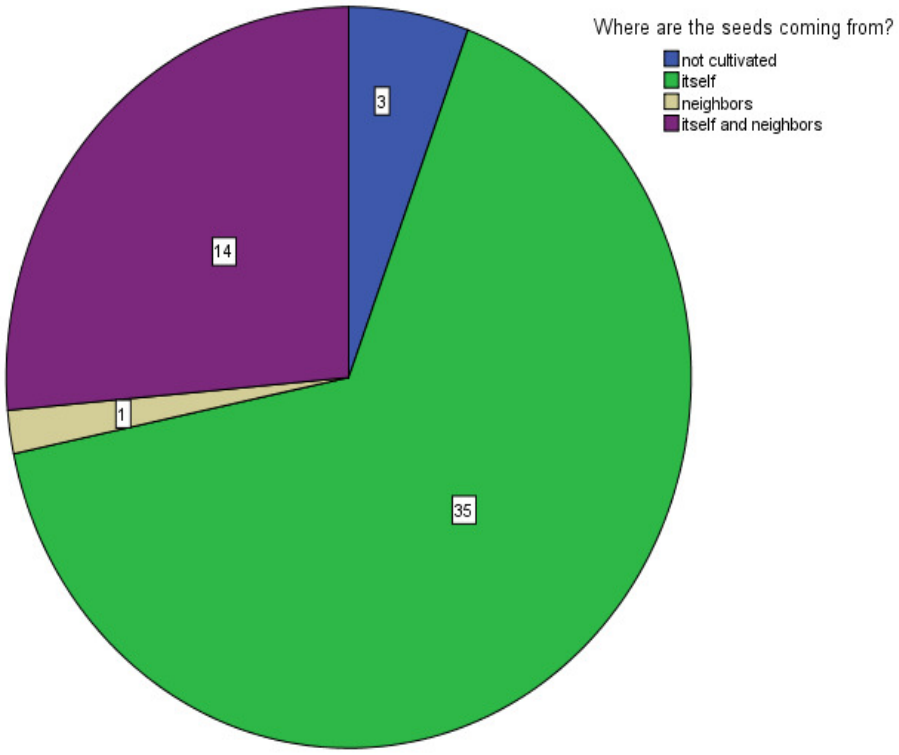


Graphic 4.16 How is the average yield compared to 15 years

Table 4.17 Where do the seeds come from

Where do the seeds come from	Frequency	Percent (%)
Not cultivated	3	5.7
Themselves	35	66.0
Neighbors	1	1.9
Themselves and neighbors	14	26.4
Total	53	100.0

Among participants, 66% stored the seed by themselves and use it next year. 26.4% obtained from themselves and their neighbors (Table 4.17; Graphic 4.17). The seed wa not sold in the commercial market. So it was difficult to find einkorn and emmer seeds. The biggest problem in this issue is the inability to find seeds. The seeds to be used as seeds are not kept in proper conditions during their storage and if they are not sprayed at the required time, microorganisms found in the plants reproduce and some of them form sports colonies causing microbial load of the grain (Akın 2017). However, due to its einkorn and emmer hulled structure; it is suitable for storage and is resistant to pesticides. The use of diseased seeds causes the sports to pass through the new plant and become ill.



Graphic 4.17 Where do the participants get the seed

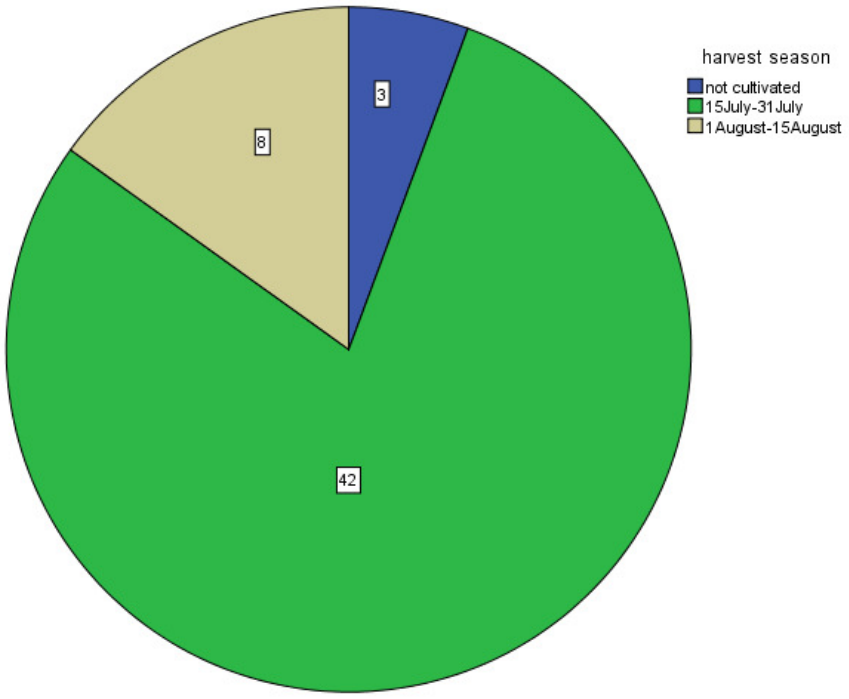
Table 4.18 According to the participants, when was the harvest season

Harvest season	Frequency	Percent (%)
Not cultivated	3	5.7
15 July-31July	42	79.2
1August-15August	8	15.1
Total	53	100.0

According to 79.2% of the farmers, harvest season was between 15 and 31 July (Table 4.18; Graphic 4.18). The harvest season varied depending on rainfall, temperature and drought, and is usually the second half of July.

Completion of seed and harvest works within a certain time period is the most important factor in achieving the highest yield. For the sowing process, the soil and seeds have a direct influence on germination and the subsequent development of the plant. The wheat harvest is the fact that there is a loss of spillage and breakage due to a decrease in the moisture content of the spike and grain, and therefore a reduction in the amount of products and income. The size of along with the variation of wheat varieties, the resistance to harvest time decreases with the increase of the grain head. Due to this decrease, losses occur during natural spillage and harvesting. Decrease in

grain moisture also causes the formation of broken grains and also causes loss of grain (Say SM 2009). In order to prevent losses in the product, it has to be done at the time of harvesting.



Graphic 4.18 When was the harvest season

4.2 Statistical studies based on wheat and soil analysis results

Nutrient and macro-micro element content are important in terms of wheat quality. This part of the work we measured the nutritional values of wheat species we collected from five provinces (Bolu, Kastamonu, Samsun, Sinop, Karabük) of the Western Black Sea region with checks of Bezostaja-1 and Kunduru-1149. We studied a total of two types of wheat einkorn and emmer with one durum (Kunduru-1149) and one bread (Bezostaja-1) wheat. We evaluated their nutritional values and macro-micro element content and precented below.

Table 4.19 Mean squares of macro-micro elements of wheat in ANOVA

Source of Variation	DF	N (mg/kg)	P (kg/kg)	K (kg/kg)	Cu (mg/kg)	Fe (mg/kg)	Zn (mg/kg)	Mn (mg/kg)
Entries	10	0.46	1216.26*	747.75*	1.10	296.68*	369.49*	218.26*
Error	22	0.02	0.055	0.625	106711.38	0.64	4.01	1.08

D.F.: Degrees of freedom
F-table value for 5% is 2.755.

Mean squares values in ANOVA (Table 4.19) were shown among entries for macro and micro element contents. Statistical differences (P<0.05) were noted. According the table, the results were significant in terms of macro-micro elements (N, P, K, Fe, Zn, Mn) content, not significant in terms of micro element (Cu,) content of 11 different wheat species.

Table 4.20 Mean squares for wheat quality values in ANOVA

Source of Variation	DF	1000 KW	Crude protein	Energy	Raw ash	Crude cellulose	Raw oil	Hektoliter	Carbohydrate	Starch %	Total sugar %
Entries	10	273.98	13.07	346.09	140.00	1.47	0.55	29.53	30.39	25.92	0.33
Error	22	1.03	0.47	50.33	1563.82	0.01	0.01	4.58	2.23	2.54	0.0043

D.F.: Degrees of freedom
** Significant at 0.01
* Significant at 0.05

According the table, the results were significant in terms of 1000 KW, crude protein, energy, crude cellulose, raw oil, hectoliter, carbohydrate, starch %, total sugar % content, in significant in terms of raw ash content of 11 different wheat entries.

Table 4.21 Mean squares for soil macro-micro elements in ANOVA

Source of Variation	DF	Total N %	Na (mg/kg)	K (kg/kg)	Fe (mg/kg)	Cu (mg/kg)	Ca (kg/kg)	Zn (mg/kg)	Mn (mg/kg)	Mg (kg/kg)
Entries	10	0.096	27.43	34.60	645.04	25.25	2553.07	6.28	1486.08	21.74
Error	22	0.02	0.0044	0.09	0.07	0.008	127.11	0.0086	0.39	0.035

D.F.: Degrees of freedom
** Significant at 0.01
* Significant at 0.05

After analysis of the experiments, the F values in ANOVA (Table 4.21) were shown among entries for their macro and micro element contents. (P<0.01) value is highly significant, (P<0.05) value is significant, except for those value is not significant. According the table, the results were significant in terms of macro-micro elements for N, Na, K, Fe, Cu, Ca, Zn, Mn, Mg content in 11 different soil samples.

Table 4.22 MS's of ANOVA's for soil structure

Source of Variation	DF	$CaCO_3$ %	Active lime %	EC ms/cm	K_2O kg/da	Organic matter %	P_2O_5 kg/da	Water saturation	Saturation with water pH	Total salt %
Entries	10	984.16	246.69	0.0133	7494.41	2.36	740.07	966.76	0.72	0.0001
Enter	22	0,11	0.21	0.0071	10.94	0.18	0.17	10.81	0.01	0.002

D.F.: Degrees of freedom

After analysis of the experiments, the F values in ANOVA (Table 4.22) are shown between $CaCO_3$ %, Active lime %, EC, K_2O, Organic matter %, P_2O_5, water saturation, saturation with water pH, total salt %content and varieties; significant (P<0.01) differences, significant (P<0.05) differences, except for those values, are not significant. According to the table, the results are significant in terms of $CaCO_3$ %, Active lime %, K_2O, Organic matter %, P_2O_5, water saturation, saturation with water pH, content, not significant in terms of EC, total salt % content of 11 different soil samples.

There are no differences between the 11 samples in terms of successive applications (replications). The bottom two tables were prepared according to wheat characteristics, 1000 KW, crude protein, energy, raw ash, crude cellulose, raw oil, hectoliter, carbohydrate, starch %, total sugar %, macro elements (N, P, K) and micro elements (Fe, Cu, Zn, Mn).

Table 4.23 LSD ranking of populations / cultivars for wheat macro-micro elements characteristics

Entries	N (mg/kg)	P (mg/kg)	K (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Zn (mg/kg)	Mn (mg/kg)
Population-1 Kastamonu-Safranbolu	2.11c	4324.33e	4721.67c	4.64a	35.81e	48.13e	34.16c
Population-2 Kastamonu-İhsangazi	2.20b	4217.33f	4240.67f	4.79a	30.67f	74.68a	44.75b
Population-3 Kastamonu-İhsangazi	1.93c	4341.33d	4774.67c	4.74a	29.30f	55.05c	36.38c
Population-4 Kastamonu-İhsangazi	2.13c	5687.00a	5651.00a	4.86a	59.32a	62.05b	53.75a
Population-5 Samsun-Ladik	1.97c	3774.33i	4344.00e	4.67a	30.34f	42.65g	29.64e
Population-6 Sinop-Durağan	1.68d	3926.33h	4452.33d	4.16a	27.55g	38.15h	24.48f
Population-7 Bolu-Seben	2.50b	3472.67j	4176.00g	5.37a	76.30b	53.75c	31.07d
Population-8 Sinop-Durağan	1.55d	4420.33c	5123.67b	4.52a	27.30g	45.72f	32.41d
Population-9 Bolu-Seben	2.19b	3328.33k	4267.67f	5.33a	42.87c	51.44d	28.07e
Bezostaja-1	2.02c	4081.33g	3842.00h	4.59a	30.11f	35.62i	34.41c
Kunduru-1149	3.02a	4647.00b	4496.00d	6.42a	38.22d	46.31e	43.57b

According to the differentiation by least significant difference (LSD), (Table 4.23) in terms of N content, Kunduru-1149 had the highest, comes followed by Population-7, Popuation-2, and Population-9, respectively. In terms of P content, Population-4 had the highest, followed by Kunduru-1149 and Population-8. As the amount of K, Population-4 was highest, followed by Population-8, Population-1, and Population-3. We did not get a meaningful result for Cu. In the samples we worked out, we obtained values close to each other in terms of Cu. As the amount of Fe, Population-4 had the highest, followed by Population-7 and Population-9. As the amount of Zn, Population-2 came the highest, followed by Population-4, Population-3, and Population-7. As the amount of Mn, Population-4 were the highest, followed by Population-2 and Kunduru-1149, respectively. As a result, Population-4 had the highest P, K, Cu, Fe, and Mn except N and Zn. We can say that; Population-4 was the richest in terms of most macro-micro elements content.

Table 4.24 Differentiation of quality characters in populations by LSD

Entries	1000 KW	Crude protein	Energy	Raw ash	Crude cellulose	Raw oil	Hectoliter	Carbohydrate	Starch %	Total sugar %
Population-1 Kastamonu-Safranbolu	27.87f	12.07b	307.00a	1.77d	3.04b	1.62b	71.97b	61.24b	60.32a	0.58d
Population-2 Kastamonu-İhsangazi	21.55h	12.47b	279.67b	1.72f	2.99b	1.25c	77.42a	54.50c	53.63c	0.83b
Population-3 Kastamonu-İhsangazi	33.57d	11.13c	283.00b	1.70f	2.44c	1.43b	80.07a	56.41c	55.46c	0.91b
Population-4 Kastamonu-İhsangazi	23.30g	12.25b	305.67a	2.01b	1.28f	1.45b	78.02a	60.54b	59.13b	1.69a
Population-5 Samsun-Ladik	29.18f	11.25b	302.57a	1.64f	2.27c	1.71b	70.67b	60.45b	59.95a	0.66c
Population-6 Sinop-Durağan	32.13e	9.68c	300.67a	1.73e	2.10d	1.94a	75.37b	60.93b	60.12a	0.82b
Population-7 Bolu-Seben	27.20f	14.27b	296.33a	1.42h	2.40c	1.27c	79.15a	57.23c	56.24b	0.96b
Population-8 Sinop-Durağan	37.87c	8.75d	311.00a	1.51g	1.70e	2.04a	75.10b	64.63a	63.28a	0.77c
Population-9 Bolu-Seben	25.50g	12.72b	285.33b	24.34a	2.13d	1.50b	80.33a	55.47c	54.68c	0.65c
Bezostaja-1	48.10b	11.61b	288.67b	1.56g	2.97b	0.42d	75.10b	59.20b	59.12b	0.42e
Kunduru-1149	50.55a	16.50a	303.00a	1.82c	3.80a	1.58b	77.57a	55.16c	56.37b	0.54d

In terms of 1000 KW Kunduru-1149 had the heaviest grains, followed by Bezostaja-1 and Population-8. As the amount of crude protein content, Kunduru-1149 was the highest, followed by Population-9, Population-2, Population-4, and Population-1. As the amount of energy content, Population-8 came, followed by Population-1, Population-4, Kunduru-1149, and Population-5. As the amount of raw ash content Population-9 had the most, followed by Population-4, Kunduru-1149, and Population-1. As the amount of crude cellulose content, Kunduru-1149 obtained the highest, followed by Population-1, Population-2, and Bezostaja-1. As the amount of raw oil content, Population-8 was the highest, followed by Population-6, Population-5, and Population-1. As the amount of hectoliter weight, Population-9 had the heaviest, followed by Population-3, Population-7, Population-4, and Kunduru-1149. As the amount of carbohydrate, Population-8 had the highest, followed by Population-1, Population-6, Population-4, and Population-5. As the amount of starch % content Population-8 had the most, followed by Population-1,

Population-6, Population-5, and Population-4. As the amount of total sugar % content, Population-4 came the first, followed by Population-7, Population-3, Population-2, and Population-6. As a result, Kunduru-1149, durum wheat cultivar, was at the forefront in terms of 1000 KW, crude protein, energy, crude cellulose, and hectoliter. It was followed by Population-8, rich in energy, raw oil, carbohydrate, and starch.

The bottom two tables (Tables 4.24) were prepared according to soil characteristics $CaCO_3$, active lime, E.C, K_2O, organic matter, P_2O_5, water saturation, saturation with water pH, total salt, total N, Na, K, Fe, Cu, Ca, Zn, Mn, and Mg.

Table 4.25 Differentiation of soil macro-micro elements by LSD

Entries	Total N %	Na (mg/kg)	K (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Ca (mg/kg)	Zn (mg/kg)	Mn (mg/kg)	Mg (mg/kg)
Population-1 (Kastamonu-Safranbolu)	0.26b	7.92a	331.60b	3.92e	5.37f	4904.67b	0.58d	33.70g	145.60d
Population-2 (Kastamonu-İhsangazi)	0.74a	0.01d	316.47b	13.32b	8.59c	3584.67c	4.32a	56.37d	153.03d
Population-3 Kastamonu-İhsangazi	0.52a	5.25c	306.73c	4.97d	9.12b	5630.67a	0.01e	69.06b	143.23e
Population-4 Kastamonu-İhsangazi	0.52a	5.95b	371.27a	2.83f	9.10b	4628.67b	0.14e	49.80e	178.40c
Population-5 Samsun-Ladik	0.34b	0.01d	104.80h	3.33e	13.98a	5739.67a	0.39d	25.62h	395.57a
Population-6 Sinop-Durağan	0.52a	0.01d	59.43i	12.93b	5.57f	3161.67d	2.84b	61.98c	88.17g
Population-7 Bolu-Seben	0.13b	0.01d	145.83g	2.46f	3.35h	3726.33c	0.01e	22.23i	176.23c
Population-8 Sinop-Durağan	0.53a	0.01d	117.03h	53.15a	7.14d	3108.37d	1.83c	95.35a	283.53b
Population-9 Bolu-Seben	0.18b	0.01d	128.63g	2.20f	4.45g	4047.67c	0.01e	23.65i	122.47f
Bezostaja-1	0.35b	0.11d	180.00e	9.82c	6.59e	3481.67c	0.08e	43.33f	158.33d
Kunduru-1149	0.38a	0.15d	208.33d	9.88c	6.70e	4238.33b	0.10e	43.97f	180.00c

According to the above Table 4.25; in terms of total N % content; Population-2 was the highest, followed by Population-8, Population-3, Population-4, and Population-6. As the amount of Na content Population-1 was the highest, followed by Population-4, Population-3, and Kunduru-1149. As the amount of K content Population-4 was the highest, followed by Population-1, Population-2, Population-3,

and Kunduru-1149. As the amount of Fe content, Population-8 was the highest, followed by Population-2, Population-6, Kunduru-1149, and Bezostaja-1. As the amount of Cu content Population-5 was the highest, followed by Population-3, Population-4, Population-2, and Population-8. As the amount of Ca content, Population-5 was the highest, followed by Population-3, Population-1, Population-4, and Kunduru-1149. As the amount of Zn content, Population-2 was the highest, followed by Population-6, Population-8, Population-1, and Population-5. As the amount of Mn content, Population-8 was the highest, followed by Population-3, Population-6, Population-2, and Population-4. As the amount of Mg content, Population-5 was the highest, followed by Population-8, Kunduru-1149, Population-4, and Population-7. This table also had two populations in the foreground. Population-5 was in the foreground in terms of Cu, Ca, and Mg. Population-8 was the front plate for total N, Fe, and Mn.

Table 4.26 Distingushing for other soil charactersitics by LSD

Entries	$CaCO_3$ %	Active lime %	E.C ms/cm	K_2O kg/da	Organic matter %	P_2O_5 kg/da	Water saturation	Saturation with water pH	Total salt %
Population-1 Kastamonu-Safranbolu	0.80h	0.40h	0.46a	153.43d	1.33c	0.03h	127.40a	7.24b	0.06a
Population-2 Kastamonu-İhsangazi	59.23a	29.63a	0.59a	258.22a	3.78a	54.90a	69.17e	7.23b	0.04a
Population-3 Kastamonu-İhsangazi	16.63d	8.43d	0.60a	160.60c	2.62b	10.43d	96.69b	7.51a	0.04a
Population-4 Kastamonu-İhsangazi	5.21f	2.63f	0.53a	184.33b	2.58b	2.63g	91.47b	7.60a	0.04a
Population-5 Samsun-Ladik	2.98g	1.53g	0.60a	90.55h	1.72b	5.09e	72.60d	7.36b	0.03a
Population-6 Sinop-Durağan	1.21h	0.63g	0.42a	65.87i	2.55b	22.45b	59.43f	7.17b	0.03a
Population-7 Bolu-Seben	36.17b	18.20b	0.44a	146.77e	0.65c	3.24f	84.77c	7.61a	0.03a
Population-8 Sinop-Durağan	0.04i	0.01h	0.47a	116.07g	2.37b	22.89b	77.00d	6.22d	0.03a
Population-9 Bolu-Seben	19.23c	9.63c	0.47a	153.10d	0.93c	3.61f	79.23c	7.55a	0.03a
Bezostaja-1	14.07e	7.05e	0.46a	132.33f	1.81b	12.35c	75.50d	6.48c	0.04a
Kunduru-1149	14.22e	7.15e	0.49a	141.33e	1.87b	12.47c	77.72c	6.57c	0.04a

According to the above Table 4.26 in terms of total $CaCO_3$ % content Population-2 was the highest, followed by Population-7, Population-9, Population-4, and Population-3. As the amount of active lime % content, Population-2 was the highest, followed by Population-7, Population-9, and Population-3. As the amount of EC content Population-3 was the highest, followed by Population-5, Population-2, Population-4, and Kunduru-1149. As the amount of K_2O content Population-2 was the highest, followed by Population-4, Population-3, Population-1, and Population-9. As the amount of organic matter % content, Population-2 was the highest, followed by Population-3, Population-4, Population-6, and Population-8. As the amount of P_2O_5 content, Population-2 was the highest, followed by Population-8, Population-6, Kunduru-1149, and Bezostaja-1. As the amount of water saturation content, Population-1 was the highest, followed by Population-3, Population-4, Population-7, and Population-9. As the amount of saturation with water pH content, Population-7 was the highest, followed by Population-4, Population-9, Population-3, and Population-5. As the amount of total salt % content, Population-1 was the highest, followed by Kunduru-1149, Population-3, Population-4, and Population-2. According to the values in the Table 4.26; Population-2 soil sample was rich in $CaCO_3$, active lime, E.C, K_2O, organic matter, P_2O_5, and total salt.

4.3 Correlation tables for wheat and soil structure

Probability theory and correlation in statistics indicate the strength and direction of the linear relationship between two independent variables. In widespread statistical use, the correlation shows how far away from independence is.

We evaluated the results obtained from wheat and soil samples that we worked with correlation calculation method. In this way we have seen the relationship between macro-micro elements and other properties.

4.3.1 Hulled wheat structure

4.3.1.1 Macro-micro element characteristics

Table 4.27 Correlations among macro-micro elements

Characters	N (mg/kg)	P (mg/kg)	K (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Zn (mg/kg)
Mn (mg/kg)	0.400	0.838**	0.512	0.318	0.532	0.634*
Zn (mg/kg)	0.219	0.218	0.275	0.145	0.380	-
Fe (mg/kg)	0.449	0.389	0.424	0.409	-	
Cu (mg/kg)	0.926**	0.026	-0.116	-		
K (mg/kg)	-0.229	0.788**	-			
P (mg/kg)	0.049	-				

Correlations among 11 wheat entries for macro-micro element content provided highly significant relationship between N-Cu (0.926), P-Mn (0.838), and P-K (0.788) and significant relationship between Zn-Mn (0.634). No relationships existed between N-Mn (0.400), N-Zn (0.219), N-Fe (0.449), N-P (0.049), P-Zn (0.218), P-Fe (0.389), P-Cu (0.026), K-Mn (0.512), K-Zn (0.275), K-Fe (0.424), Cu-Mn (0.318), Cu-Zn (0.145), Cu-Fe (0.409), Fe-Mn (0.532), and Fe-Zn (0.380).

4.3.1.2 Quality characteristics in wheat entries

Table 4.28 Quality characteristics in wheat

Characters	1000 KW	Crude protein	Energy	Raw ash	Crude cellulose	Raw oil	Hectoliter	Carbohydrate	Starch %
Total sugar %	-0.544	-0.069	0.154	-0.139	-0.687*	0.160	0.351	0.121	-0.009
Starch %	-0.234	-0.605*	0.817**	-0.380	-0.379	0.378	-0.691*	0.975**	-
Carbohydrate	0.047	-0.706*	0.762**	-0.340	-0.531	0.403	-0.626*	-	
Hectoliter	-0.102	0.353	-0.545	0.413	-0.097	-0.194	-		
Raw oil	-0.235	-0.304	0.565	0.024	-0.346	-			
Crude cellulose	0.504	0.609*	-0.248	-0.160	-				
Raw ash	-0.245	0.109	-0.346	-					
Energy	0.163	-0.137	-						
Crude protein	0.177	-							

Evaluation of 11 wheat entries in terms of their quality characteristics according to correlation constants (r); highly significant relationships existed

between carbohydrate-starch (0.975), energy-starch % (0.817), and energy-carbohydrate (0.762) respectively. Positive significant relationships were between crude protein-crude cellulose (0.609) and negative ones between crude protein-starch % (-0.605), crude protein-carbohydrate (-0.706), crude cellulose-total sugar % (-0.687), hectoliter-starch % (-0.691), hectoliter-carbohydrate (-0.626) (Table 4.28).

4.3.2 Soil characteristics

4.3.2.1 Macro-micro elements characteristics in soil samples

Table 4.29 Macro-micro elements characteristics with soil

Characters	Total N%	Na (mg/kg)	K (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	Ca (mg/kg)	Zn (mg/kg)	Mn (mg/kg)
Mg(mg/kg)	-0.033	-0.216	0.251	0.282	0.704*	0.355	-0.137	-.006
Mn (mg/kg)	0.736**	0.018	0.338	0.802**	0.117	-0.321	0.458	-
Zn (mg/kg)	0.725*	-0.289	0.241	0.405	0.054	-0.497	-	
Ca (mg/kg)	-0.149	0.554	0.072	-0.533	0.608*	-		
Cu (mg/kg)	0.433	0.062	0.113	-0.024	-			
Fe (mg/kg)	0.402	-0.299	0.390	-				
K (mg/kg)	0.144	0.054	-					
Na (mg/kg)	0.019	-						

Correlation contstants (r) among 11 soil samples for macro-micro element contents showed a highly significant relationship between Fe-Mn (0.802), total N %-Mn (0.736). The significant linear relationships existed between total N %-Zn (0.725), Cu-Mg (0.704), and Cu-Ca (0.608).

4.3.2.2 The other characteristics in soil samples

Table 4.30 The other characteristics of soil samples

Characters	$CaCO_3$ %	Active lime %	E.C ms/cm	K_2O kg/da	Organic matter %	P_2O_5 kg/da	Water saturation	Saturstion with water pH
Total salt %	-0.062	-0.062	0.116	0.400	0.086	-0.103	0.829**	0.143
Saturation with water pH	0.249	0.251	0.288	0.252	-0.154	-0.279	0.249	-
Water saturation	-0.224	-0.224	-0.001	0.228	-0.310	-0.515	-	
P_2O_5 kg/da	0.599	0.597	0.265	0.445	0.789**	-		
Organic matter %	0.255	0.253	0.518	0.408	-			
K_2O kg/da	0.750**	0.749**	0.438	-				
E.C ms/cm	0.283	0.284	-					
Active lime %	1.000**	-						

Evaluation of 11 soil samples for correlation constants revealed that significant relationships existed between $CaCO_3$ %-active lime (1.000), water saturation-total salt % (0.829), organic matter- P_2O (0.789) $CaCO_3$ %- K_2O (0.750), and active lime- K_2O (0.749).

4.4 Wheat and soil characteristics by dendogram

Dendrogram is a kind of clustering technique. Clustering analysis is the process of separating information in a data set into groups according to certain proximity criteria. Each of these groups is called a 'cluster'. The process of clustering analysis is called clustering. The simplest definition of clustering is to distinguish data elements that have similar characteristics among themselves. The similarity between the elements in the same cluster should be high and the similarity between the clusters should be small. We used dendogram to establish the proximity and distance relationship of wheat populations and soil samples.

4.4.1 Wheat characteristics by dendogram

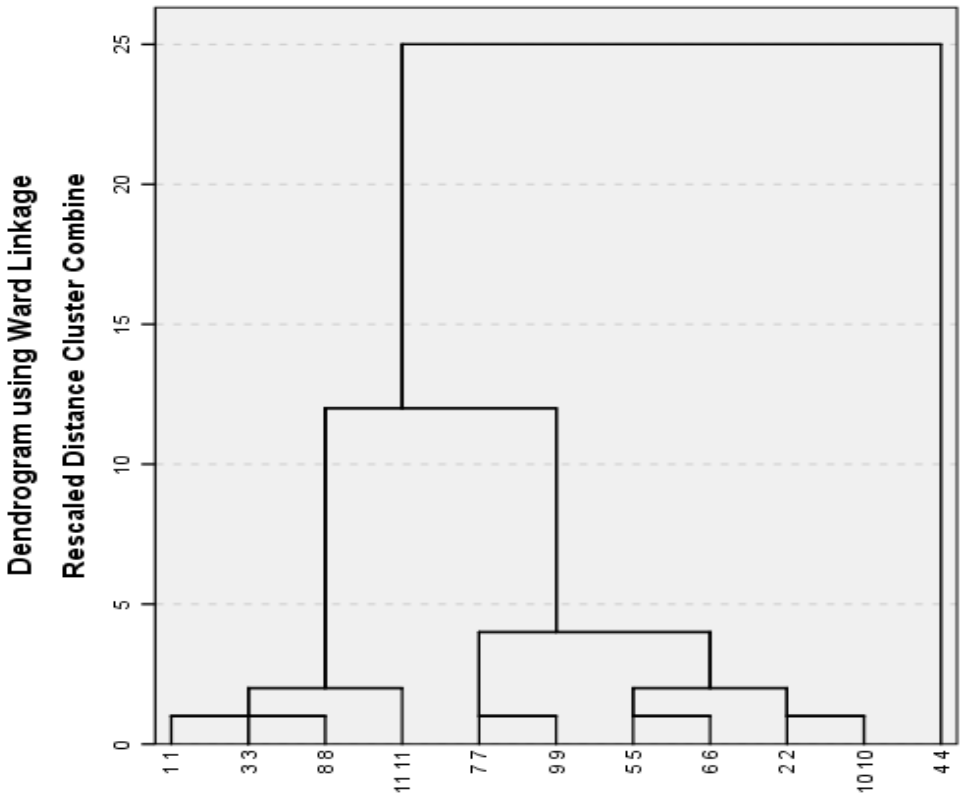


Figure 4.1 Dendogram for 11 entires of five einkorn, four emmer, one durum, and one bread wheat based on 1000 KW, crude protein, energy, raw ash, crude cellulose, raw oil, hectoliter, carbohydrate, starch %, total sugar %, macro elements (N, P, K) and micro elements (Fe, Cu, Zn, Mn) characteristics.

A dendogram based on the avarages of 1000 KW, crude protein, energy, raw ash, crude cellulose, raw oil, hectoliter, carbohydrate, starch %, total sugar %, macro elements (N, P, K) and micro elements (Fe, Cu, Zn, Mn) grouped 11 wheat entires into two main groups (Figure 4.1). The first main group had two subgroups while the second main group had only Population-4. The first subgroup in the first main group was limited to only Population-1, Population-3, Population-8, and Kunduru-1149. The second subgroup in the first group was also divided into two subgroups. From these groups, the first subgroup had Population-7 and Population-9, and the second subgroup Population-5, Population-6, Population-2, and Bezostaja-1. At this point we can say; Population-4 was very different from other populations in terms of macro-micro element content and nutritional values. Population-4 Kastamonu, İhsangazi, example from the village of Enbiya. This example is very different from

the others in terms of nutritional value and quality. Factors affecting this result; seed quality and quantity, cultivation, sowing time, harvest season, abandonment, soil and climatic conditions, irrigation. This Population-4 can serve as an example for other farmers, taking into account the better observed and influencing factors. Kastamonu, İhsangazi people are very conscious about politics and increasingly expanding the field of cultivation. With these studies, our other farmers have knowledge.

4.4.2 Soil characteristics by dendogram

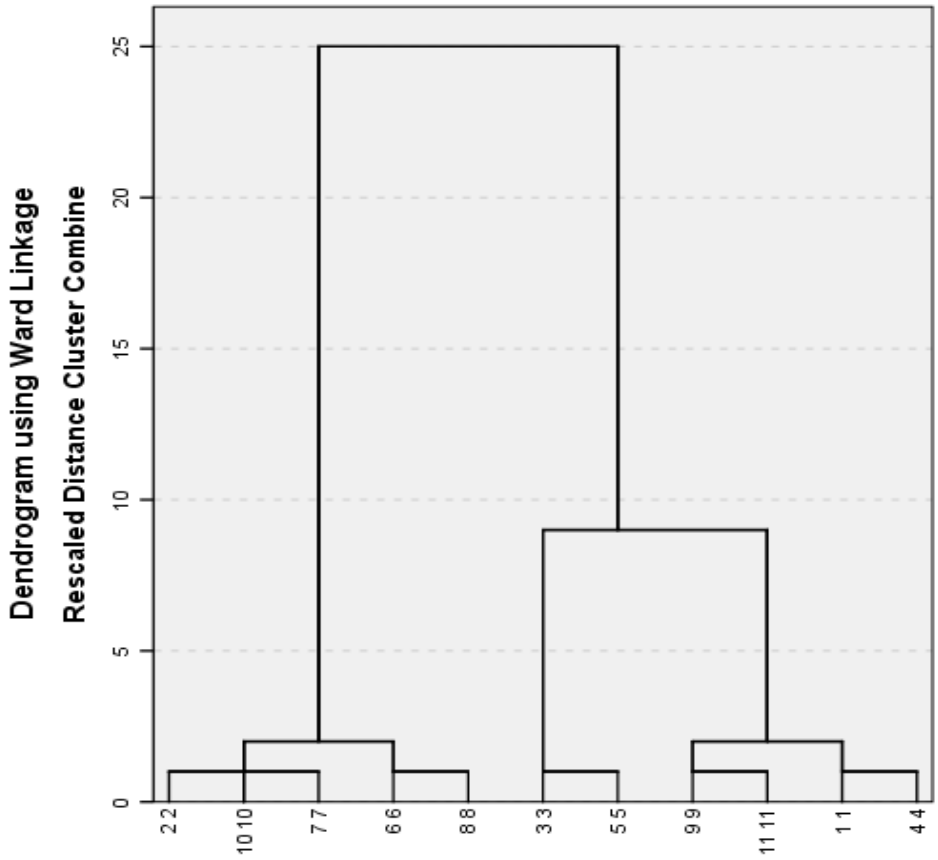


Figure 4.2 Dendogram of our species of 11 wheat entries populations based on $CaCO_3$, active lime, E.C, K_2O, organic matter, P_2O_5, water saturation, saturation with water pH, total salt, total N, Na, K, Fe, Cu, Ca, Zn, Mn, and Mg characterisitcs of soil samples taken from the fields.

A dendogram based on the average of $CaCO_3$, active lime, E.C, K_2O, organic matter, P_2O_5, water saturation, saturation with water pH, total salt, total N, Na, K, Fe, Cu, Ca, Zn, Mn, and Mg in 11 soil samples formed two main groups (Figure 4.2).

The first main group consisted of five populations and the second main group consisted of two subgroups. The first main group was as limited to only Population-2, Bezostaja-1, Population-7, Population-6, and Population-8. The first subgroup in the second main group Population-3 and Population-5, and the in second subgroup Population-9, Kunduru-1149, Population-1, and Population-4 took place.

5. CONCLUSIONS AND RECOMMENDATIONS

In our age, the working hours of the people have increased and the feeding time is limited. Practical and fast-food style has been the foreground to feed. Illness is increasing as a result of unhealthy nutrition. The natural and reliable food we eat will greatly affect our health. In our study, we have dealt with the most basic food sources and the wheat that has the largest share in our food. Wheat is also rich in terms of wheat products. Main products originating from wheat; bulgur, flour, pasta, pastry, cookies, tarhana, and bran. Here, we have tried to draw attention to healthy and natural foods by studying the nutritional values of wheat ancestors, einkorn and emmer here.

We went out of this way to investigate einkorn and emmer wheats. We obtained information by asking general questions about einkorn and ember wheat with 53 open-ended questionnaires in five provinces (Bolu, Karabük, Kastamonu, Sinop, Samsun) of Western Black Sea Region. With these questions; we tried to determine wheat planting areas, why they were planted, the structure of soil, irrigation size, conditions affecting productivity, why it was broken, harvest season, socio-economic situation where they were planted and processed and difficulties in production. The results showed that farmers had difficulties in finding seeds, not trained in agricultural issues, that there was no salary for the majority and that they were primary school graduates, that the number of female farmers was too small to be tried, that diesel, fertilizers and pesticides are expensive, the product is grown in limited areas, could not earn enough income from farming, and it was difficult to harvest and process the products.

We got wheat and soil samples from these above mentioned cities. In wheat samples, macro elements (N, P, K), micro elements (Fe, Mn, Zn, Cu), energy, carbohydrate, protein, starch, fat, fiber, sugar, crude ash, crude protein, weight of 1000 grains were determined. In soil samples, saturation, salt, pH, $CaCO_3$, active lime, K_2O (potassium oxide), P_2O_5 (phosphorus pentoxide), electrical conductivity

(EC), nitrogen, sodium, potassium, calcium, magnesium, iron, manganese, zinc, copper and organic matter analyses were run. With these results, we tried to evaluate nutritional value of both einkorn and emmer. We tried to understand how it was influenced by the soil properties in the cultivated fields as well.

Local varieties (village varieties) are a collection of similar individuals whose appearance is mostly populated by local populations, which survive under natural and artificial selection. They have a broad genetic basis. Since local varieties can not compete in yield and profitability with modern varieties of culture, the cultivation areas are decreasing day by day. 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.

Hulled wheat has become a tradition to grow by humans. Thanks to this habit, our ancestral values have not disappeared. The only thing we can do right now is to recognize, promote and distiribute hulled wheats. Because they are indispensable for a quality and healthy life.

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7. APPENDICES

Appendix Table.7.1

Questionnaire number:

Distribution, growing, consumption, macro-micro element content of Hulled wheat

QUESTIONNAIRE FARMER (and PROCESSOR)

MODULE A: SURVEY INFORMATION

1. Date of interview: (day/month/year)							
2. Interviewer:							
3. Species name (local name)							

MODULE B: HOUSEHOLD INFORMATION

MODULE B-1: IDENTIFICATION

1. Name and gender of the acting head of household (who is currently responsible for making decisions)		Male Female
2. Location of household (name of village, Province)		
3. Name of respondent (if not head), and relation to head of household (who is actually responding to the questionnaire)		

MODULE B-2: COMPOSITION

1. Number of household members	…...male …female	
2. Number of children below the age of 12 (below working age)	……male …female	
3. Number of elderly people (above working age)	……male ….female	
4. Number of absent members of household, and for which reason (school, army, migrant labour)	Number:	Reason:
5. Highest level of education of the head of household?	o 1. Primary o 2. High School o 3. College o 4. Post graduate	
6. Main source of income of the household		

MODULE C: CAPITAL AND TECHNOLOGY

1.	Land holding category	How many acres of irrigated land?	How many acres of rain fed land?	Do you have access to free range land? (Yes, No)
	Owned			
	Rented			
	Other			

2	What is the quality of the agricultural land you are using, relative to the land of other farmers in the village?	○ 1.Better than average ○ 2.Average ○ 3.Poorer than average ○ 4.Much poorer than average

3	Which equipment/technology do you use?	Used for producing the target species (yes/no)	Used for other crop production (yes/no)
	Tractor		
	Ploughing equipment		
	Any other machinery		
	Pesticides / fertilisers /		
	other purchased inputs		

4. Do you have the possibility to store the target species?	1. yes 2. no
5. What type of structure does your household have for storage?	

MODULE D: AGRICULTURE

MODULE D-1: AGRICULTURAL PRODUCTION

List the crops you produce in order of economic importance (including the target species)

	1. Crop	Number of trees/area	Rank in terms of income
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

MODULE D-2: PRODUCTION OF the target species

Variety n.	1. Variety name (write the local name in order of importance)	For cultivated crop, indicate if the variety is:	Is it cultivated in: Irrigated (I) Rain fed (R) Land?	What is the % of your land cultivated with this variety?	Do you collect it from the wild?
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

2. From the table above, indicate the 3 varieties you would mostly like to work on market related activities (processing, selling, etc.) and indicate why (easier to process, more consumers' request, higher income, etc.).

	Variety 1	Variety 2	Variety 3 (used, but difficult to sell)
Variety name			
Reason why			

MODULE D-3: CULTIVATION AND COLLECTION

1	Where do you get seeds/planting materials? (Please indicate if there are multiple sources and differences in varieties, please write the variety number)	own	from relatives	from the wild	From farmers in the village		From farmers outside the village		from shop
					exchanged	purchased	exchanged	purchased	From institutions / government
2	If you collect this species also from the wild, which are the main differences and what are the main problems?								

MODULE D-4: LABOUR AND HARVEST/COLLECTING FROM THE WILD

Please report answers related to (Variety1), (Variety 2) (Variety 3) as in question D2

		Variety 1			Variety 2			Variety 3		
1	When is the harvesting date/season?									
2	How long is the harvesting season?									
3	How much is the yield per variety per year?									
4	How much is the yield in a: (indicate the amount of yield for each variety, in the three cases, good, bad and common year)	good year:			good year:			good year:		
		bad year:			bad year:			bad year:		
		common year:			common year:			common year:		
5	How is the quantity of yield today comparing to 15 years ago? (cross the right answer for each variety)	more	same	less	more	same	less	more	same	less
6	How is the quality of yield today comparing to 15 years ago? (cross the right answer for each variety)	better	same	poorer	better	same	poorer	better	same	poorer

7	How many years in the last 15 years were:	good years	bad years	common years

MODULE E -SOCIAL / LABOUR

Please report answers related to (Variety1), (Variety 2) (Variety 3) as given in question D2

MODULE E-1: SOCIAL

1	Which is the main reason for growing/collecting this target species?	local customs / imitation of neighbours			Food			income			others (please indicate other reason):		
	Variety:	1.	2.	3.	1.	2.	3.	1.	2.	3.	1.	2.	3.
2	Which is the starting year of cultivation/collection?	Variety 1 in year:			Variety 2 in year:			Variety 3 in year:					

3	What is the use of the varieties and their derived products? Please indicate the quantity of the particular use					
	Variety:	Food (kg) Indicate if fresh, jam, juice, etc.	Flour (kg)	Fodder (kg)	Cultural/religious (kg)	Other (e.g. fiber, dyes, crafts, etc) (kg)
	1.					
	2.					
	3.					
	4.					
	5.					

Please report answers related to (Variety1), (Variety 2) (Variety 3) as in question D2
Variety 4 and Variety 5 can be otherimportantvarieties.

MODULE E– 2: PROCESSING

1	Is the target species processed? In which products according to which variety? (ex: from variety 1, two products P1.1 and P1.2 are derived, from variety 2 only P2.1)	Type of final products (findings, bran, flour, fodder, other)	Type of processing (No process, drying, extracting, other)	Where is it processed? (House/community / other)
	Variety 1:	P1.1:		
		P1.2:		
		P1.3:		
	Variety 2:	P2.1:		
		P2.2:		
		P2.3:		
	Variety 3:	P3.1:		
		P3.2:		
		P3.3:		
2	Which kind of technology is used for processing?			
	Variety 1:	P1.1:		
		P1.2:		
		P1.3:		
	Variety 2:	P2.1:		
		P2.2:		
		P2.3:		
	Variety 3:	P3.1:		
		P3.2:		
		P3.3:		
3	Are the products packaged?	Type of packaging		Where is it packaging done? (House/community / other)
	Variety 1:	P1.1:		
		P1.2:		
		P1.3:		
	Variety 2:	P2.1:		
		P2.2:		
		P2.3:		
	Variety 3:	P3.1:		
		P3.2:		
		P3.3:		

MODULE E-3: LABOUR IN CULTIVATING/COLLECTING FROM THE WILD FOR THE TARGET SPECIES

1	Number of people involved in cultivating and harvesting (family members + external workers)	Tot. no. :	No. of women	No. of children <12 year old:	Estimate average age:
		family members:	family members:	family members:	
		Paid workers:	Etc workers:	workers:	
		Paid seasonal workers:	Etc seasonal workers:	seasonal workers:	
2	Number of people involved in collecting from the wild (family members + external workers)	Tot. no. :	No. of women	No. of children <12 year old:	Estimate average age:
		family members:	family members:	family members:	
		workers:	workers:	workers:	
		seasonal workers:	seasonal workers:	seasonal workers:	
3	Number of people involved in the processing (family members + external workers)	Tot. no. :	No. of women	No. of children <12 year old:	Estimate average age
		family members:	family members:	family members:	
		workers:	workers:	workers:	
		seasonal workers:	seasonal workers:	seasonal workers:	
4	Number of people involved in the packaging (family members + external workers)	Tot. no. :	No. of women	No. of children <12 year old:	Estimate average age:
		family members:	family members:	family members:	
		workers:	workers:	workers:	
		seasonal workers:	seasonal workers:	seasonal workers:	

5	Who is involved in this activity?	Household members (e.g. mother, father, sons, daughters, grandparents)	How much time is spent on this activity?	Which is the most difficult and time consuming activity?
	Cultivation			
	Harvesting			
	Collecting			
	Processing			
	Packaging			
	Selling			

6	Who has the specialization in this activity? (what knowledge and who has it)	Household members (please specify):	Community farmers	Farmers from other communities	Government, institutions Agencies, extension (please specify):
	Cultivation				
	Harvesting				
	Collecting				
	Processing	(Ex. father, drying)			
	Packaging				
	Selling				

MODULE E-4: CONSTRAINTS ENCOUNTERED

1		What are the main problems you encounter when cultivating this variety?		What would be a way to overcome the problem? (fertilizer availability, training, etc.)
	Variety 1:			
	Variety 2:			
	Variety 3:			
2		What are the main problems do you encounter when processing and/or selling these products?		What would be a way to overcome the problem? (machinery availability, training, etc.)
	Variety 1:	P1. 1:		
		P1. 2:		
		P1. 3:		
	Variety 2:	P2. 1:		
		P2. 2:		
		P2. 3:		
	Variety 3:	P3. 1:		
		P3. 2:		
		P3. 3:		

3	Are farmers trained to cultivate/collect this species?	Women		Men	
		Household members	Community farmers	Farmers from other communities	Government, institutions Agencies, extension (please indicate):
4	Are farmers trained to process this species?				
5	Training need areas (specify)				

MODULE E 5: TIMING

1	What it the time for the following activities: (indicate the month)	Variety 1:			Variety 2:			Variety 3:		
		P1.1	P 1.2	P1. 3	P2. 1	P 2.2	P2. 3	P3. 1	P3. 2	P 3.3
	Cultivation									
	Harvest									
	Processing (findings, bran, flour, fodder, other)									
	Packaging/storage									
	Selling									

MODULE F – MARKET

MODULE F-1: MARKET PLACE

1	Which is the destination of the product? (indicate the %)	**Variety 1:**			**Variety 2:**			**Variety 3:**		
		P1.1	P 1.2	P1.3	P 2.1	P 2.2	P 2.3	P3. 1	P3. 2	P 3.3
	Household consumption[1]									
	Selling									
	Barter exchange									
	Others									
2	To whom do you sell the product?									
	nobody									
	middlemen									
	Local consumers in the community									
	Local consumers outside the community									
3	Where is the market place? tick How much does it cost to get to the market? in hours and/or money	P1.1	P 1.2	P1.3	P 2.1	P 2.2	P 2.3	P3. 1	P3. 2	P 3.3
	nowhere									
	street									
	Village market [district capital]									
	city main markets									
4	Main problems in transporting/storage of the product? (write the problem or leave it blank)									
5	What is the marketable threshold of the product? (ex: individual farmer produces 20 kg of P1, but it is only feasible to transport/market it when it is 200 kg)									
6	Where should the production be located to get easiest access to market place?									
	at home									
	community level									
	Centralised (where?)									

7	How do you get to the market place?	own transport	paid transport
8	Is the market easily reached by middlemen/consumers?		

MODULE F-2: QUALITY and PRICE

1	Price. (specify the price)	2 years ago			Last year			This year		
		P1.1 P1.2 P1.3	P2.1 P2.2 P2.3	P3.1 P3.2 P3.3	P1.1 P1.2 P1.3	P2.1 P2.2 P2.3	P3.1 P3.2 P3.3	P1.1 P1.2 P1.3	P2.1 P2.2 P2.3	P3.1 P3.2 P3.3
2	Price fluctuation throughout the year (indicate if there are differences for various products)	Variety 1 P1.1 Y / N P1.2 Y / N P1.3 Y / N			Variety 2 P2.1 Y / N P2.2 Y / N P2.3 Y / N			Variety 3 P3.1 Y / N P3.2 Y / N P3.3 Y / N		
3	How price is established?	open market (freely determined by demand/supply)			monopolistic market			others		
4	What is the % of the total income coming from the sale of the target species? (specify at variety level)	2 years ago			Last year			This year		
		Var 1	Var 2	Var 3	Var 1	Var 2	Var 3	Var 1	Var 2	Var 3

MODULE F-3: ACCESS TO MARKET INFORMATION

1	Does the supply meet the demand? (tick)	Supply equal to demand			supply higher than demand			supply lower than demand			
		P1.1 P1.2 P1.3	P2.1 P2.2 P2.3	P3.1 P3.2 P3.3	P1.1 P1.2 P1.3	P2.1 P2.2 P2.3	P3.1 P3.2 P3.3	P1.1 P1.2 P1.3	P2.1 P2.2 P2.3	P3.1 P3.2 P3.3	
2	Which aspects should be improved to increase the demand? (tick)	taste			Appearance/packaging			processing			others (specify)
		P1.1 P1.2 P1.3	P2.1 P2.2 P2.3	P3.1 P3.2 P3.3	P1.1 P1.2 P1.3	P2.1 P2.2 P2.3	P3.1 P3.2 P3.3	P1.1 P1.2 P1.3	P2.1 P2.2 P2.3	P3.1 P3.2 P3.3	
3	Do you have any knowledge about market requirements?	YES By whom? On what?						NO			
4.	What kind of information do you have about the products?	o 1.price o 2. quantity required by the market (if the demand is less or more than your supply) o 3.appreciation about the quality (from consumers) o 4.varieties and type of products preferred on the market o 5.other (specify)									
5	From what source do you receive this information?	o 1.gov't institution o 2.NGO o 3.private company o 4.traders o 5.radio/ TV o 6.myself o 7.other (specify)									

MODULE G: ECONOMICS and INSTITUTIONAL

MODULE G 1- ECONOMICS

1	Share of the yearly income generated by selling products derived by this species (ex. 3% of the total yearly household income is generated by selling variety 1)	Variety 1 %	Variety 2 %	Variety 3 %	Variety 4 %	Variety 5 %
2	Use of the income generated by selling the products derived by this species (cross the appropriate answer(s))	Food and nutrition needs	house needs (renovation, furniture, TV, etc)	education	working needs (new equipment, more labour force, etc)	others (please indicate):

MODULE G-2: FINANCIAL / LEGAL

1	Is there any legal restriction/protection regulating the production, collection, processing and trading of the product?	YES (which one?):		NO	don't know
2	Is there any price regulation?	NO	by government	market monopoly	others (please indicate):
3	Did you receive a loan for the production running activities?	YES when how much source		NO	did not know about the possibility to get a loan

MODULE G-3: SOCIAL NETWORKS

1. Are you or any of your household members a member of an organisation / society or do you participate in group activities?	○ 1. Cooperative ○ 2. Farmer association ○ 3. (Women) self help group ○ 4. Other - Specify: ○ 5.NONE
2. What kind of activities do you do together?	1. Farming 2. Collecting from the wild 3. Gathering the yield to handle to the middlemen 4. Deciding the selling price 5. Processing 6. Trading 7. Product quality control 8. Transporting the goods to the market 9. Community projects (building houses, irrigation canals, etc.) 10. Other – specify
3. When did the household member join the organisation / society?	YEAR
4. IF NOT, why are you not a member of an organisation / society?	○ 1.none available in the area ○ 2.not useful ○ 3.too costly ○ 4.do not trust them ○ 5.not possible to join ○ 6.collaboration happens on ad hoc basis ○ 7. Other – specify

MODULE H: PERSPECTIVE ON DIVERSITY

1. Which crops/varieties do you hold in highest esteem?

WHY?	reliability	traits	Family bond	Easy to market	Other (specify)
Name the variety					

2. Are there varieties you are (considering of) not growing anymore? What are the reasons?

Name the variety	WHY?

3. Why are you growing more than one variety? (Why are you not just growing the best one?) (Open question)

4. If you were given the option to replace your trees with a very high yielding variety, what considerations would you have before making a decision?
(Open question)

5. Would you rather grow 5, 3, or 1 variety – why?
(Open question)

6. If you could improve your field, what would you do? Would you add varieties?

7. Could you reflect on the risks losses and benefits for your household and for your community of the following alternatives (open-ended question):

	Risks	Benefits
Grow a few (introduced) commercial varieties that provide high income		
Grow a few local varieties		
Grow a combination of local and introduced commercial varieties		

8. CURRICULUM VITAE

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